Subsistence of Neolithic Pearl River Estuary Area, South China

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Abstract

The thesis is a study of the subsistence of the Pearl River Estuary (abbreviated as PRE) area in the southernmost Mainland China during the Neolithic (6,000-3,500 BP).

Despite poor preservation of organic subsistence material in this (sub) tropical and coastal area, important Neolithic sites, artifacts and faunal remains have been unearthed in recent years. Some new methods such as isotopic analysis have been employed. To make good use of the data and make up for the geographic disadvantage in preservation, it is attempted in this thesis to summarize and interpret available archaeological material, coupled with site catchment analysis, to address the subsistence.

First, the subsistence of the Early Neolithic of Lingnan is discussed, and used as a fore-scene to suggest the PRE subsistence appearing later in the Middle Neolithic. Second, ecofact, artifact and site data of the PRE (Middle/Late Neolithic) are synthesized, serving as a solid but limited factual foundation for assessing the subsistence. Finally, site catchment analysis is used to enhance or mutually verify with the empirical material, or to provide new lines of reference. Ecological data are integrated wherever possible.

The conclusion is that the Neolithic subsistence of the PRE would have been generally foraging based, particularly fishing and mollusk collecting. However, farming would have been playing more and more important role, especially during the Late Phase of the Late Neolithic (4,300-3,500 BP), with probable economic and political interactions with rice farming cultures, increase of sedentism, exchange and population, and of social competition with other groups in South China.

The PRE case tends to confirm to the understanding that even though farming skill was mastered, if foraging resources were rich and handy, foraging would have prevailed and farming might have been maintained to the minimum just as a supplement.

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Chapter 1. Background

1.1 Introduction

In China, comprehensive archaeological study of subsistence is rare, although brief sketches of it are available from excavation reports and research monographs. Since the 1990s, the situation has improved and good subsistence research is occurring (Zhang 1999). Although important sites have been excavated, however, detailed or thematic subsistence study is still not easy to find, particularly in South China or Lingnan, where the preservation conditions for organic remains, which are significant for subsistence studies, are usually poorer than in Middle or North China.

Nonetheless, South China is widely considered a possible center of the world origin of rice (and perhaps of tubers), thanks to the ideal environments for those species to flourish, both as wild and as domesticated crop (Sauer 1952). Recent researches (Yuan 1996; Yingde City Museum 1999a) rate highly the probability that cultivated rice appeared around 10,000 years ago in this area. It has also been argued that the regional development of South China was more advanced than that seen in North or Middle China in the Early Neolithic (Huang 1995), at a time when agriculture was just emerging.

Intriguingly, South China, later in the Neolithic (*circa* 7,000-3,500 BP), seems to have lagged behind Middle and North China, particularly in terms of the development of agriculture (Huang 1995). Why would Lingnan have slowed down in the course of early farming developments, while the environment appears to have changed little?

An examination of its subsistence can shed light on the question. First, the early development of agriculture was in essence a transformation process from one mode of subsistence (foraging) to another (farming). And second, it is assumed that subsistence is a fundamental part of any society, and that therefore a key to understanding a particular society is in an understanding of its subsistence. Accordingly, this subsistence study aims to aid in the comprehension of the sluggish farming development of Lingnan during the Middle and Late Neolithic. It also intends to call for more research attention to be paid to the study of prehistoric subsistence in China.

That the study will cover only the Pearl River Estuary (PRE) area, rather than Lingnan in entirety, is due in small part to the length of the thesis, and in large part to the fact that the PRE contains the largest number of sites and of the best-dug sites in the Lingnan region from the Middle and Late Neolithic.

The conclusions of this study corroborate, and are corroborated by, an existing body of scholarship about prehistoric Southeast Asia: Southeast Asia is ecologically similar to Lingnan (Li 1983) and linked to it culturally (Higham 1996a). More particularly, the fact that Neolithic PRE was linked to the farming cultures in northern Guangdong and Middle China is comparable in a substantial sense to the linkage between Southeast Asia and Middle/South China. For instance, if rice-farming cultures, or farmers from China, reached Southeast Asia by 3,000 BC (Higham 1996b: 309), it is very likely that similar influences had reached the PRE much earlier, albeit with different consequence.

These are the reasons why this thesis attempts to assess the PRE Neolithic subsistence, in spite of the shortage of faunal or floral remains. The supply in which organic matter is available notwithstanding, a diversity of materials is essential for achieving a comprehensive study, especially for such early periods as the Neolithic. The combination of unearthed evidence and analytical results in the thesis is hence a good compensation for the shortcoming at present.

1.2 Ecological Setting

The PRE area is located at the confluence of the Pearl River and the South China Sea. At the southernmost fringe of Mainland China, it is entirely south of the Tropic of Cancer, approximately between 22° - 23° latitude, and 113° - 114°30' longitude (Zhong 1992). It consists of part of southern Guangdong province, all of Hong Kong and Macau. In terms of topography the PRE area includes the Pearl River estuary, shorelines, peninsulas and islands, with mainly hilly terrain punctuated by small bays and plains.

It also constitutes part of the southern half of the Lingnan region. Lingnan, literally "south of the mountains", is enclosed by the Nanling Mountains to the north, with peaks of up to 1,902 m in altitude, and is open to the South China Sea to the south (Wang 1961: 145). This region has been defined in both broad and narrow terms. In the narrow sense, Lingnan refers to Guangdong, Guangxi provinces, and Hong Kong, Macau regions (e.g., Zhang and Huang 1995:1). In the broad sense, it also includes sections of Fujian, the whole Hainan province, northern Vietnam, and even Taiwan (Xu and Peel 1991: 130-131). For the purposes of this paper, I use the term in its narrow sense.

Defined as belonging to the southernmost part of the south subtropical climate zone of South China, the PRE area is more tropical than subtropical in many aspects (Xu 1956:27; Lu 1990: 308-320). Basically, the region is humid and warm. Cold winter winds from the north are substantially blocked by the Nanling Mountains (Zeng 1994: 259-279). The rainy season is from

April to October, and the dry season is from November to March. The summer season is six months or longer, with an average temperature of about 22°C. Basically there is no winter, which is usually defined as having an average temperature of about 10°C (Lu 1990:50). January is the coldest month, with an average temperature of about 14°C, and July is the hottest month, averaging over 28°C in temperature. Autumn doesn't usually arrive until October, when the monthly average temperature is still 24°C. So the PRE has rich heat resources, suitable for thermophilic organisms (Lu 1990:53-63, 255, 262).

The vegetation is generally evergreen. Plants grow quickly year-round. Three crops of grain and more than eight crops of vegetables can be grown in a year. The variety of tropical fruits and crops is considerably greater than in other parts of China (Xu and Peel 1991: 135). There are three main forest types in the region: evergreen sclerophyllous broad-leaved forest, rain forest, and littoral forest (Wang 1961: 129). The latter two types are more common in the PRE area than in other areas of Lingnan. The rain forest is found mainly in warm and humid valleys or lowlands (Wang 1961: 130, 155). The littoral forest, where mangrove is the most common forest type, is a segment of the rain forest. As such, it is distributed along the mainland and island warm water saline shores and extends inland along streams and rivers where the water is brackish. (Wang 1961: 129-130, 167, 236). It has been claimed that the forest density was much greater in the Neolithic Age than it is today (ibid. : 129).

The terrain slopes considerably from north to south, thus waters also run in the same direction, flowing into the sea. Three major river tributaries come from hilly areas of Guangxi, northern and eastern Guangdong, respectively, and converge in central Guangdong, forming the Pearl River that flows into the sea. It is the longest river in South China, with a length of 2129 km, and the fifth largest river in the country (Lu 1990:1-4; Xu 1956: 9-14). Today, only about 12 percent of the land of Lingnan is arable, mainly distributed over a terrain of river deltas, basins or valleys; and some 70 percent of the cultivated land is devoted to rice paddies (Xu and Peel 1991: 135-136; Xu 1956: 69-94). In addition, the coast of South China is unique, the so-termed "South China Coast Type", has both deep inland bays and distant off-shore islands, exceptionally convenient for inland and coastal or sea transportation or fishery (Zeng 1957: 88-90).

The PRE is famous in China for its tropical monsoon climate, located in a crucial position in the East Asian Monsoon Area, which consists of three series of annual monsoons: the southwesterly and southeasterly in summer, and the northeasterly ones in winter. In other words, the winter monsoons (northerly) prevail from October to April; and in the summer (southerly), they dominate from June to August; May and September are the transitional periods respectively.

The southwesterly monsoons are largely contemporary with the rainy seasons (Lu 1990: 33, 256-266).

The leading ecological features of South China are also its advantages: rich light, heat and water resources. The rich light or sun radiation, heat, and precipitation are extremely favorable for agriculture (Lu 1990: 325-327). However, typhoons, floods, droughts, acidic soils, limited flat lands and even rich foraging resources can hinder agriculture, although these disadvantages should not be considered fatal to agriculture, especially when the many advantages are taken into consideration.

South China has the most precipitation in the country. The PRE has a yearly average precipitation of about 2200mm (Lu 1990: 68-74). However, along the coast and on the offshore islands, there is less precipitation than on the mainland areas. In the meantime, evaporation on the offshore areas is heavier than on the mainland areas. These factors combined mean that the offshore islands tend to have an inadequate fresh water supply (Lu 1990: 228-231).

Likewise, the area is also affected by frequent typhoons and either drought or flood periods (Lu 1990: Introduction, 254). Typhoons can occur from May to November in the PRE, but most occur from July to October, with the peak in August (Lu 1990: 106-109).

During the dry season crops can suffer from drought, and in the wet season floods and typhoons can be harmful to agriculture (Xu 1956: 20-26; Xu and Peel 1991: 135), except in the inland areas of northern Lingnan (Zeng 1957: 20). The major type of soil is red (laterite), which is heavily leached, acidic and low in humus (Xu 1956: 38; Wang 1961: 130).

The ecology of the PRE in the Neolithic may have been very similar to that of today, except that the area would have been more wooded and the topography may have been somewhat different due to erosion and other factors (Atherton and Burnett 1986). Cultural influences are also detected; for instance, in early historical times, some acidic lands were developed into paddy fields by adding lime (ZUGD 1988: 309-316).

1.3 Archaeology

The archaeology of the PRE area began in the 1920s, but it is only since the 1970s that major Neolithic discoveries have been made (Su 1994: 464-491; GCRT 1993; Yeung and Li 1995; Li 1996). The Neolithic sites found in Lingnan, including the PRE, have most commonly been divided into Early, Middle and Late periods, with subdivisions within each period. The Early Neolithic (some subdivisions sometimes called Mesolithic) dates to about 10,000-7,000 BP; its beginning is defined with the appearance of pottery and polished stone tools. Sites of this period have not been found in the PRE area, but evidence has been found in inland areas of northern Guangdong and Guangxi provinces. Major sites of this period are located in caves, shell middens and tablelands along rivers.

The PRE Neolithic began with the Middle Neolithic, dating between about 6,000 and 5,000 BP, characterised with the appearance of painted pottery and the bark cloth beater. The Late Neolithic spans from 5,000 to 3,500 BP; its beginning is defined by the appearance of the geometric stamped pottery and its ending with the occurrence of bronze artefacts. The latter two periods are not present in cave sites of Lingnan. In the PRE area Middle and Late Neolithic evidence consists primarily of sand dune sites around coastal bays, while the Neolithic sites in the Pearl River Delta are mainly shell midden sites. The research presented in this thesis will focus on the subsistence of the Middle and Late Neolithic periods (6,000-3,500 BP) (Table 1).

Since the Middle Neolithic (6,000 BP) is the earliest period that sites have been revealed in the PRE area, the first question that should be asked is: "where did the Middle Neolithic people come from?" This is a crucial question as it pertains to the nature and characteristics of the subsistence of the area. This will be examined in more details in a later section. According to substantial ecological and archaeological evidence, it is reasonable to say that at least some of the the people came from adjacent Mainland China, most likely from the Guangdong or Guangxi provinces in the southernmost coast of the mainland (in fact, part of the PRE area lies within Guangdong province).

Before 6,000 BP, up to more than 10,000 BP, the ecological history shows that the sea level of this area was much lower than present levels. For example, it has been reported that around 13,700 BP the sea level was 131m below that of today, although it was gradually rising (Li *et al.* 1991: 65). However, the sea level was still some 20m below that of today at 8,000 BP, and some 13m below that of today at 7,500 BP in the Pearl River Delta area, according to pollen analyses (Li *et al.* 1991: 67). It was around 6,000 BP that the sea reached today's higher levels (Fig. 1). This correlates with the fact that no materials dating earlier than 6,000 BP have been found in the PRE area. In other words, the likelihood exists that earlier sites may have been situated along now submerged coastlines.

At about 6,000 BP, nonetheless, sites containing painted pottery abruptly appeared in the area. Where were the people of these sites from? Would they have come from the adjacent mainland of China, or distant islands or mainland Asia or beyond? The answer seems obvious. It was probably not difficult at that time for people to travel down the rivers from the mainland to this area via boat. The canoe or some kind of watercraft probably existed at or before 6,000 BP in the PRE area, as has been suggested by the evidence of canoeing found in southeast China before 6,000 BP. Wooden oars and pottery boats, more than 7,000 years old, have been unearthed from the Hemudu site in Zhejiang province in the Lower Yangzi River Valley (Liu and Yao 1993; ZRC 1978). It would not be surprising that boats of some kind were used in the PRE area at least 6,000 years ago, otherwise the people of the PRE in the Neolithic would have had no way to travel between the mainland and the islands, or from one island to another. There still remains the possibility, however, that some of the PRE people of the Middle Neolithic might have come from coastlines that were located much further into today's sea, and are now submerged.

Furthermore, sites earlier than 6,000 BP (i.e., the Early Neolithic) have been found in adjacent northern Guangdong and Guangxi as mentioned above. More important, similarities and connections are plentiful between these sites and those found in the PRE area in the Middle Neolithic. These points will be elaborated in the following text.

Chapter 2. Theories and Methods

The examination of Neolithic subsistence is by no means an easy task, particularly for an area such as the PRE where very little direct subsistence evidence such as the faunal or floral remains have been found. On the other hand, in theory subsistence cannot be looked at alone. That is, the subsistence must be understood by linking it with other parts of a society and its environment such as ecology, settlements and social dynamics. A good understanding of subsistence should also consider historical factors. To learn the subsistence of the Middle Neolithic, for instance, one ought to look into that of the Early Neolithic as well as that of later, even historical, periods if possible. Accordingly, it is believed that the dynamics of a prehistoric subsistence involved interwoven historical and environmental developments. Thus its study calls for historical, social and ecological perspectives. The evidence thus far suggests that at least part of the PRE people were probably descendants of early inland agriculturists, or were closely connected with agriculturalists and the consideration of their subsistence should not thus be confined within an exclusive "foraging" conception or category. Rather, the assessment of their subsistence needs to involve the research on inland agricultural early developments. Since the PRE people and their forerunners of the Neolithic lived during a time (10,000 – 3,500 BP) when agriculture was in its initial and early stages. These issues also have to be taken into account.

2.1 Initial and Continuous Agricultural Stages

Origins of agriculture and related issues have been widely discussed. Discussion thus far has mainly focused on the origin and spread of agriculture (e.g., Sauer 1952; Harris 1996), although increasing attention is being put into the exploration of the later stages of farming. The origin and early developments of agriculture, or the transformations from foraging to farming are comprised of a minimum of two stages: 1. The initial stage, and 2. The continuous stage. "Initial" meaning the stage when the techniques of plant cultivation were invented or adopted by a community or a group of people. "Continuous" refers to the processes occurring after agriculture was invented or adopted by a community.

Distinguishing between these two stages should help clarify some major theoretical issues concerning the development of agriculture. For example, the places where agriculture originated may not necessarily be the same as where it was maintained or further developed. Also, domesticates of the first stage could be different from those in the second stage (Hayden 1992); and the reasons why farming was initially practiced may not be the same as why it continued to be practiced. For instance, agricultural products were more in demand in the Late Neolithic of the PRE area than before, probably due to political competition; this might not have been the case when agriculture was first invented in northern Lingnan in the Early Neolithic. The continuation of farming, like the origin of it, likely involved a number of factors or reasons, which would be of both ecological and social nature. For instance, in Japan, the promoting and restricting factors for the change from foraging to agriculture have "both ecological and cultural components" (Sasaki 1979: 14).

Other research has shown that farming is not necessarily an irreversible process. Intensive farming could revert back to extensive farming (Netting 1993: 261-270), and farming could revert to foraging (Henry 1989). In some cases foraging continues long after farming has been adopted (Flannery 1973; Price and Gebauer 1992; Gebauer and Price 1992; Kent 1989). The continuous stage appears to be more critical than the origin stage in light of the interaction between foraging and farming. In all likelihood, the process entails long-term dynamics between the two. The degree of acceptance of farming by foragers could be related to technology or to the maintenance of a minimum of farming for limited purposes such as feasting (Blake *et al.* 1992: 134-135). It can also be accepted epiphenomenonally (e.g., Hayden 1992), or omni-culturally.

In past decades, the transition from foraging to farming has been viewed in different ways. Many hypotheses have been proposed to account for this transition, including the oasis hypothesis (Childe 1956), the nuclear zone hypothesis (Braidwood 1958), equilibrium/population pressure (Binford 1968; Cohen 1977), marginal zone (Binford 1968; Flannery 1969, 1973), human-plant symbiosis (Rindos 1984), or demands for social prestige/Big Men (Clark and Blake 1994; Hayden 1992). In the 1930-50s, farming was thought to be a welcome invention, but since the 1960s until recently, it has been redefined as a hard and harsh undertaking (Service 1966). However, more recent research suggests that farming is not necessarily harder work than foraging (Wood 1998), at least during a slash-and-burn stage of extensive land use (Netting 1993: 106-107).

All these ideas have revealed the complex nature of agricultural origin and early developments, and deepened ones understanding of the interplay between foraging and farming. The evidence provided in this thesis correlates with the following theory: During its extensive stage (Sahlins 1972: 42), agriculture was probably not necessarily more laborious than foraging, although in its intensive stage, farming became more physically demanding than foraging. Therefore, foragers or extensive farmers would have probably been reluctant of becoming or returning to intensive farming (Netting 1993: 106-107, 261-294). In (sub) tropical Neolithic PRE, if farming did exist, it would have most likely been extensive. This would have been of great antiquity as seen in many parts of Southeast Asia (Hutterer 1976), while intensive farming would have become common only at a later time.

According to evidence presented here, this paper contends that the Neolithic PRE was probably involved in the second continuous stage, while a major part of the Early Neolithic of the Lingnan region can be assigned to the first "initial" stage. The Lingnan people dwelling in caves in the Early Neolithic likely developed plant cultivation, since they had long-term familiarity with plants. By the same token, they also maintained long-term contact with animals and probably domesticated pigs. In the Middle and Late Neolithic, or the continuous stage, factors such as competition for prestige, exchange with farmers and population pressure would have played increasingly important roles in the agricultural developments of the PRE area. Since no Early Neolithic evidence has been found in the PRE area, my discussion will focus on the continuous stage.

2.2 Agricultural Consolidation and Maintenance

The continuous stage shows the processes of agricultural developments, in the most simplified sense, as either consolidation or maintenance. Hence the term "consolidation" will be used to refer to a process in which agriculture tends to gain increasing importance or dominance, and becomes a staple in a community in a relatively shorter period of time. Judging from many cases and for the convenience of comparison, I would use an estimate of 1,000 years as the maximum limit for the completion of this process. On the other hand, in a "maintenance" process, agriculture is in limited demand and bears no major importance on subsistence. This could endure for a rather lengthy period of time, possibly for over 1,000 years. Very specific natural and/or social reasons may be discerned for this kind of situation where agriculture did not become a staple of a community for more than 1,000 years after its birth or appearance, although in most cases, either process of agricultural development has ultimately led to the reliance on farming as staple.

Even though it is relatively shorter than the maintenance process, the consolidation process of agriculture as defined above can still be as long as several hundred years. For example, it took 500 years from its beginning to the full adoption of farming in Southern Scandinavia (Price and Gebauer 1992). Maize appeared 4,700 years ago in Mesoamerica but it did not become a staple until 3,500 BP (Matson and Dohm 1994). In coastal Chiapas, early complex sedentary communities were based on foraging, and they consumed small amount of maize for about 700 years after this cultigen was first introduced, before it became a staple (Blake *et al.* 1992).

Early agricultural developments of the maintenance process that take more than 1,000 years are clearly present in Southeast Asia and Japan. In Japan, peas were among the earliest cultigens. Barley and dry-land rice appeared in Late Jomon, while wet rice was introduced during the Final Jomon. It took even longer (about 5,000 years) for the Japanese agricultural pattern to become fully established after the initial appearance of domesticates (Pearson 1992: 68). This transition in Southeast Asia could have been characterized by early agricultural developments and late survival of a foraging based economy for as long as a few thousand years (Hutterer 1976: 225-226). The PRE case appears to be very similar to the Southeast Asian case as will be discussed later.

2.3 Ecological and Social Perspectives

Due to the complex nature of agricultural origin and early developments, the subsistence of the PRE area cannot be completely understood by a simple examination of its faunal or floral remains. It is also necessary to probe into other factors such as the settlement characteristics, cultural traditions, social interaction and environmental properties or developments. The complexity of the problem has led to the employment of both an ecological and a social approach. In theory, the ecological and social factors should be seen as being of equal importance in order to understand the Neolithic subsistence of the area. The study of the ecological evidence is indispensable (Roosevelt 1991: 5), especially in Neolithic archaeology where aspects of human social life, such as motivation, cannot be approached directly, and are very hard to reconstruct. The ecological conditions are believed to have imposed a combination of differing constraints and advantages for the development of the PRE (Lingnan) Neolithic. Rich light sources, high temperature, plentiful rainwater, etc, would have been strong merits for agricultural developments. However, other environmental elements such as limited arable land, circumscribed environments, rich coastal foraging resources, acid soils and typhoons would have been disadvantageous. At the same time, internal and external social factors should have also played critical roles. For instance, intra- and inter- group political evolutionary processes and inter-regional exchange and interactions, particularly with more advanced farmers, would also have significantly influenced the development of the PRE area. Neither social nor ecological aspects alone can account for the development. In addition, the developments of subsistence may not have necessarily corresponded to ecological fitness or rationality, and thus cannot be explained by the efficiency / cost ratio. For example, the production of the big *yue* ceremonial axes at the Yung Long site may have been limited to political purposes rather than for exchange or economic purposes (AMO

1997); it may not have led either to improvements in the economy. Rather, the "aggrandisers" might have employed this kind of ceremonial tool to compete for their own interests or prestige (Clark and Blake 1994; GCRT 1993: 186-195).

2.4 Methods

In addition to what has been addressed above, the study of the subsistence of the PRE area is also constrained by available archaeological data as well as related scientific results such as the accuracy of dating. For instance, the limited faunal data found in the area (due to poor preservation conditions, etc.) make it hard to conduct faunal studies such as the MNI or NISP. Also, measurements of most of the artifactual data are incomplete, and the quantitative manipulation of them is limited to a minimum. Thus, the methods are trimmed to fit the local situations, as the theories are channeled to adapt to local context. Data are gathered mainly from published materials, with a small amount resulting from unpublished ones, some of from personal fieldwork.

As discussed earlier, the Neolithic subsistence was closely linked to historical and ecological developments. An archaeological synthesis of the forerunners of the PRE people is carried out. Therefore, in order to better grasp the origin of the PRE subsistence in the Middle and Late Neolithic periods, it is important to trace the early agricultural developments in northern Lingnan and other major parts of China during the Early Neolithic.

Related ecological dynamics such as sea level changes are examined, and an environmental reconstruction is attempted in this thesis, with necessary historical comparisons. In terms of the subsistence of the PRE Middle and Late Neolithic periods, focus is placed on changes of ecofacts, artifacts, site functions, and site distributions and catchment analysis. Scientific research results regarding the subsistence such as those of pollen, phytolith and isotopic profiles are also sorted out.

Site catchment analysis will be carried out as a supplement to above-mentioned undertaking in determining subsistence. This will be done because the empirical ecofact, artifact and site data are fragmentary, and they can only serve as a limited though basic factual foundation for the study. The catchment analysis can provide a rough picture of the resource potentials of the sites in the area, and suggest changes of land use through time. It can also stand as an independent line of reference for the reconstruction of the subsistence. It is particularly useful when site catchment analysis is adapted to local ecological and economic situations and conditions.

Using empirical and analytical data, reconstruction will be conducted for the subsistence of the (Middle and Late Neolithic) PRE, by way of site location and distribution assessment, ethnographic analogy, and the examination of food types and food processing methods.

The social impacts from exchange between the PRE area and other areas, and intrusion of advanced intensive rice farming cultures into the PRE area will also be inspected where necessary.

In short, the syntheses, interpretations and analyses will be guided by both ecological and social perspectives, as well as by theoretical and field research on the early development of agriculture --- vital element in the Neolithic --- and will be carried out within the historical context of the PRE area.

Chapter 3. Early Neolithic Subsistence Base

As mentioned in Chapter 1, forerunners of the PRE people would have most likely originated from adjacent inland northern Guangdong and Guangxi provinces.

Before they came to the PRE area, the northern Guangdong or Guangxi people were living in a subtropical area, i.e., northern Lingnan, which is widely accepted to be the probable point of agricultural origin, particularly for rice and tuber crops (e.g. Pei 1998; Zhang 2000; Harris 1972). Recent archaeological findings from the two provinces indicate with high credibility that people in this region would have learned how to cultivate plants (i.e., rice) some 10,000-8,000 years ago, if not earlier. In order to provide clarification, a brief review of the origin and early developments of agriculture in China including the Lingnan area is presented below.

3.1 Early Agricultural Developments in North and Middle China

As solid archaeological data have showed, at almost the same time as early plant cultivation (around 8,000 BP), very early millet farming (dryland agriculture) was flourishing in the area of the Yellow River Valley of North China; and some of the earliest rice farming (wetland agriculture) was occurring in the Middle Yangzi River Valley of Middle China (regarded as part of South China in some situations). Syntheses in English are available (e.g., Underhill 1997; Lu 1999). The former is represented by the Cishan culture (MCA and MCA 1981), Peiligang culture (MCA and MCA 1978), and the sites of Jiahu (Zhang 1999) and Dadiwan (Dadiwan Excavation Group 1982). The Nanzhuangtou site is the earliest Neolithic site in North China dated more than 10,000 BP (Ren 1995). For the latter (wetland agriculture), representative cultures are the Pengtoushan of 9,000 – 8,000 BP (HIA and Lixian Museum 1990; He 1995b), Bashidang culture of 8,000 BP or earlier, and the sites of Fenshanbao, Zaoshi, Hujiawuchang and Chengbeixi (Pei 1998). Since 7,000 BP, sophisticated and flourishing rice farming can be best exemplified by the well-known Hemudu culture in the Lower Yangzi River Valley (Liu and Yao 1993; ZRC 1978; Smith 1995).

Many scholars have argued that these farming cultures (8,000 BP), except for the Nanzhuangtou site, were at a relatively advanced stage in early agricultural development (e.g. Yan 1992). These theories reflect that there should have been an incipient stage of agricultural origin prior to this stage. Millet or rice remains are widely and abundantly found in the sites of this incipient stage. For instance, numerous carbonized millet seeds were found at the Cishan site. It has been suggested that the carbonized seeds, if converted into fresh millet, would amount to 50,000 kg (Yan 1992). Domesticated pigs and dogs of 10,000 – 8,000 BP were also reported at

Nanzhuangtou (Yuan *et al.* 1991). In addition, more than 10,000 rice grains, identified as a domesticated species, have been discovered at Bashidang (Pei 1998).

In sum, since 8,000 BP early dryland farming occurred in the Yellow River Valley and paddy farming in the Yangzi River Valley, with millet or rice as major crops. However, they were not the earliest types of farming, indicating that the original or incipient stage of agriculture in these two regions should have had an earlier date. For the purposes of this thesis, it would be prudent to examine the early agricultural developments in the Lingnan region.

3.2 Early Developments and Emergence of Agriculture in Lingnan

Research indicates that more than 100 Early Holocene sites have been located in the Lingnan region. A quarter of these sites have been excavated, although just a few contain relatively clear stratigraphy. It has been suggested that the period of these sites spans from 14,000 to 7,000 BP (e.g., Jiao 1994). This period includes the Early Neolithic of Lingnan, usually dated from 10,000 to 7,000 BP (Jiao 1994). Although the rough time framework is acceptable, a fine chronology of this region is still wanting. This is mainly due to the dating problems in the inland limestone area, where the majority of the Early Holocene sites (as cave sites) are found (Ren 1995). This limestone area is usually dated a few thousand years older than it had been in the past, with the exception of the wood samples (Yuan 1993). From 10,000 BP onward, a number of riverine shell midden, tableland sites, accompanied by the appearance of pottery and completely polished stone tools have appeared. This coincides with the beginning of the Early Neolithic of the PRE region. Some scholars (e.g., Jiao 1994) claim that coastal shell midden sites appeared later (around 8,000-7,000 BP), suggesting a gradual population movement from northern inland to the southern coast. In terms of Early Neolithic sites, the major ones in Guangdong are located in the north or northwest areas, including Dushizi, Huangyandong, Qingtang and Niulandong (Qiu *et al.* 1982; Yingde City Museum *et al.* 1999a). In Guangxi the representative Early Neolithic sites include Zengpiyan, Liyuzhui, Baozitou, Bailiandong and Miaoyan (Zhang 1990; Yingde City Museum *et al.* 1999b).

Major artifacts include chipped pebble tools, polished stone tools, pottery vessels and bone/antler tools. Judging from the available faunal/floral remains and tool assemblages, the evidence points to a foraging based subsistence for the Lingnan Early Neolithic. However, a number of important phenomena merit attention.

1. A number of new items appeared in the Early Neolithic about 10,000 – 9,000 BP, including pottery and wholly polished stone celts along with new site types (riverine

shell midden and table-land sites). At that time the people would have lived not only in caves, but also in a much larger territory. This suggests changes in subsistence and settlement strategies.

2. Pigs appear to have been domesticated. Domesticated pigs have been unearthed from the Zengpiyan cave site dating at least 8,000 years old (Ren 1995). Samples of 67 pigs have been found, mostly 1-2 years old. These samples were found to have small and weak incisors and canines, with an absence of worn molars, all pointing to domestication (Li and Han 1978). The domesticated pig is most often linked to plant domestication, although this is not an absolute correlation.
3. The exchange network appears to have expanded. Closer connections between Guangdong and neighboring areas were apparently developed and maintained. For example, the Early Neolithic stone tools of Guangdong, Guangxi of Lingnan and Hunan of Middle Yangzi River Valley are mostly made of pebbles from the macro pebble tool tradition, Late Paleolithic, of South China. These tools were primarily fabricated by a unifacial percussion method. They also share resemblance to some stone tool forms such as the chopper, scraper and perforated stone (planting-stick weight), indicating communication with their fabricators (Qiu 1995). Also, it is suggested that in the early Neolithic period, the relation between the assemblages in Dao County of Hunan and those of Guangdong were even closer than that between Guangxi and Guangdong. This suggests that northern Guangdong would have had a closer relationship with the Middle Yangzi River Valley than with Guangxi (Qiu 1995). However, a little later, the Zengpiyan assemblage of Guangxi and the Huangyandong - Dushizi assemblages of Guangdong have many similarities. It seems that an exchange network may have existed as early as the Mesolithic (Qiu 1995). This communication would have facilitated the development of Lingnan.
4. It should also be noted that the Early Neolithic cave sites of Lingnan are primarily situated in northern Guangdong or northern Guangxi, which are both close and accessible via river to the Middle Yangzi River Valley, an early developed rice farming center. This geographic proximity implies likely communication between groups. That is likely the reason why the Dao County assemblages of the Yangzi River Valley could have shared common characteristics with those of Guangdong in Early Neolithic as mentioned. Recent excavations at the Dingshishan site of Guangxi reveal that some pootery forms have some similarities with those of the Pengtoushan site (Fu *et al.* 1998).

Some scholars have also argued that the prehistoric Lingnan would have reached advanced stages of cultural development faster than many parts of Southeast Asia (e.g., Gorman 1970).

This material suggests that new subsistence practices may have come into being since some 10,000 years ago. Would it have been due to the emergence of agriculture? Although important, the above data cannot answer this question directly. Encouragingly, more direct evidence regarding the origin of agriculture in Lingnan has emerged more recently.

The most important example would be the Niulandong lime stone cave site where rice phytolith has been found (Yingde City Museum *et al.* 1999a). The site is located at the Yingde city of northern inland Guangdong, with marsh lands and a river 25m wide nearby, which runs into the North River, a tributary of the Pearl River. It was excavated once in 1996 and again in 1998 by archaeologists from Zhongshan University, Institute of Cultural Relics and Archaeology of Guangdong and the Yingde City Museum. An area of $51m^2$ was dug. The excavators argue that it is an Early Holocene site, with assemblages from Upper Paleolithic to Early Neolithic, dated from 12,000 to 8,000 BP. The assemblages have been divided into three stages: 1. Late Upper Paleolithic (12,000-11,000 BP); 2. Mesolithic (11,000-10,000); 3. Early Neolithic (10,000-8,000) (Yingde City Museum *et al.* 1999a: 96-108). I think the chronology provides credible though perhaps somehwat rough outline, particularly the of last phase, with 22 consistent C14 dates and assemblage comparisons with those of nearby similar sites.

According to over 1,000 stone artifacts found, the site is said to belong to the above-mentioned pebble tool tradition of South China. Also found were two dozen tools made of animal tooth, antler, bone and shell. Faunal remains are also plentiful, primarily artiodactyl herbivores (like the deer *Pseudaxis sp.*), carnivores, hydrophilous or aquatic animals like the otter (*Lutra sp.*), fish and shellfish. Their appearance suggests a tropical/subtropical environment with flourishing woods, grasses and fresh water. It is also notable that pottery and weight stone were also found (Yingde City Museum *et al.* 1999a: 94-95, 102).

Of particular interest , is the finding of cultivated rice some 11,000-8,000 BP, i.e., belonging to Mesolithic and Early Neolithic by the excavators. Thirty-one samples were used for phytolith and pollen analyses by an expert from the Institute of Cultural Relics and Archaeology of Hunan Province. Seven out of the 31 samples contain 24 pieces of rice phytolith and two kinds of rice phytolith were found. One is the two-peaked-shape phytolith, the other is the fan-shape phytolith. The research of the phytolith indicates that the rice of this site is neither long-grained nor round-grained rice. In other words, the rice is of the type found prior to the stage of long- and round-grained rice differentiation. In short, it was declared to be primeval cultivated rice (Zhang 2000). The finding also indicates that the rice of this site is more advanced than that of the Yuchan site, mentioned below (Yingde City Museum *et al.* 1999a: 108-109, 113-122; Yingde City Museum *et al.* 1999b: 382-389).

Since the phytolith sample from Niulandong is small, further evidence is certainly needed to confrim the rice cultivation origin in Lingnan. However, if one compares it to some other major sites that show evidence of rice cultivation nearby, it would not be surprising if the evidence shows that rice cultivation originated some 10,000 years ago in Lingnan.

The first mentionable site is the Yuchan cave located in the southern fringe of Hunan province, at the north side of the Nanling Mountains. This site is very close to Niulandong and Zengpiyan sites at the southern side of the Nanling Mountains. It was excavated in 1993 and 1995 (Yuan 1996). The stone toolkit found there belongs to the South China pebble tool tradition, similar to those found in Lingnan. Pottery is also present, with walls 2 cm thick also as found in Lingnan. The most significant finding is the discovery of a couple of rice husks in a calcareous concretion, including wild and cultivated species (Zhang 2000). This is supported by the phytolith analysis that suggests the presence of a primeval type of rice cultivation 12,000-10,000 years ago, dated by the AMS and conventional C14 (Zhang 2000; Yuan 1996). This claims that the cultivated rice of the Niulandong and Yuchan some 10,000 BP or earlier was the earliest primeval cultivated rice discovered so far (Zhang 2000).

The second related site is the Diaotonghuan shelter located a mere 800 m to the west of the famous Xianrendong site, in northern Jiangxi province (Zhao 2000). Reports state that this site has abundant phytoliths of both wild rice and cultivated rice. The wild rice has been dated to zones G-F, Upper Paleolithic (14,000-12,000 BP) and the cultivated rice to zones E-B, Early Neolithic (12,000-8,000 BP), though the details of the dating results have not yet been made public. This research shows that cultivated rice phytoliths increased with time, while the wild rice phytoliths decreased, suggesting the development of rice cultivation. However, both phytoliths existed during the same period in the Early Neolithic, indicating that rice collecting was not immediately replaced by rice cultivation, but that the two co-existed for a long time, with foraging as the base (Zhao 2000). In other words, rice cultivation might have originated long before a specialized rice cultivation system was established (Harris 1972). This may be exemplified by the Shixia Culture in the Late Neolithic in northern Guangdong.

The Xianrendong site is located in a limestone area south of the Yangzi River. Multidisciplinary research has been conducted on the Xianrendong cave site in 1993 and 1995 by experts from China and the US (MacNeish *et al.* 1998). The key achievements from this research are the clear partition of a pre-ceramic and a ceramic cultural layer, and the finding of phytoliths of wild and cultivated rice (Zhao 2000). Consistent with Diaotonghuan, it was dated 12,000-8,000 BP.

The Early Neolithic sites in Lingnan and nearby South China all had similar ecological properties that related to origin of rice cultivation. For instance, they were all located in the distribution area of wild rice, surrounded with abundant fresh water and faunal and floral resources. The limestone area location would have also played a role in determining the origin of rice cultivation, considering the likely significance of the neutralizing role of limestone to the acidic red soil in South China, found both today and in prehistoric times. In addition, all of the sites held some kind of artifacts that appear to be related to rice cultivation. For example, the weight stone could have been used as rice planting-stick weight, the perforated shell as harvesting tool, and the pestle/mortar as rice husking or grinding toolkit.

To summarize, the origin of paddy rice cultivation can be best exemplified by the several sites in Lingnan and nearby South China. Most of these sites contain evidence of cultivated rice suggested by phytolith analysis and rice remains, and all of them contain ecological and cultural assets that are, in theory, related to rice cultivation. In this way, one can make an optimistic speculation and hypothesize that rice cultivation emerged in areas around the Nanling Mountains, including part of Guangdong, Jiangxi, Hunan and possibly Guangxi. Although more research would help support this hypothesis, it can be put forth that rice cultivation did originate some 10,000 years ago in Lingnan. Further research may tell a different story, but at this time evidence is strong.

3.3 Probable Subsistence Source of Neolithic PRE

Judging from the evidence on rice origin, fauna, flora, artifacts and settlements, the Lingnan people were likely leading a broad spectrum subsistence with a base of foraging supplemental rice (possibly also tuber) cultivation prior to a shift to the coast (e.g., An 1981; Yan 1992; Tong 1989; Chen 1989; Zhu 1989; Su 1994). Rice would have been but one small source of food among many other collected or cultivated foods in the people's diet. These people should therefore have had skills and experience in hunting, fishing, mollusk collecting, plant exploitation and cultivation at the onset of their Pearl River Estuary settlement. For example, pollen research has detected 181 plant species in the Zengpiyan site, including edible, oil-bearing and medicinal plants (Yang 1992). Although no direct evidence suggests the cultivation of any of these plants, the people of that time were probably quite familiar with these plants growing in the immediate environment. If one considers the the appearance of domesticated pigs at the site, plus its approximation, culturally and geographically, to those sites showing evidence of rice cultivation, the possibility that the Zengpiyan people cultivated cannot be excluded. Suggested by the occurrence of rice cultivation, pig domestication, rich plant and faunal remains or pollens, burials and thick archaeological deposits at sites, the Early Neolithic people (circa 10,000-8,000 BP) would have established a relatively permanent, sedentary life particularly in the caves (Zhang 1990; Underhill 1997; Harris 1972). The appearance of early pottery might have also implied the enhancement of a sedentary lifestyle (Higham 1989: 60). Unfortunately, the technical and topical limitations of this thesis do not allow for an in-depth analysis of Early Neolithic subsistence, although further investigation would be merited at another time. The key points of this thesis up to this point are: 1) soon before the beginning of the Middle Neolithic (6,000 BP) in the PRE, rice agriculture probably originated at the latest 8,000 years ago in areas around northern Guangdong and the Middle Yangzi River Valley; 2) the settlement was relatively sedentary for a long period of time; 3) the subsistence was likely broadly based on foraging. Plus probable contact with rice farmers in the Middle Yangzi River Valley, the Middle Neolithic culture of PRE at the beginning would have been more advanced than previously believed.

Chapter 4. Subsistence of Stage One-Middle Neolithic

The examination of subsistence of the PRE in the Neolithic must be based on sound chronology. The periodization of the PRE Neolithic has been subjected to heated debate in the past decade, and more than 10 different schemes have been proposed. Some treat the PRE chronology alone, while others consider it as part of the entire Pearl River Delta area chronology. Some divide the PRE Neolithic into four phases (Chau 1993), but some simply subsume it into two phases (Ou 1994). Furthermore, there are scattered discrepancies on the subdivisions as well as on the assemblage characteristics of each phase or sub-phase, as subsumed by different researchers. With an increase in discoveries and available scientific dating results in recent years, it is more appropriate to employ a finer chronology instead of the older, more basic one (e.g., Wu and Ye 1993). Therefore, I largely base my chronology on the four-phase chronology proposed by many scholars in more recent years (e.g., AMO 1999; Shang and Mao 1997). Please note, however, that I have altered some of the dates to ensure accuracy and have used "circa time" (Table 3). Although this chronology is imperfect due to complexities of the archaeological data found, and it may need to be updated and refined with new findings or research, for now it is adequate for a general reconstruction of the subsistence. The four phases will be dichotomized into two stages, the Middle and Late Neolithic Periods, both of which consisting respectively of early and late phases.

The First Stage, the Middle Neolithic, began with the appearance of painted or white pottery or bark cloth beaters, dating from 6,000 to 5,000 BP. The Second Stage, Late Neolithic, began with the appearance of the soft geometric stamped fine pottery and concluded with the appearance of bronze ware, dating from 5,000 to 3,500 BP. The periodization, time brackets, and characteristics of these stages are outlined in Table 2. This chapter deals with the subsistence of the First Stage, consisting of its Early and Late Phases.

4.1 Linkages with Early Neolithic

In examining subsistence of the Middle Neolithic of PRE, the first thing to consider should be its links with the Early Neolithic of Lingnan where at least some of the PRE people are assumed to have dispersed from.

As mentioned, both ecological and archaeological data have suggested that at least some of the PRE people were from the adjacent inland Guangdong and Guangxi provinces largely between 10,000 and 7,000 BP. In addition, the Middle Neolithic coastal PRE people belong to a time span between 6,000 and 5,000 BP. It should be noted that the archaeological data from 7,000 BP to 6,000 BP have not been clearly identified, though some clues have been found. However, many indirect or direct similarities can still be discerned between the inland Early Neolithic and the coastal Middle Neolithic.

Gu (1995) states that the first evidence is that the pebble tool tradition of the Early Neolithic was partially maintained. In the Middle Neolithic sites of the PRE, about 10% - 60% of tools are of the chipped pebble type (Peng *et al.* 1990; Wen and Chen 1990; Wu and Ye 1993). In addition, the method of alternating retouching was continued. It is also easy to find similarities among the polished stone tools between the Guangdong Early and PRE Middle Neolithic. For example, many trapezoid axes from both periods had polished edges only (Zhu 1989: 60). It is also worth noting that some geologists have suggested that half of the stone tools of prehistoric Hong Kong were not of local origin in terms of raw material, implying that they were imported, or brought in by their makers (e.g., Davis 1952: 192). For example, it is said that the type of sandstone used for some cutting tools is a rarely found in the Hong Kong territory (Davis 1952: 193). If this is correct, the stone tools found in Hong Kong were most likely from mainland Guangdong according to their resemblance with those found in the Pearl River Delta (Li 1996). However, some scholars argue that most of the Hong Kong prehistoric stone tools were probably made of local materials (Meacham 1978: 183-215). A conservative reasoning of these conflicting arguments is that some, if not many, of the stone tools of Neolithic Hong Kong may have been brought in from the mainland, perhaps indicating cultural continuity. Further research should be carried out on Hong Kong as well as the mainland coastal Middle Neolithic lithic assemblages before a firm answer can be obtained on this issue.

The pebble "picks", or so-called "oyster picks", have been found from the Early Neolithic Chingtang, Chenqiao sites of inland Guangdong as well as in many Middle Neolithic sites in the PRE area, such as Tung Wan (Au *et al.* 1990) and Sham Wan (Meacham 1978). Many of the bone, antler, shell tools of the coastal shell midden sites of the Middle Neolithic are also similar to those of the inland Early Neolithic sites of Guangdong.

Another similarity with the Early Neolithic is that the bulk of the pottery found is of the corded coarse type. For example, usually more than 80% of the pottery of the Middle Neolithic PRE are of the coarse corded pottery (Li 1996, 1997). In addition, the round bottom *fu* pot remained as the major ware (Zhu 1989).

Also interesting is that in the Pearl River Delta a Middle Neolithic shell midden site (Yankezhou) has been found with some two dozen burials (Gu and Li 1991). These burials are all flexed, similar to those found at the Zengpiyan and other Early Neolithic sites in Guangxi (Zhang 1990). Other Middle Neolithic burials sites seem to have been extended (Wu and Ye 1993). The late Neolithic burials found in the Pearl River Delta or PRE are also mainly extended ones (AMO 1997). This indicates that the main burials in Guangdong (i.e., the PRE and Pearl River Delta) appear to have been extended ones, and the appearance of the flexed burials in the Pearl River Delta would have been a result of influence from Guangxi, which might have occurred in the Middle Neolithic or earlier. Since very few other Middle Neolithic burials of such defined style have been found, a solid answer for this question has yet to be brought forth. A clear answer would call for more Middle Neolithic burials with good preservation in the Pearl River Delta as well as in the PRE. But other research has indicated that the shouldered celts, which were common in the Middle Neolithic of the PRE or Pearl River Delta, were present in the Early Neolithic in Guangxi, implying that the PRE in the Middle Neolithic might have received some inspirations from Guangxi of the Early Neolithic (Peng and Jiang 1991).

In short, much evidence indicates that the PRE people in the Middle Neolithic have inherited cultural properties from the Early Neolithic in northern inland Guangdong and eastern Guangxi. They may also have had connections with the descendants of the Early Neolithic dwellers of northern Guangdong or eastern Guangxi during the Middle Neolithic. At least some of the Early Neolithic people of these areas would have moved to the PRE around 8,000-6,000 BP, though some of them remained in their place of origin during the Middle even Late Neolithic. For example, at some sites, assemblages of 7,000-4,000 BP are present in inland Guangdong and Guangxi, suggesting that some of them did not move to the coast. The fact that some moved to the coast might be due to population pressure or to the lure of richer and more diverse coastal resources. A recent spore/pollen analysis has indicated in detail that the hot and wet climate of the Early Holocene in the Pearl River Delta was similar to that of today. It seems, however, that the climate between 6,500-5,000 BP became slightly cooler, becoming more warm and moist (Li *et al.* 1991: 1-22). This was at about the same time as when the PRE people had allegedly moved to the coast from the mainland inland. Although significant, at the moment it is difficult to judge whether this climate change has had any impact on the Lingnan Early Neolithic people to move to the coast.

To provide another perspective, it is also likely that part of the PRE Middle Neolithic population were people who had scattered along the coast toward the sea, because the sea level earlier than 6,000 BP was lower than that of 6,000 BP or that of today (Fig. 1). These Neolithic people may have moved to the same area as the Middle Neolithic PRE people and could have been assimilated into the population. This would have occurred with the sea level that was gradually rising to its present level. The sea levels have been consistent since 6,000 BP, when the Middle Neolithic Period of the PRE just began.

It follows that there is a possibility that some of the PRE people came from inland, and some of them would have withdrawn back from the coast. Before moving to the coast from the mainland around 6,000 years ago, they would have already had an established terrestrial lifestyle. They were probably not at first familiar with the coastal setting, being newcomers to the coast. It would therefore have taken some time for them to adapt to the new estuary and occeanic environment. The "inertia" of mainland life might have influenced early coastal life , and may have had no greater impact than simply being "exploratory". This may be one of the reasons that the sites of the PRE in the Middle Neolithic do not show evidence of a sedentary lifestyle. The coast may not have been considered as a long-term place to live at the beginning, but just as one of many "experimental living spots". This is supported by the fact that the Middle Neolithic sites there seem to have been used only on a short-term basis, and lack substantial settlement evidence such as burials or houses. On the other hand, as an assimilated group of people, they may have been living along the coast for a long time and became accustomed to the coastal life. They may also have been able to help the other group to adapt to the coast more quickly than if they hadn't been present at all. In this way, the sites reflect sedentism later on in the Late Neolithic. Perhaps after a period of trials and the mutual adjustments between these two groups of people, the exploratory period ended, and people became better adapted to the coastal setting, both environmentally and culturally. This also explains why fishing was intensified rather than diminished in the PRE area in the Late Neolithic. This is a period when farming was much more influential and was probably a much larger undertaking than ever before in South China or Lingnan. This intensification of fishing in the Late Neolithic would have been one outcome of successful adaptation to the coast, along with an increase in sedentism, with demographic pressure another factor in the equation.

Consequently, the PRE people would have been neither pure inlanders nor pure coastal people, when they just moved to the PRE area in the Middle Neolithic. If the evidence is acccepted that agriculture was invented at least 8,000 BP ago in Guangdong even Guangxi as mentioned above, part of the PRE people would have been able to bring with them knowledge of cultivation to the coast. Their subsistence would not have been the same as that of "pure" coastal peoples such as the Jomon people of Japan who appear to have had no agricultural expertise when they began to live on the coast (Pearson 1992). The PRE group may have been able to combine their terrestrial, perhaps cultivation expertise with the coastal foraging knowledge introduced by the returned coastal population. This coastal life may have well been a combination of foraging and farming. Further archaeological findings may support this theory. It also appears to not have been difficult for them to accept or re-accept cultivation (of rice and/or tubers, of which they may have had long-term knowledge) later on.

Furthermore, since some of the PRE people may have had roots in the mainland, it would have been second nature for them to maintain a connection with the mainland. This is probably why similarities are seen between the Middle Neolithic culture of the PRE area and that of the Pearl River Delta area, even between PRE area culture and those of northern Guangdong and Guangxi. There also appears to be a connection between the PRE area culture and that of the Middle Yangzi River Valley in the Middle Neolithic. This is seen through similarities present on the painted pottery vessels found in both areas. In the Late Neolithic this kind of connection was further extended and enhanced.

4.2 Close Ties with Pre-Shixia Culture in Middle Neolithic

Especially interesting, during the Early Phase of Middle Neolithic in about 6,000-5,500 BP, similar pottery vessel types and decorated designs have been extensively found in both the PRE area and northern Guangdong area. For instance, a kind of fine pottery ring-foot basin with perforation in the foot has been unearthed in considerable quantity from the Layer 5 (pre-Shixia layer) of the Shixia site in North Guangdong, immediately beneath the famous Shixia Culture strata but apparently different from the Shixia Culture (Zhu 1988; Yang 1989). This type of basin is very similar to the painted pottery basin typical of the Early Phase of the Middle Neolithic in the PRE (Yang 1989). It should be noted that North Guangdong is where the Early Neolithic cultures are usually found, as discussed above. In fact, earlier examples have also been found there. Some scholars argue that a type of painted pottery older than that of the Middle Neolithic PRE is present in northern Guangdong and the Pearl River Delta, dating about 7,000 BP, and these two types of painted pottery are similar (Wu 1997). All this suggests that connections between northern Guangdong and the PRE/Pearl River Delta have been maintained from the Early Neolithic to the Middle Neolithic.

More significantly, it is pointed out that rice remains (carbonized domesticated rice and rice husks) have been uncovered from this pre-Shixia layer, around 6,000-5,500 BP, indicating that rice farming was likely existing then (Yang 1989: 32), even though it is not clear whether farming was the major subsistence. Given the close relationships between this pre-Shixia culture and the

Early Phase of the PRE Middle Neolithic, it can be assumed that the latter should have at least been aware of farming, if agriculture was not an important subsistence component. This close relationship seems also to support the theory that part of the PRE Middle Neolithic population may have come from northern Guangdong, as just addressed.

4.3 Site Location, Distribution and Ecology

The various sites of the Middle Neolithic PRE have many things in common. A site is usually located on a raised sand bar along the mainland or island, in a well-sheltered bay, around 4 -10 m above sea level. The bays are mostly open to the south, southwest or southeast, and each bay has a headland at each end that extends into the sea. It is widely believed that the sites would have been protected from northerly winds, with their hilly lands behind and their headlands in front of the bays. However, the sites found around the river mouth sometimes face east or west, depending on which side of the river bank they are situated on.

The sites frequently have contemporary cultivated land above or nearby, have (or once had) lagoons and/or mangroves close to the sand bar. One or two streams can usually be found nearby. Some of the sites are located several hundred meters or more from the beach. This is supported by the fact that through alluviation, the shores near the estuary and delta have been growing outward into the sea. In other words, seawater coverage is withdrawing from the land (Li *et al.* 1991: 58).

In terms of the flora and fauna of the PRE in the Middle Neolithic, a detailed description is not feasible due to lack of data, but a few examples are provided here to aid understanding. First, the Tung Kwu site is situated on a small island under the same name. It is argued that the island may have had tall trees and forest vegetation when the site was occupied, similar to large areas of Hong Kong. The forests have been extensively cut for fuel during historical times, leading to the erosion of deep forest soil and the replacement of the forest by scrub and grassland. The plants may have served as food or medicine, or for wood for making boats. It is said that the island had no permanent water (Gott 1975), thus it would have only been suitable as a seasonal residence, rather than permanent one.

The lagoon with mangroves is one of the richest areas of resources, with abundant shrimp, crab, birds, shellfish and fish, ideal for collecting and fishing. To illustrate, research suggests that the main fauna and flora of Hong Kong's mangroves include 45 species of bird, 23 species of invertebrate and 17 species of plant (Wong and Tam 1997: 21-28). The mangroves trees themselves can be used for medicine, fuel, wood and also protect the bays from waves and storms (Wong and Tam 1997: 105-108). On the other hand, the acidic and salty soil of the mangrove field is unfavorable, or a "problem soil", for farming (Wong and Tam 1997: 73-84, 328-343).

4.3-1 Middle Neolithic-Early Phase (1-1)

There are 15 well-dated sites belonging to the Early Phase of the Middle Neolithic. They are precisely dated in terms of the stratigraphy, providing absolute dating and assemblage, covering the cities or regions of Shenzhen, Zhuhai, Zhongshan of southern Guangdong, Macau, and especially Hong Kong. They include Dahuangsha (Wen and Chen 1990), Xiaomeisha (Mo 1982), Dameisha (Shenzhen City Museum 1993), Houshawan (Li 1991), Longxue (Zhongshan City Museum 1991), Xiantouling (Peng *et al.* 1990), Chung Hom Wan (Tomlin 1971, 1972; Bard 1976), Tai Wan (Finn 1958), Hac Sa Wan (Kelly 1973; Meacham 1986), Yung Long (Meacham 1993a), Hai Dei Wan (Williams 1980), Lung Kwu Tan (Chiu 1995), Sham Wan Village (Meacham 1994), Tung Kwu (Kelly 1974, 1976; Meacham 1976), and Baishuijing (Yang 1998b) (Fig. 2).

These sites are mainly clustered around the river mouth, but are not as dense as those of later phases. Most of them are closely situated around the river mouth in a setting of estuary riparian and marine ecotone, except for four sites that are further from the river mouth, located on the mainland coast of the Shenzhen City in the north-east corner of the PRE area (Li 1997). This site distribution indicates that the first peopling of this area would have been there mainly for procuring aquatic, both riverine and marine resources. This would have included shellfish collecting, fishing and even some sort of hunting. Although catchment analyses suggest the possibility of limited cultivation of tuber crops or even rice, the lack of ecofacts provide little support to this. To decide whether cultivation existed in this phase, the function of the artifacts would need to be re-interpreted. Considering that the exploitation of the PRE area at the beginning would have been "exploratory" as discussed above, the sites of this phase would have reflected transience, being used for very short periods of time. In this way, cultivation, which usually accompanies more stable residence and invites long-term care, might not have been a consideration to those who first came to temporarily explore this coastal area.

Some of the sites seem to have been used for longer periods of time than others, perhaps because of better locations for food procurement and/or transportation. For example, some sites have yielded only the assemblages of the Early Phase of the First Stage, while some were continually exploited in the Late Phase of the First Stage even in the Second Stage (Late Neolithic) and into Historical times.

4.3-2 Middle Neolithic-Late Phase (1-2)

While some of the Early Phase sites continued to be used into the Late Phase of the First Stage, some new sites have been found. Besides the slight increase of site numbers, it is important to note that the site location and distribution seem to have moved further towards the sea in this phase, though they still remain within the estuary area. This seems to indicate a heavier emphasis on marine resource procurement than riverine resources in the estuary (Fig. 3).

This heavier emphasis can be shown by the following two phenomena. 1. Many Early Phase sites found closer to the riverine, (also known as inner north) section of the estuary were no longer used in the Late Phase Examples of these include Xiantouling, Dameisha, Xiaomeisha, Longxue, Baishuijing, Houshawan, Yung Long and Lung Kwu Tan. On the other hand, many sites belonging to the marine, (outer or south), section of the estuary were still used in the Late Phase as can be seen at Dahuangsha, Chung Hom Wan, Tai Wan, Hac Sa Wan, Sham Wan Village, Tung Kwu and Hai Dei Wan. Furthermore, a couple of new sites appeared at the same time, mainly in the marine or outer south section, and include Sham Wan (Meacham 1978), Fu Tei (Meacham 1994), Kwo Lo Wan (Meacham 1994), Tung Wan (Au *et al.* 1990), Tungwantsai North (AMO and IA CASS 1999), Sai Wan (Rodwell and Wellings 1990), Tai Long (Bard 1972; Meacham 1982), Sha Chau (Frost 1976), Lo So Shing (Meacham 1980), and Ngkayuen (HKAS 1999) of Hong Kong, and Caotangwan (Liang and Li 1991) of Zhuhai. Also worth noting is that the Baojingwan site in Zhuhai (Li and Tang 2000: 62-68, 108-198) has been uncovered at the southernmost fringe of the marine part of the estuary. It was found well within the marine setting of the estuary, indicating that the river mouth marine resources were probably being exploited to a maximum extent.

2. The discontinued use of several mainland coastal sites of Shenzhen, i.e., Xiaomeisha, Dameisha, and Xiantouling in the northeastern corner of the PRE area seems also to point to a shifting of subsistence, towards a more centered exploitation of the marine section of the estuary. This shifting of subsistence would have resulted from long-term experiments through the Early Phase and a gradual awareness of richer resources that were available in that particular section of the estuary.

It is also very interesting to note that the Sai Wan site is different from most other sand bar deposited sites. It is located on a flat hill ridge at about 30 meters above the sea, over-looking Sai Wan ("West Bay"). All the finds come from the hill soil area. The excavator has suggested that the site was in a non-marine setting, well above sea level and beach deposits, and would not have easily served a marine oriented population (Meacham 1979b; Rodwell and Wellings 1990). This may indicate that in the Late Phase the PRE people would have probably been looking for alternative subsistence resources to foraging, such as cultivation, which is more suitable for long-term living. This would have occurred after they had become more familiar with the coastal environment. Cultivation can be carried out more easily with an increase in residence stability. Indeed, sedentism appears to have increased during this phase, with the appearance of burials that were not seen in last phase. For example, six burials were uncovered from Kwo Lo Wan, 10 from Fu Tei, and several others from Sham Wan (Meacham 1978: 232-247).

It has also been observed that some sites of this phase have a permanent, or perennial, fresh water supply, with one or several streams, as seen at the Sham Wan site (Meacham 1978: 20) (Fig. 6). Some other sites of last phase have only limited-term water supply during the year. For instance, at the Tung Kwu site water is not available from January to March (Meacham 1976: 65). The Tung Kwu site was also used in the early phase, but since the last phase was exploratory, people would not have cared much about the conditions for permanent living. If the Neolithic ecology in the PRE was similar to today's as is widely accepted, (e.g., Morton 1978), this phase then suggests a tendency towards more stable life compared to the last phase.

4.4 Ecofacts and Artifacts

4.4-1 Middle Neolithic - Early Phase (1-1)

Very few faunal or floral remains have been found from this phase. However, an analysis of the tools found can shed some light on the subsistence of the Middle Neolithic Early Phase. Functions such as woodworking or hunting can be inferred from tools such as stone adzes, stone chisels, and stone arrowheads (Fig. 4).

The pebbles "picks", or "oyster picks" in various shapes, might have been multi-functional to include uses related to foraging and farming. By the same token, many of the polished bifacial axes or unifacial adzes found at many sites from this phase, particularly the large or long axes, might have been used to fell trees or do land clearance for cultivation, as well as for woodworking. For example, an axe having the length of 22.5 cm has been found at the Dahuangsha site, and axes of 21cm long at the Xiantouling site. It is hard to believe that axes or adzes of this length were not employed for cultivating activities, and were limited to woodworking purposes (Khoach 1980).

Two types of stone knives, shell-shaped and triangle-shaped, have also been found from the Xiantouling site. It has been pointed out that the latter type is similar to the sickle of the Peiligang culture of North China mentioned above (Wu and Ye 1993).

Some scholars have even argued that the Yangzi River valley shared some of the similarities with the PRE. The painted pottery is a good example (He 1995a). During the Late Neolithic similarities are found even more frequently. On the other hand, the bark cloth beaters are the earliest examples so far found in East Asia, Southeast Asia, or in the world (Li 1996). Their discovery indicates a familiarity with the use of plants and fibers.

4.4-2 Middle Neolithic-Late Phase (1-2)

Most of the fish bones found at the Sham Wan site in this phase belong to the Head Grunt, *Pomadasys hasta,* represented by the cranial parts (Chan 1978: 254). Although this taxon is relatively abundant in deep marine water, it can tolerate fluctuations of salinity and is common off estuaries, and is even found in large freshwater systems. Particularly interesting, this kind of fish is readily accessible in shallow inshore waters during spring and early summer, when it migrates shoreward to spawn. Therefore it follows that when fishing techniques were rudimentary, as they likely were in Middle Neolithic times, this kind of fish could have been be caught at least during the spring and early summer. It has also been suggested that these fish could have been caught in shallow waters in the coves or deep inlets of the shore, particularly if fish numbers were much greater than they are today (Chan 1978: 256). This may be true, because the number of head grunts found in this phase is much less than that found at the site in the Late Phase of the Late Neolithic. In addition to the head grunts, remains of percoid, ray fish and shark teeth have been reported in the Sham Wan site of this phase (Chan 1978: 254-256).

Many pig tooth fragments have also been found from the Sham Wan site in this phase. The excavator of this site argues that the pig would very likely have been domesticated, although no evidence of domestication has been detected from the teeth themselves, probably due to the fact that the pig bones found were too fragmentary (Meacham 1978: 258). Considering that domesticated pigs were present in the Early Neolithic, it is acceptable to assume that domesticated pigs could have been present in this phase as well. If the pigs really were domesticated, it would also suggest that the people of this phase may have been more sedentary than in last phase. In addition, deer or *Cervus* teeth have also been found in the same phase (Meacham 1978: 258).

Stone tool use wear and silica polishing analyses have been conducted for some of the sites. For instance, at the Fu Tei and Kwo Lo Wan sites of this phase, silica polishing analysis indicates that although the smaller adzes would have been primarily used for woodworking, the larger ones might have served for agricultural clearance work (Esser 1993: 68). At the same time, there was a finding of two very large chipped stone celts (approximately 22x32 cm and over 2 kg each), also called hoes or shovels, also indicating other possible agricultural function (Esser 1993: 71) (Fig. 5).

Six burials have been found in the Kwo Lo Wan site and 10 from the Fu Tei site (Meacham 1994: 45-85, 129-152). Interestingly, a fine pottery *dou* cup from Fu Tei bears similarities with those found from the similarly dated Lower Yangzi River area. This indicates a possible relation to the area (AMO 1999). The increasing relationship with more distant areas indicates that maritime transport has improved.

In summary, there are many similarities in subsistence between the two phases of the Middle Neolithic. Most sites concentrate around the river mouth. Almost every site is located on the sand bar behind a bay, with lagoons nearby. Most sites have painted or white pottery that suggests a possible linkage with the Middle Yangzi River area. Analyses on the ecofacts, artifacts and catchment all indicate that foraging, mainly fishing, would have been the bulk subsistence activity, although limited farming cannot be ruled out.

The main differences are that burials have been found in the Late Phase. In addition, sites that reflect a possible farming setting are present. This seems to suggest that the residence became more stable with time and that farming may also have considerably increased in the Late Phase, in comparison to the Early Phase. Also worth noting is that some artifacts of the Late Phase indicate probable connection with the Lower Yangzi River area, implying an extension of a communication network.

Chapter 5. Subsistence Of Stage Two-Late Neolithic

Similar to the Middle Neolithic, the Late Neolithic of the PRE consists of both the Early and Late Phases. The Early Phase of the Late Neolithic was about 700 years (5,000-4,300 BP), and the Late Phase was slightly longer in duration, approximately 800 years (4,300-3,500 BP).

5.1 Site Location, Distribution and Ecology

5.1-1 Late Neolithic-Early Phase (2-1)

The division of the Early and Late phases has not been clearly made at some sites, though some other sites have clearly delineated time periods.

Some of the sites that were present in the Early or Late phase of the Middle Neolithic have continued into this Early Phase of the Late Neolithic. The representative ones are Yung Long (AMO 1997), Sham Wan, and Tung Wan (Frost 1980a) of Hong Kong and Houshawan of Zhuhai.

In the meantime, some new sites were discovered, particularly around the inner northern part of the river mouth. The representative ones include the Sha Lo Wan (Drewett 1995), Lung Kwu Sheung Tan (Meacham 1993a) sites of Hong Kong, the Chiwan site (Mo 1958, 1961a, 1961b, 1982) of Shenzhen, and the Nanshawan (Zhao 1991) and Lengjiaozui sites (Long 1991) of Zhuhai (Fig. 7).

One of the most interesting changes was the abandonment of some sites in the southernmost areas on the exterior of this river mouth area during the Late Neolithic. For example, the Hac Sha Wan site of Macao, Tai Wan sites of Hong Kong, and the Baojingwan site of Zhuhai (Li and Tang 2000: 62-68, 108-198) were not continuously used in the Late Neolithic. This is clear since no Late Neolithic remains have been found at these sites. On the other hand, some new Late Neolithic sites have been discovered in the northern or inner part of the river mouth area. The distribution of sites seems to have shrunk to concentrate around the inner part of the river mouth.

Although the reasons are still ambiguous, one of the causes for this change may have been to look for places ideal for long-term living. It appears that the inner part of the estuary was more accessible to all-important terrestrial, estuary and marine resources. In fact, more burials and houses are present, pointing to the same conclusion. It may have also been effective for transportation and communication, being located closer to the mainland and the river mouth. Approximately a dozen burials have been unearthed from the Yung Long site (AMO 1997), and four were unearthed from Sha Lo Wan (Drewett 1995). House remains, though not perfectly preserved, have also been found at Yung Long and Sha Lo Wan. The site size, features, plus the numerous artifacts from these two sites, all indicate that settlements of substantial scale and complexity had already been developed in this phase of the Late Neolithic.

Another possible reason for this shift to the inner part of the estuary would be that farming was playing an increasingly important role, because more land was available in this area than in the exterior regions. This is supported by the discovery of some agriculture-type tools found, and also by the fact that the advanced rice farming Shixia Culture (4,700-4,300 BP) had begun to impact on the PRE during this phase (5,000-4,300 BP), as will be further discussed below. Furthermore, some sites are located more inland, probably more favorable to farming and less suitable for fishing, as seen at the Nanshawan site (Zhao 1991).

Also of interest is the Sha Lo Wan site located at the headland of a bay, containing house structures. This was not seen in the Middle Neolithic period, and more cases have been found in next phase---the Late Phase of the Late Neolithic. This would point to an increase in population - an added pressure to obtain resources other than foraging and fishing. This issue will be discussed further in this paper.

5.1-2 Late Neolithic-Late Phase (2-2)

Many new and interesting aspects have been found in this phase that indicate the climax in the entire Neolithic period of PRE in their exploitation of subsistence resources. These resources include (riparian and marine) aquatic and land foraging foods and farming produce, probably due to dramatic population increase, enhancement of sedentism, extension of communication network, a result of the impact from northern rice farmers, and local developments of the PRE/Pearl River Delta area (Fig. 8).

This phase saw the widest distribution of sites, as compared to other phases of the Neolithic in the PRE area (AMO 1999). Many sites that had been used in the last phase or in the Middle Neolithic were continually used. The representatives of these re-used sites in Hong Kong include Tung Wan Tsai North (AMO and IA CASS 1999), Sham Wan, Sham Wan Tsuen (Village), Tung Kwu (Kelly 1974, 1976), Tai Long (Bard 1972; Meacham 1982), Sha Lo Wan (Drewett 1995), Long Kwu Tan (Chiu 1995), Tung Wan (Au *et al.* 1990), Hai Dei Wan (Williams 1980), Lo Sho Shing, Fu Tei, Chung Hom Wan (Bard 1976; Tomlin 1971, 1972), Ngkayuen site (HKAS 1999) and Sha Chau (Frost 1976). The representative re-used site in Zhuhai of this phase is Chaotangwan (Liang and Li 1991).

Many new sites have also appeared. The key ones in Hong Kong include Shek Kwo Tsui (Salmon 1972), Man Kwo Tsui (Davis 1960), Siu A Chau (Frost 1980b), Tai Kwai Wan (Meacham 1979a), Sha Lao Tong Wan (Chau 1995), Po Yue Wan (Wellings 1993), Sha Po Tsuen (Spry 1990; Meacham 1993b), Pa Tau Kwu (Chiu 1995), Fa Peng Deng (Chiu 1995; Shang and Mao 1997) and Pa Mong (Deng *et al.* 1997). The representative new site in Shenzhen is Hedishan site (Mo 1982) and the new site in Zhuhai is Dongaowan (Li 1990).

Similar to the last phase, the newly discovered sites as well as the known sites that were continually used in this phase are mainly concentrated in the northern part of the river mouth area. By the same token, this may again suggest that sedentism and farming could have been further enhanced during this phase. Stress on resources may have been heightened as well.

Well-preserved human skeletons of 19 individuals have been unearthed from the Tungwantsai North site (AMO and IA CASS 1999). This cemetery was well planned. For instance, the 19 burials are all single-person burials, 13 of them orient north-south, 6 east-west; 15 contain human bone remains, and 7 contain well-preserved skeletons. The cemetery's structure and order could also indicate increase of sedentism and/or territoriality. Dr. Brian Chisholm of UBC has taken 13 samples of the human bone for isotopic analysis on the diet. His research results will be incorporated into the catchment chapter (Section *6.3-3* of Chapter 6) of this paper. Some of the burials contain accompanying objects of stone or jade implements, but those close to the hillside mostly contain pottery ware. Some of the skulls show the evidence of tooth-removal, which was present in earlier times as well as more recent, in the Pearl River Delta and along the East Coast of Mainland China. As with other remains such as pottery vessels, the tooth-removal custom also points to a connection with the Pearl River Delta and even the Lower Yangzi River area in this Late Phase of the Late Neolithic time.

A large earth-rammed house floor (i.e., House 1) of 106.25 m^2 (12.5m x 8.5m) has been found at the Ngkayuen site (HKAS 1999). The excavators have argued that the house may have been used as a ceremonial center. It, plus the y*ue* ceremonial axe found, also indicates the emergence of chief-like local "aggrandisers" (Clark and Blake 1994), in addition to suggesting the existence of permanent residence (Fig. 11).

What is of particular interest is that more new inland and upland sites have been found than ever before. For example, deposits of the phase have been discovered recently at the Fa Peng Deng site on an upland area of northeastern Lantau, at some 1 km from the coast and 200 meters above the sea (Chiu 1995). Similar situations are also present at the Shek Kwo Tsui site (Salmon 1972). Research elsewhere in Southeast Asia indicates that upland swidden cultivation is a major type of rice farming (Glover and Higham 1996: 413). The upland sites' appearance in this phase may have likely been linked to development in upland farming.

Likewise, headland sites have been uncovered from Po Yue Wan (Wellings 1993) and Pa Tau Kwu; the latter even has house structures (Chiu 1995). The occupying of the headland site implies that pressure on land has increased, likely through demographic growth. They may have come from neighboring areas such as the Pearl River Delta, or have been pushed southward by rice farmers in northern Guangdong further north. This point is particularly notable when one considers the impact of the rice cultivators of the Shixia Culture in northern Guangdong, and the several large settlements that were developing in the Pearl River Delta during the Late Neolithic particularly during the Late Phase, as seen at the Chuntou (Qiu and Liu 1991), Yingzhou and Hedang sites (Yang and Chen 1981). The dramatic increase of site numbers in this phase indicates population increase.

The population pressure would have led to shortage of resources, at least some of the time. Thus, a more extensive or intensive search for other subsistence resources besides staple fishing or mollusk collecting would have become more and more urgent in the Late Neolithic period, particularly in the Late Phase. This is probably why some inland, upland, headland areas, besides the sheltered bays, were occupied. The open headland would have been less optimal for dwelling than the well-sheltered sand bar, especially during windy or typhoon seasons. This occupation suggests that living stress would have been heightened in the Late Neolithic, particularly in the Late Phase. At Po Yue Wan, for instance, sites have been found ranging from the sand bar, the hill ridge top to the headland (Crawford 1986; Wellings 1993), indicating that the space and probably the area's resources, had been fully exploited. Had they not been forced to do so, the people may have simply needed to stay well off the protected sand bar as before, and might not have had to move to the open headland. Thus farming, as well as foraging and fishing, would have increasingly been depended upon (Fig. 12).

5.2 Interactions with Rice Farming Shixia and Post-Shixia Cultures

As addressed, one of the reasons for the population increase in the PRE area may have been pressure from the intensive inland rice farming Shixia culture in north Guangdong (GDPM and QCCB 1972), whose expansion may have been due to an overcrowding and led to a forced migration of those living in close proximity, especially southwards to the coast. Actually, the Shixia culture seems to have had a great impact on the PRE in the Early Phase of the Late Neolithic (5,000-4,300 BP). In addition, its successors known as the post-Shixia cultures, had considerable interactions with the PRE during the Late Phase (4,300-3,500 BP). Therefore, it is necessary to elaborate on these interactions before going into the detailed descriptions of the PRE artifacts/ecofacts in the Late Neolithic, for doing so will help better understand the PRE materials.

During its period of existence (4,700-4,300 BP), the Shixia culture would have had a stronger cultural influence on the PRE than the other way around. This is probably due to the advanced farming economy of the Shixia. However, after the Shixia diminished (4,300-3,500 BP, i.e., the Late Phase of Late Neolithic of PRE), the PRE/Pearl River Delta appears to have become increasingly more influential than the post-Shixia cultures. This would have been a result from the rapid developments evident in the PRE/Pearl River Delta area during the Late Phase, and a seeming cultural decline or re-organization in northern Guangdong in the post-Shixia time, as compared to the Shixia era. Later on, the PRE/Pearl River Delta area, in particular, the delta itself, gradually but steadily evolved into a center for the whole Lingnan region, particularly during the Western Han Dynasty (206 BC-23 AD, i.e., around 2,000 BP) when the Southern Yue Kingdom was capitalized in today's Guangzhou City.

Importantly, all these processes suggest that the Pearl River Delta/PRE area would have been taking the initiative more and more aggressively, and eventually prevailed in competition with other groups in South China, particularly the Lingnan.

5.2-1 Late Neolithic-Early Phase (2-1)

During this phase (5,000-4,300 BP), the advanced rice farming Shixia culture (4,700-4,300 BP) was quite influential, because many Shixia-type sites have been found in eastern and western Guangdong (Wu *et al.* 1991), and Shixia-type artifacts been unearthed in many places of Lingnan (Yang and Chen 1989; Zhu *et al.* 1989), indicating that it was then prevailing and widespread (Wu and Ye 1993). Therefore, in this Early Phase of the Late Neolithic, there are many similarities present between the pottery and stone artifacts of the PRE/Pearl River Delta and those of the contemporary rice farming Shixia culture.

For example, some possible tripod legs have been found in the Pearl River Delta/PRE in this Early Phase of Late Neolithic. It is said that this is the outcome of Shixia influence, for tripods prevail in the Shixia Culture, while there are no Middle Neolithic tripod vessels in the Pearl River Delta/PRE, and very few of these vessels from the Late Neolithic (Wu and Ye 1993). To further illustrate this, many *yue* axes that are found at the Yung Long site are widely considered a result of influence from Shixia (e.g., Yang 1998a: 315).

At the Early Cultural Layer of the Yinzhou site (4,200 BP) of the Pearl River Delta, a tile-shape leg of a *guan* pot from a burial is found identical in shape to the prevailing tile-shape leg of the *ding* tripod of the Shixia Culture (4,700-4,300 BP) (Zhu 1995: 295). Since the Early Cultural Layer of the Yinzhou site of a later period than Shixia, this may still be an example of influence from the Shixia.

Considering connections between the PRE and the Shixia area of northern Guangdong, and those between the PRE and the Middle Yangzi River Valley even further away, were established early in the Middle Neolithic time, it is not surprising to see the close interaction between the PRE and Shixia during the Late Neolithic. Furthermore, this interaction appears to have been enhanced in later time in the next phase (the Late Phase of Late Neolithic), though it is thought that the interaction would have taken another form, i.e., the Pearl River Delta/PRE, rather than inland northern Guangdong, becoming the influential culture, as claimed by many researchers.

5.2-2 Late Neolithic-Late Phase (2-2)

In the Late Neolithic phase (4,300-3,500 BP), the coastal PRE/Pearl River Delta seems to have been taking the initiative more frequently in interaction with the post-Shixia cultures of northern inland Guangdong, rather than the other way around, compared to the Shixia Culture time (4,700-4,300 BP). For example, by the end of the Shixia period or the Early Phase of the Late Neolithic, the style of geometric stamped pottery of Shixia culture had begun to be affected by, rather than to affect upon, the PRE or Pearl River Delta (Zhao 1999). Moreover, an adz of Pearl River Delta style is found at a Shixia-type site, the Loshagang site (4,400 BP) in western Guangdong, suggesting that influence from the Pearl River Delta/PRE reached as far as western Guangdong by the end of last phase (Yang 1998a: 312).

During this phase, meaning after the Shixia culture, this trend appears more apparent. For instance, some Yung Long type geometric stamped pottery *guan* pots have been found from the Early Phase of the 2B Cultural Layer of the Shixia site (a post-Shixia layer), which is about 4,200 BP (Yang 1998a: 315). This similarity in the *guan* pots between the two sites may indicate an influence from the PRE to northern Guangdong, rather than the other way around, since the Yung Long culture was a little bit earlier than the post-Shixia (Early Phase of the 2B) layer of the Shixia site.

Similarities, particularly in terms of pottery style, between the assemblages of the PRE/Pearl River Delta and those of some sites in Hunan nearby the Middle Yangzi River in this phase of the Late Neolithic have also been found (He 1993: 177-183). A scholar (from Hunan) believes that the PRE/Pearl River Delta was the giver of these assemblage similarities, and that the sites in

Hunan were recipients (He 1993: 183). This opinion is similar to He (1986, 1995b), who also argues that during the Late Neolithic the Pearl River Delta/PRE began its dramatic impact upon southern Hunan, particularly the southwestern part of the province.

All of these cases reveal that the PRE/Pearl River Delta has become very influential after the end of the Shixia Culture (i.e., after 4,300 BP), and particularly during this Late Phase of the Late Neolithic (4,300-3,500 BP). On the other side, although still primarily rice farmers, the pottery assemblages of the post-Shixia cultures in northern Guangdong have lost the Shixia style and maintained very slim linkage with those of Shixia. Conversely, they possess many similarities with those of eastern and western Guangdong as well as the PRE/Pearl River Delta in this phase of the Late Neolithic (Yang 1998b: 202-203). In addition, in the bordering areas between western Guangdong and eastern Guangxi, Late Neolithic cultures share similarities with cultures in PRE/Pearl River Delta, northern Guangdong and southern Guangxi (Yang 1998b: 204), implying that the PRE/Pearl River Delta may have been increasingly more influential than northern Guangdong.

Further evidence shows the PRE not only had connections with the rice cultivating Shixia or post-Shixia cultures in north Guangdong, but also with cultures further away. For instance, a type of stepped adz found at the Hai Dei Wan site is similar to that found in southeast coastal China and as far away as the Philippines and Polynesia (Yang 1998a: 316). This suggests a broad extension of the communication network with wider neighboring areas since the Late Phase of the Late Neolithic.

5.3 Ecofacts and Artifacts

5.3-1 Late Neolithic-Early Phase (2-1)

More stone tools, with a larger variety in vessel shapes, have been found in this phase than in the previous phases of the Middle Neolithic period. The *yue* ceremonial axes and rings or slotted rings are among the new types. In addition, many more stone net sinkers were found, which were rare in the Middle Neolithic (Shang and Mao 1997). More importantly, many of them appear to have been made of local materials *in situ* at site. For example, large quantities of the *yue* axe debitages, blanks, debris and complete ones have been found from the Yung Long site. This seems to support the idea that sedentism would have very likely been reinforced in this phase with the discovery of more burials and houses. The subsistence resources would also have been exploited more intensively than before, with the appearance of more stone arrow heads, net sinkers, anchors, spades, axes and adzes (Fig. 9).

The main characteristics of pottery in this Early Phase are the disappearance of the fine red, white pottery and the appearance of the stamped geometric soft fine pottery. The stamped leaf-vein and tortuous patterns are also common.

One of the most interesting things is the appearance of the fire grate in this phase. It might have been used as today's barbecue fire grate, simply by putting some kind of stand beneath to lift it up and support it. Pottery stands have been widely found in the Middle and Late Neolithic of the PRE area, and the stands can be employed to support vessels such as the *fu* pot or the fire grate. Although the function of the grate is not conclusive from the available comparative ethnographic and other data, the fire grate seems to have had something to do with roasting food, most likely tubers and/or fish.

Ancient texts 2,000 – 1,500 years ago have recorded that people in southern China used tubers for food, and ancient fishermen of Hainan Island in southernmost China cultivated tuber crops, rather than rice, as staple (Chen 1998: 67; Tong 1998: 140-141). This habit of using tubers as staple food had lasted in Hainan Island until the Qing Dynasty (1644 – 1911 AD) (Chen 1998: 68). Research elsewhere indicates that wild or domesticated plants can be detoxified by roasting them (Arnold 1985: 233). Since plant domestication was likely to have been long established by the Late Neolithic, the appearance of the fire grate may suggest intensification of tuber crop cultivation (for roasting off the toxic substances from tubers, or simply for baking tubers to eat). It may also suggest the intensification of fishing (for barbecuing fishes). Since new tool shapes such as the stone spade suitable for cultivation have been found in this phase, and more net sinkers or arrow heads for fishing have also been found, one can postulate that both farming and fishing of the area would have been intensified in the Late Neolithic.

In this phase, both the appearance of large amount of pottery spindle whorls, such as those found at the Yung Long site, which were rare in the Middle Neolithic, and the disappearance of the bark cloth beater, suggests relatively dramatic changes during this phase. It is logical to say that the bark clothing was being replaced by clothing made of other types of fibers; for instance, hemp may be a possible candidate as it could have been processed with the spindle whorl. It is not clear whether the disappearance of the bark cloth beater represents a decrease in wood sources. If so, the wood would have become more in demand for other things such as boats and houses. Another likely factor is that forests were shrinking because of the increasing need for clearance for farming.

The finding of some new stone tool shapes, such as the presence of a high quantity of longer and larger adzes (more than 100 pieces) at Yung Long, probably suggests changes in subsistence activities. Some of the adzes found at Yung Long are larger and longer than the bulk of adzes commonly found in the Middle Neolithic.

Considering the finding of numerous blanks, debitages, debris as well as elaborately refined complete *yue* tools at Yung Long, and the fact that most of the complete ones found show no sign of use, it is very likely that the manufacture of these *yue* tools was for exchange. The Yung Long and Shixia Cultures existed around the same period of time as discussed above. In this way, it is not surprising that the *yue* tools were made expressly to exchange for other items such as rice. Some of the *yue* tools look almost identical with those found from the Shixia Culture, being as long as 30cm. The Shixia people's staple also happened to be rice (Yang 1998a: 315). The reason for mentioning this staple is that rice, although may have been cultivated in the PRE, would have been not easy to grow there, compared to northern Guangdong, while fishing and making stone tools would have been easier since they had abundant related resources.

5.3-2 Late Neolithic-Late Phase (2-2)

Very similar to earlier phases, the sites of this phase yield very few faunal or floral remains, except perhaps for the Po Yue Wan site, where more faunal remains are present. It is lucky that at the Tung Wan Tsai North site human skeletal remains of 20 individuals have survived, but besides that only small amount of shells, shell knives and fish bone objects were found. It may be that the acidic condition of many of these sites has prevented substantial preservation of ecofacts.

Considerable faunal remains have been found at the Po Yue Wan site. A quantity of fish bones has also been unearthed, suggesting that the head grunt rather than the marine catfish were the predominant types of fish consumed at Po Yue Wan during this phase (Crawford 1986: 77). Also found were large quantities of shells including the bones and shells of turtles, birds and mammals, such as dolphins. In addition, shell knives or scrapers, bone arrowheads and awls have also been uncovered (Crawford 1986). At Sham Wan during this phase, as in the Late Phase of the Middle Neolithic, the major fish present are, first, the head grunt and second, the marine catfish (Chan 1978).

Shells including gastropods and bivalves have also been found from the Late Neolithic coarse geometric horizon at the Po Yue Wan site. What is interesting about this is that they come from different habitats. Most of the gastropods such as the *Lunella coronata, Nerita albicilla* and *Thais luteostoma* are from the rocky shore. Some, such as the *Strombus luhuanus, Cyprea arabica,* and *Turbo argystroma* can also be found at the sub-tidal rocky shore. There are still a few from mangroves (e.g., *Terebralia*) and shelf (e.g., *Melo melo*). The bivalve shellfishes, such as the *Barbatia* sp., mainly come from the rocky shore, and from estuarine setting, like *Crassostrea gigas* (Crawford 1986: 74). These mollusk habitats match with the settings where the sites are located, indicating that the shellfish should have been exploited at or around the sites. These various habitats include the rocky shore, sub-tidal rocky shore, mangroves, estuarine and shelf. It has been argued that the presence of the *Melo melo,* a shelf dweller that lives at a depth of 10-20 meters, indicates mollusk collecting by deep-water diving. In addition, the *Patella flexuosa, Turbo argystroma* and *Strombus luhuanus* could have been collected in a similar manner at the Po Yue Wan site.

Since all of the above shellfishes are edible, they probably represent food remains at the sites (Crawford 1986: 75). Circumstantial evidence shows that most shells from this Late Neolithic horizon have unworn external sculpture and shell margins, while the shells from the layers earlier than this one are mostly worn smooth by surf, with their sculpture eroded away, similar to the Sham Wan case (Morton 1978: 264). This indicates that the shells of the coarse geometric layers were likely collected alive by humans, probably for consumption.

All this indicates that fishing and mollusk collecting would still have been the primary procurement activities during this phase as in the earlier phases. Since the mollusks are present in larger quantities during this phase than earlier phases in the PRE area represented by the Po Yue Wan and Sham Wan sites, shellfish collecting would have been enhanced during this phase.

While the bulk of ground stone tools, such as the small adzes and axes, may have still been used basically for woodworking, large stone tools that would have been employed for agricultural activities have also been widely found. At the Po Yue Wan site, for example, an axe 33 cms long and weighing 2.5 kgs has been discovered (Wellings 1993) (Fig. 10).

Marine products may have been used for exchange, as there is much evidence indicating expansion of an exchange network, as discussed above. Consequently, the exchange network expansion seems to have led to increasing craft specialization. Many cases indicate that intensification of craft specialization would have been for the exchange of exotic foods, in addition to the exchange of stone tools (e.g., Drewett 1995: 51-54). Craft specialization appears to have developed during the last phase and spread further into this phase. At Po Yue Wan, for instance, the shell scrapers or knives are found associated with only the fish heads and without the fish vertebra, suggesting that the fish bodies had been brought away from the site (Crawford 1986). Similarly, another interesting phenomenon has been seen at the Sham Wan site. At Sham

Wan, the grunt fish heads are associated with more vertebrae in lower or earlier layers than in later upper layers during the Late Neolithic. For example, in terms of the head grunt, the crania of 206 fish and vertebrae of 158 fish were found in the depth of 140-180cm at B1; crania of 620 fish and vertebrae of 253 fish found in 90-110cm deep at B1. However, in the depth of 75-95cm, only crania of some 122 fish, without vertebrae, are present (Chan 1978: 252-254). As the excavator of the Po Yue Wan site has claimed, the head grunt fish was probably prepared by removal of the head, leaving the fish body to sun-dry for trading (Crawford 1986: 79). If this speculation is correct, the Sham Wan changes of the crania/vertebrae ratio may represent the evolution towards an increase in head grunt fishing during the Late Neolithic time. In this way, it is easy to accept that the dried fish could have been used to exchange with inland produce such as rice, coming from quite far away. For example, as mentioned above, the Shixia Culture people in northern Guangdong (4,700-4,300 BP) could also have used their specialty---rice---to exchange with the coastal specialties from the PRE area, given the contacts between the two areas as was discussed earlier. Although rice cultivation might have been mastered by the PRE people in the Neolithic time, it would have been very difficult to substantially maintain in the PRE, limited by the environments in the river mouth area, which were probably much more advantageous and handy for fishing than for farming.

Chapter 6. Site Catchment Analysis

Since significant materials for assessing subsistence, such as faunal or floral data, are fragmentary in the PRE area, it has been decided to conduct site catchment analysis to supply supporting information. This is because the method is capable of reconstructing economically important information, such as subsistence, even in the absence of plant and animal remains. In the PRE case, the analysis can provide a supplemental independent line of inference data to the available floral or faunal evidence. It can mutually verify, though not without its own limitations, the faunal or floral remains. Faunal or floral remains, in fact, are regarded as no less subject to skew or bias than site catchment analysis (Zvelebil 1983: 73, 76). Thus, site catchment analysis can at least serve as a complement to other methods or materials for prehistoric subsistence assessment or reconstruction. Site catchment analysis will still remain at the inference level, and better-derived empirical archaeological and paleo-ecological data are needed to confirm the analytical results.

6.1 Concepts of Site Catchment Analysis

6.1-1 Catchment and Location

The term *catchment* comes from geomorphology and is usually used to refer to the drainage basin or the area from which a river collects its water. Just as the term suggests, "the catchment of an archaeological site is that area from which a site (or more properly, the inhabitants of a site) derived its resources" (Roper 1979: 120). While a natural catchment such as a watershed is physically observable, a prehistoric archaeological site catchment is actually not, and is instead a theoretical reconstructed plan. If this is so, then what should be used to reconstruct an archaeological site catchment? To reiterate the question, what elements would have been significant in determining where to situate a site, or where to establish a village in prehistoric times? In essence, this makes location the key problem for land use (Chisholm 1968: 12). In terms of locational studies, Roper (1979: 119-120) has made the distinction between two sets of approaches after a synthesis of the studies under the name of site catchment analysis. One set, as in the central place theory or gravity models, deals largely with man-man relationships in ordering space. The other ---site catchment analysis, belonging to the other set of approaches, is mainly concerned with man-land relationships in arranging site location and land use. Accordingly, she goes further to argue that site catchment analysis is more concerned with the inventories of natural resources (like abundance of plants or animals) as determining factors in deciding the site of a village, than on other factors such as band spacing or population density (Roper 1979: 120). Yet, the social factors like demography have not been overlooked.

This emphasis on economic or man-land relationships in site catchment analysis seems to have come from related studies in geography and ethnography, from which the method is derived. For example, Chisholm (1968: 102), a geographer, considers that water, arable land, grazing land, fuel and building materials are five basic economic elements for an agricultural settlement. Similarly, for Bushman hunters and gatherers of the Dobe area of Botswana in the harsh Kalahari Desert, Lee (1969: 56) believes that the single most vital factor for determining the site of a camp is a permanent waterhole.

6.1-2 Distance Between Site and Resource

The distance between a site and its surrounding resources, such as water, arable land or fishing grounds, is a crucial factor in determining the site's location, and it is argued that this is universal in all locations worldwide (Chisholm 1968: 12). In other words, the closer the resources are to a site, the more important they will be considered, or the more likely they are to be exploited. Conversely, the further they are from a site, the less likely these resources are to be consumed (Vita-Finzi and Higgs 1970: 7).

In practice, archaeologists usually demarcate an area (in form of a circle) around a site for assessing the site's catchment. This is considered the characteristic that distinguishes site catchment analysis from other man-land approaches (Roper 1979: 120). Regarding the specific distance from a site or the size of a site catchment area, most archaeologists have widely followed Lee's ethnographic observation of the !Kung (Lee 1969: 61) and used a six mile or 10 km radius catchment zone or circle for foragers. By the same token, they have adopted the studies by geographer Chisholm (1968:131) and employed a 5 km radius catchment circle for farmers. These distances are usually measured in terms of the time it takes to cover the distance; that is about 2 hours' walk for the 10 km radius for foragers and 1 hour's walk for the 5 km radius for farmers (e.g., Roper 1979).

Nonetheless, the mechanical use of Lee and Chisholm's figures has been criticized (Roper 1979: 124). In fact, the 10-km/5-km catchment radii are seldom reached in real situations, and in most cases they stand for the longer and more rarely the maximum limits of distance that foragers/farmers normally would go or would not exceed, to find food.

The 10 km radius Lee observed was often the maximum distance that the !Kung Bushmen would walk from their camps to procure food resources. Generally they would not go as far as the limit if foods were abundant closer to their camps. Lee (1969: 59-60) has summarized the basic principle of Bushmen foraging strategy in a single sentence as this: "At a given moment, the members of a camp prefer to collect and eat the desirable foods that are at the least distance from standing water". As Lee (1969: 60) further describes, the Bushmen would typically stay at a camp for a few weeks or months to consume the food found in its vicinity. The food would be exhausted within a one-mile radius in the first week before they needed to go any farther to the two-mile radius in the second week, and then the three-mile radius in the third week if necessary. Therefore, it can be assumed that if the foods within the one-mile radius were enough to support the camp residents for the weeks or months, they would not have to gather foods from further away (Lee 1969: 60). As Lee (1969: 60-61) finds, when the distance reaches six miles, the cost curve for procuring food increases sharply, which means that, the Bushmen would normally be reluctant to go beyond that point for food unless they were forced to do so, such as during the dry season. However, even in the dry season, some of the camp members, such as the elders, would choose to collect the less desirable foods nearby, and only the younger people would make the longer trips to distant resources. With the distance increasing, more camp members would more likely search nearby less desirable foods and fewer people would go on the long trips for the more desirable ones (with better taste and nutrition, for example). In addition, it should be noted that, during the rainy, food-abundant season, the catchment radius never exceeds the 3-mile or 5 km level (Lee 1969: 61). Also worth noting, the Bushmen were living in a harsh desert environment with only the simplest technologies (Lee 1969: 47). The site catchment radius would be much smaller if it is in a resource-rich environment and the site residents possess more advanced technology, for people would not need to go so far to procure food under those circumstances.

Similarly, the 5-km radius that Chisholm (1968) suggests for a farming settlement also appears to be the maximum distance under normal situations. In fact, in many of the cases he has quoted, the radius is a lot shorter than 5 kilometers. For instance, in Finland and the Netherlands, the average distance from the dwelling to the fields was between 1.0 and 1.1 km (Chisholm 1968: 46). In China, the average distance between farmstead and field was even shorter (0.6 km) and the average distance to the furthest fields was 1.1 km in the country as a whole. Similar situations were present in Pakistan as well. Furthermore, in such rice double-cropping areas as Sichuan ('Szechwan' in Chisholm's book) of southwestern China, the average distance between field and farmhouse was just 0.3 km (Chisholm 1968: 46).

Other cases also indicate that site catchment radius or size can vary a great deal, due to variations in environments and other factors (Zarky 1976: 119). For example, Woodburn (1968) has proposed a one-hour, rather than the more accepted two-hour walk distance for Hadza foragers. Akazawa (1980) also believes that the 10 km radius was too large for the hunter-gathers at the Nittano site in Japan.

It turns out that under normal situations, a distinction can be made between a smaller catchment area that immediately surrounds a site, providing daily subsistence to the site's inhabitants under normal situations, and a larger catchment area around the site, of which the resources are more irregularly exploited such as in difficult times. Moreover, in most cases this smaller or regular catchment area has a radius much shorter than 10 kilometers for foragers or 5 kilometers for farmers, while these two normative radii may often represent the unusual even maximum limits of the larger or irregular catchment areas in many cases.

6.1-3 Primary and Secondary Site Catchments

Starting from an alternative point, Flannery (1976) has come to a similar conclusion to distinguish a regular site catchment zone from an irregular one. Unlike most other site catchment analytical methods, he uses the remains found at a site as a given to trace the probable origin of those resources. Using this method for assessing the catchment of a Formative agricultural village in Oaxaca, Mexico, he claims that the most basic subsistence needs of the village would have been met within a 2.5-km radius of the site. He has even indicated that this 2.5-km catchment tended to provide more land than the village would need (Flannery 1976: 117). On the other hand, the resources irregularly exploited by the villagers would have been derived from a larger area, even as distant as over 200 km away from the site for obtaining exotic ceremonial materials (Flannery 1976: 106-111).

Different names have been assigned to these two kinds of catchment areas. The most widely used ones are the term *site exploitation territory* for "the area immediately accessible to a site's inhabitants", and the term *site catchment* to mean "the total area from which the contents of a site were derived" (Roper 1979: 124; Renfrew and Bahn 1996: 243). However, as the site exploitation territory is also part of the site catchment, there is no difference in type between the two except for the difference in degree within a same type, it would be confusing to use two different terms to refer to something in the same category. Therefore, it is preferable to employ a single name for a single category and use different names to denote the different variations in degree of the same category. In the case in question, the single category is the site catchment, and the variations of the site catchment degree are that one catchment is closer to a site and smaller in size. The other is farther from the site and larger in size. In this case, I would use the terms *primary site catchment* (PSC) and *secondary site catchment* (SSC). The primary site catchment refers to the area whose resources are under primary, regular and often daily exploitation by a site's occupants, while the secondary site catchment stands for the area whose resources are exploited but irregularly or occasionally by the occupants. In other words, the primary site catchment, normally within the immediate vicinity of a site, covers the area where the most basic or vital subsistence resources are drawn. By contrast, the secondary site catchment tends to accommodate the resources that, though important, are not major subsistence source and are further from a site and not of regularly vital utility. Apparently, the former is smaller in size than the latter.

In short, the terminology of primary site catchment and secondary site catchment are used largely in terms of the degree in site exploitation regularity and intensity. It is also understood that a primary site catchment is more of subsistence in nature than the secondary site catchment. The secondary site catchment subsistence contribution is of lesser importance but often embodies other, for instance ceremonial or prestigious, meanings for the site inhabitants.

6.2 Size of the Primary Site Catchment in Neolithic PRE

Bearing in mind the concepts of site location, distance between site and resource, and the primary and secondary site catchments, the site catchments in the PRE during the Middle and Late Neolithic periods will further be analyzed in this section.

The artifacts found suggest that some may have been brought in from far away, even as far as northern Guangdong (e.g., the ceremonial *yue* axe) or Lower Yangzi River (e.g., the *dou* vessel), although most of the PRE materials should have been drawn from areas immediately surrounding sites. It is very likely that the exchange would have been for obtaining exotic goods for the PRE people, but a subsistence purpose cannot be excluded. Even though we should not ignore the importance of the materials obtained from distant areas, for the inquiry of basic subsistence it appears sufficient to focus just on the subsistence resources derived from around a site in immediate distance. This is because the local resources should supply the most regular food resources for the site. In terms of site catchment analysis, the area that covers the resources surrounding a site in immediate distance should be defined as the primary site catchment, while the area beyond this one should be defined as the secondary site catchment. Therefore, for this study of the subsistence of the PRE, it is sufficient to emphasize only the primary site catchment. In fact, it would be impossible or unwise to do a site catchment analysis for the secondary site catchment of the PRE, because the secondary site catchment area would be too large. The area is, excluding topographic distortion, more than 200 km from the PRE to the Shixia Culture in northern Guangdong and over 1,000 km to the Lower Yangzi River area.

The logical next step is to define the size for the primary site catchment of a site in the PRE area in the Middle and Late Neolithic. To do this, some key determining factors should be taken into account. These factors should include the characteristics of environments, nature of subsistence activities, technological levels and possible cultural traditions. After taking these significant determining elements into consideration in the following section, it appears that the primary site catchment size of the PRE during the Neolithic would have been quite small.

6.2-1 Farming Foragers in Affluent Environments

Rich environments, readily available food, mild climate, the availability of plants and animals all year long, and advanced technology (sophisticated skills in procuring wild land or aquatic resources), are all aspects credited as conditions and situations of the PRE people during the Neolithic, and that also pertain to the site catchment analysis.

Chang (1981) has termed the precursors of the early farmers in the Pacific coastal areas of China as "affluent foragers". These people had plentiful and various food resources to consume. As discussed earlier, the PRE people were also likely living in an affluent environment during the Neolithic, being located around the estuary of the biggest river of South China and along the southern subtropical and tropical coast of South China Sea. During most of the year, most site inhabitants would have had access to rich marine, riverine and terrestrial wild or domesticated resources, with high density and year-round availability in such (sub) tropical, estuary and coastal settings possessing rich sun radiation, heat, precipitation and other water resources (Lu 1990: 325-327). As detailed discussion of the rich resources in these environments has already been done, the major points will only be summarized here. For instance, two to three crops of grain and more than eight crops of vegetables can be grown in a year. In addition, there are a large variety of tropical fruits and crops (Xu and Peel 1991: 135). The site distribution of the Middle Neolithic suggests that the first peopling of the PRE would have been due to the lure of rich food resources there, as discussed above. Most sites are situated close to the river mouth in a setting of estuary riverine and marine ecotone. This setting usually has abundant and diverse marine and land foods ideal for procurement within a small patch of geographic niche (Bailey and Parkington 1988). Typically, a site is located on a raised sand bar in a well-sheltered bay, protected from winds, and often has streams, lagoons and/or mangroves, and modern cultivated lands nearby. The lagoon with mangroves is one of the resource-richest areas, with abundant shrimp, crab, birds, shellfish and fish, ideal for collecting and fishing. Research shows that Hong Kong's mangroves have at least 45 bird species, 23 invertebrate species and 17 plant species (Wong and Tam 1997: 21-28). From an ecological perspective, many of the sites are located within the advantageous protected shores or enclosed shores, which are well sheltered from winds and waves. They also have extremely dense coverings of organisms for human consumption (Morton 1983: 129-170, 206-230). These kinds of ecologically affluent and stable areas are also favorable for sedentism and population increment (Akazawa 1988: 89).

Technology, such as the advanced Neolithic industries as the manufacturing of completely polished stone tools, coarse and fine pottery, and craft specialization like jade ornament or canoe making, were all well developed in the PRE in large quantities. This suggests that it should not have been a problem for the PRE people to carry out necessary foraging and/or farming tasks, given the level of technology attained. As discussed above, the PRE people would have largely been farming foragers, and may have based their subsistence upon broad spectrum foraging, while doing some sort of cultivation of tubers or 'vegecultures' and/or seed cultures such as rice (Li 1983). Both foraging and farming resources would have been available in close vicinity to a site.

The main implication of these affluent (sub) tropical, estuary and coastal environments is that the PRE people in the Neolithic may have been able to procure adequate food from the immediate surroundings of a site throughout the year. Many ecofacts or artifacts that have been previously discussed, also suggest that most subsistence activities such as shellfish collecting would have been carried out in the close proximity of sites. Furthermore, domestication or cultivation would have been particularly applicable within a confined space, considering the dense forests, limited flat land and hilly topography, as addressed below.

6.2-2 Local Cultural Traditions

The PRE subsistence is characterized by fertile lands or rich resources, exemplified with the high output of two major items: rice and fish (thus called "Home of Fish and Rice", or Yu Mi Zhi Xiang in Mandarin), though many other high-yielding terrestrial and aquatic foods such as tubers, roots, oil seeds, legumes, fruits and vegetables are also eaten. On the other hand, these two kinds of subsistence resources are mainly derived from circumscribed or mountainous topography or lands. This makes for a high population density, distributed in small villages.

In modern China, village size varies with changes in topography. Jin and Li (1992: 19-20) have argued, "There is a clear relationship between topography and village size" in China as a whole, and usually large villages are found on broad plains and small villages on hilly, rugged or patches of fragmented areas, though small villages may also be associated with plains. In an extreme example, the researchers (Jin and Li 1992: 20) have shown that in the fertile and productive Chengdu plain of the Sichuan province in south-western China, there are more than 1,000 villages (less than 100 persons each normally) on an area of 100 km²; that means over 10 villages per 1 km²! This implies that when lands are fertile enough, farmers may not need to walk far from home to work on the fields.

In addition, the production per man in the rice region of southern China is much higher than that in the wheat region of northern China, and the farms of the former are smaller than those of the latter. This conclusion was drawn by Buck (1937a: 119), based on an extremely extensive field survey over 16,786 farms in 168 localities and 38,256 farm families in 22 provinces in China during 1929-1933. For instance, on average, a farmer in the Spring Wheat Area (one crop area) in northern China has a crop area of more than three times the size of that of the Double Cropping Rice Area in the Lingnan region; even that of the Yangtze Rice-Wheat Area in the Middle and Lower Yangzi River region is twice as large as that of the Double Cropping Rice Area of Lingnan (Buck 1937a: 10, 120). By contrast, the Rice Region rice of southern China yields three times as much food per unit of land as the Wheat Region crops of northern China (Buck 1937a: 139).

Usually defined as a productive double cropping rice area, the Lingnan is rich as well as hilly and rugged. It is believed that this kind of mountainous topography has physically created small local communities (Nuttonson 1963: 18). Since the Pearl River Delta/PRE area is one of the most fertile, intensively cultivated and densely populated farming areas of China (Skinner 1964: 207-208; Nuttonson 1963: 20), the places where archaeological sites have been found are resource-rich areas in historical and modern times. Alternatively, they are certainly circumscribed in topography as well. For instance, during the early 1900s in Zhongshan County of the PRE the average distance from all parcels to farmstead was 0.6 km, and only 0.7 km for the average distance of the farthest parcels (Buck 1937b: 47). In addition, there was an average of 376 people per square kilometer of crop area in Zhongshan County (Buck 1937b: 424). In the Chaoan County of middle-eastern Guangdong, the average distance from all parcels was just 0.4 km, and an average of 0.9 km for the farthest parcels (Buck 1937b: 47). Relying on both fishing and farming, the Chawan village in southern coastal Guangdong has also defined its subsistence activity areas to consist of both the farmland in immediate distribution and fishing space including the beach and surrounding sea (Warfield 1992). Although no exact data on site catchment size is provided for the farming field or beach, from the author's description it seems that the fields would have been small, and the fishing area would not have extended beyond the beach with two headlands at its both ends, nor would it have exceeded the inshore part of the sea in a regular base (Warfield 1992: 114-115).

Hong Kong is also mainly hilly and mountainous, with about 14% of the land arable and for animal husbandry, taking place mostly in the New Territories (Nuttonson 1963: 130, 319). In the meantime, in Hong Kong, the "cultivated areas are confined to the coastal plain in the northwestern areas of the mainland and the numerous small valleys which open out onto the narrow flats"; and the "nature of the terrain precludes any extensive development of agriculture" (Nuttonson 1963: 319). Also, it is pointed out that the east part of Hong Kong is more rugged, difficult to access and less fertile than the west part (Balfour 1941). Because it is also less cultivated and populated than the west part, the east part of Hong Kong is characterized with thicker natural vegetation and less erosion --- probably more similar to the prehistoric environment than the west (Nuttonson 1963: 131; Anderson 1968). Likewise, the Deep Bay of northwest New Territories is regarded as one of the most aquatic resource-rich regions, as are the main farming areas, of Hong Kong (Anderson and Anderson 1973: 57-62; Nuttonson 1963: 319). Interestingly, most archaeological sites have been found in the west, southwest, or northwest areas of Hong Kong.

Historically, most Hong Kong villagers were rice farmers. The Sheung Wo Hang village researched by Hase and Lee (1992) is a good example, for it is "entirely typical of hundreds of other villages throughout the New Territories of Hong Kong" (Hase and Lee 1992: 94). The village is located on a very rugged hilly area in north-eastern part of the New Territories of Hong Kong, and was first settled in the late 17th century. Before it was settled, the area was originally poor in farmlands, being "mostly small patches at the heads of the little bays where one of the mountain streams reaches the sea" (Hase and Lee 1992: 79). The village used to grow two crops of paddy rice, and often winter sweet potatoes as a third crop, in the smaller fields. However, around 1975 farming completely ceased (Hase and Lee 1992: 80, 83). Between 1900 and 1905, there were some 700 villagers in total, making up to about 85-100 households. It has been estimated that the village was not poor then, because there should have been sufficient subsistence fields in the immediate area to support more than 100 households (Hase and Lee 1992: 83). As shown in the map of the Sheung Wo Hang village area (Fig. 13), the regular subsistence activity area looks like a long belt. The average distance of the farthest fields from the village is about 0.8 km, found on both ends of the belt (Hase and Lee 1992: 82). It is generally understood that the northeastern NT was poorer in terms of subsistence resources such as farmland than the southwestern NT. In this way, villages in the southwestern NT may have been able to have even smaller primary site catchments than those in the former area. Furthermore, the Neolithic village was probably smaller, so it would have had lighter requirement for subsistence to support the villagers. This also supports the smaller primary site catchment needed than that of today.

In Neolithic times, however, two things may have been different from those of today. 1. The rice land might not have been as fertile and extensive, being affected by salty water, and limited flatlands. 2. Population density may have been much lower than today as well, judging from the relatively small site numbers, site size, low occurrence and small sizes of houses, and the nature of foraging-based subsistence.

If it is true that the rice cultivation scale was limited at that time, it fits the argument that rice farming may have played a limited role in the subsistence of the PRE in the Neolithic. Even in marine fishery, the area that boating or canoeing could have covered in Neolithic time should have been much smaller than that of today. Although it is hard to calculate exactly, fishing would have basically been carried out along inshore coastlines, rather than on offshore ocean, as supported by unearthed ecofacts.

The question at this point becomes, how big would a primary site catchment have been in the Neolithic PRE? Based on the ample evidence brought forth in this paper, the modern primary site catchment size for farmers in southern China, including the coastal PRE, is about 0.5 km in radius averagely. For such people with subsistence that combines farming and fishing as the Chawan villagers in southern coastal Guangdong, the primary site catchment area also appears pretty small (Warfield 1992). Even the beach "begins so near the southeast entry of the village of Chawan" (Warfield 1992: 114). As Neolithic PRE people probably leaned more towards foraging than farming, a larger primary site catchment may have been assumed than that of farmers. However, the rich resources and hilly and rugged conditions would have distorted and shortened the true distance of site catchment radius. For example, the Sheung Wo Hang villagers have to walk through very zigzagged and hilly paths to leave the village to the fields or elsewhere. This terrain would discourage people from working too far from the village, especially when resources are rich in the immediate area (Hase and Lee 1992: 83). The population of Neolithic PRE would have also been much lower than the average number of 376 people per square kilometer of crop area in Zhongshan County of the PRE in the early twentieth century, as mentioned above (Buck 1937b: 424).

Although there might have been changes or variations between the Middle Neolithic and the Late Neolithic in terms of site catchment size, I will use a 1 km radius for the primary site catchment of the PRE during the Neolithic.

6.3 Analyzing Primary Site Catchments of Neolithic PRE

Since only the primary site catchment will be assessed, the word site catchment will be used as the synonym of primary site catchment in the following text, unless otherwise noted.

6.3-1 Site Catchments in Regional Perspective

A clear trend of two peaks of development, as suggested by overlapping of site catchments, is present in the Late Phase of the Middle Neolithic (1-2) and the Late Phase of the Late Neolithic (2-2), respectively.

In the Early Phase of the Middle Neolithic (1-1), sites are scattered around the river mouth and the coast of the Shenzhen mainland (Fig. 14). None of the primary site catchments is overlapped at the 1 km radius, implying adequate food supply and low population pressure. Considering the relatively transitory nature of the sites during this phase as discussed in earlier chapters, resources of this phase would have been more abundant than the site catchment would suggest. This is because a same group of people would have been able to consume foods from more than one site catchment.

More new Late Phase, Middle Neolithic (1-2) sites have appeared around the estuary, with the disappearance of most of the Shenzhen mainland coastal sites (Fig. 15). More importantly, six primary site catchments (three sites in one cluster) overlap each other within the 1 km radius. (See site clusters 2/9/10 and 4/8/16 as shown on Fig. 15). People then would have come to the river mouth to compete for the most optimal aquatic and other resources after they had recognized that this was the best spot for procuring food within the entire PRE area. Research elsewhere indicates that it is very critical for people to situate a site at an optimal resource spot of a region, though it would be hard to define the boundary of a "region" (Zarky 1976). In addition, if sedentism indeed increased, food sources would have become relatively less abundant than during the last phase, particularly with a possible population increase.

Interestingly, for the Early Phase of the Late Neolithic (2-1) fewer sites have been identified than in the last phase, with only two site catchments (site 1 and 6) almost overlapping (Fig. 16), with all others scattered far apart from each other. This may have been due to dramatic social impacts resulting from the intrusion of the rice farming Shixia Culture during this phase, although the details of the impacts have not yet been investigated.

During the Late Phase of the Late Neolithic (2-2), when life probably re-settled after the impacts, the PRE seems to have witnessed its development peak for the entire Neolithic period. Many more sites are present and they are also more densely situated, clustering around the river mouth (Fig. 17). Consequently, more site catchments overlap in light of the 1 km radius, clustering in four groups. (See site clusters 2/9, 7/12, 10/13, and 8/16). Also, some of the overlapped site catchment clusters are located so close, as seen with 7/12 and 10/13 that they almost overlap. Furthermore, the distance between each site catchment of the whole area is at its minimum as compared to previous phases. This very likely indicates a peak in resource exploitation or competition and population pressure during the entire Neolithic period.

It is likely that some of the overlapping site catchment clusters, such as cluster 7/12, might have belonged to the same group of people. This would indicate less food stress than what the site catchment cluster suggests. Although not conclusive, some of the sites may have been central, while others may have been satellite sites. However, owing to the probable overall increase in sedentism and population (e.g., newcomers to the area from post-Shixia cultures of northern Guangdong), plus expansion in economic and social exchange (e.g., appearance of tooth removal customs), food resources of this phase would have been in greater demand than in previous phases of the Neolithic.

6.3-2 Site Catchments of Individual Sites

Analysis on an individual site catchment explores the potential, not the actual, resources of the site. It is concerned with the amount of resources available in the site catchment area (Vita-Finzi and Higgs 1970). It also gives us "a good rough sketch of the resources within walking distance of a village" (Rossmann 1976: 103). As this concept assumes that the further the area is from a site, the less likely it is to be exploited, or the less important it becomes, Vita-Finzi and Higgs (1970: Table 3) have used a "weighting" parameter to measure the difference in the importance of resource distribution. The land in the 1 km circle around the site becomes weighted 100% or fully exploited; land between 1-2 km weighted 50%; and so on. However, Neolithic people might not have used the resources in such a methodical way. This is especially true since the PRE primary site catchment is considered quite small. Resources on any spot within the 1 km primary site catchment will be weighted equally.

Since a large area of the PRE was accessible only by canoe or boat, particularly between the islands, the walking time derived from the site catchment is converted into canoeing time. According to Casson (1971: 281-288), under favorable winds along coasts, ancient boats had an average speed of 4 to 6 knots, but 2 to 2.5 knots under unfavorable winds. Thus, the combined average of the two is about 3.6 knots, equaling to 6.7 km per hour. Considering that Neolithic canoeing might have been much slower than ancient boating, it would be reasonable to use 2/3 of the speed of the latter for the former, i.e., about 4.4 km per hour for Neolithic canoeing. Since walking on rugged and winding topography for 1 km would take some 1/3 to 1/4 hour, spending this same length of time, Neolithic canoeing will cover some 1.25 km. It can be assumed that canoeing time is similar to walking time in the site catchment analysis because it has been pointed out that working on the sea is by no means easier, and is probably in fact harder, than working on the land. After studying the boat people of Hong Kong, Anderson (1970: 34) argues that boat life requires heavy eating, for the "exigencies of boat work and of fishing are such that caloric intake must be maintained at high levels...certainly far higher than those of a sedentary land person." There is no reason to imagine that Neolithic canoeing took less energy than modern boating, given its more rudimentary technology.

If this figure of canoeing time is used, the primary site catchment of the PRE will be shaped into an irregular form like this: the area on the coast extends towards the sea for 1.25 km, while the area towards the land extends for only 1 km. As this is just a theoretical construct and 1.25 km is not a far cry from 1 km, for the convenience of comparison, the regional site catchment map has only been marked with the 1 km radius, and the individual site catchment map will be marked with 1.25 km, 1 km and 0.5 km radii.

Limited by difficult access to essential materials in Mainland China, and the fact that the bulk of the site samples of the PRE Neolithic have been found in Hong Kong, the individual site catchment analysis will be carried out mainly for the Hong Kong sites. After all, as all the concerned Hong Kong sites are around the Pearl River Estuary, my choice will still be highly representative. A colored Hong Kong Vegetation Map prepared by the World Wide Fund For Nature Hong Kong is used (WWF HK), which is said to be the only map of this type available (Ashworth *et al.* 1993).

Three trends have been detected. 1. At many sites the components of resources within the site catchment seem to change little through the Middle Neolithic (Stage 1) and Late Neolithic (Stage 2). This is because these sites contain evidence from both Stages. 2. In the Late Neolithic, more inland or upland sites are present, thus at some sites, the elevation of resources has increased and the area of water decreased. 3. Several sites have appeared at the headland in the Late Neolithic, indicating probable intensification of food procurement.

Considering the 1st trend, many sites have been used for both the Middle Neolithic (Stage 1) and Late Neolithic (Stage 2) at exactly the same location, suggesting little change in resource components. These sites are around the river mouth, particularly the east bank (i.e., northwestern Hong Kong), including Yung Long, Chung Hom Wan, Sham Wan, Tung Wan, Sha Lo Wan, Lung Kwu Tan, Hai Dei Wan, Tungwantsai North, Sham Wan Village, Tung Kwu, Ngkayuen, Tai Long, Lo So Shing, Fu Tei, Sha Chau in Hong Kong, and Houshawan and Chaotangwan in Zhuhai. Although the proportion of resources available may have been variable during the two Stages, or the extent of exploitation may have changed, it is in fact impossible to reveal it by current site catchment analysis.

At the Yong Lung site (Fig. 18), in the 1.0 km radius there are altogether ten types of vegetation (number 1 to 10, Table 4). Of them, nine types are present in the 0.5 km radius, suggesting similar vegetation types within the site catchments of these two sizes, though the proportion of each is different. However, four (number 3, 5, 10) out of the ten types are modern developments, while it is hard to tell whether the rest was a historical or earlier outcome (Ashworth *et al.* 1993: 10-13). In the 0.5 km and 1.0 radii, water amounts to 30-40% of the total space, and 44.3% in the 1.25km radius. It can be concluded that the main subsistence activity of Yong Lung would have been procuring aquatic resources. Another example is the Sham Wan site (Fig. 21) that has not only been used for both the Middle and Late Neolithic Stages, but also overlapped with the Lo So Shing site during both Stages (Fig. 15; Fig. 17). Similar to the Yong Lung site, nine types of vegetation are present in the 1.0 km catchment, but less water (29.5%) is covered. Apparently, marine resources should have also been important at Sham Wan, and it is not necessary that Yong Lung relied more on marine foods than Sham Wan, just because its site catchment has larger marine water coverage than Sham Wan's.

Representing the 2nd trend, more upland sites appear in the Late Neolithic, and more site catchments are overlapping as well. The Fa Peng Deng site is a good example, where within the 0.5 km radius there is no water at all, and the land is at 100 m or more above sea level (Fig. 19). There is merely 1.7% water in the 1 km radius (Table 4). Even in the 1.25 km site catchment, water covers just about 10% of the total. The site is so distant (some 1,000 m) to the sea and is as high as 200 m in altitude, it is hard to assign a fishing aspect to it. Instead, terrestrial resources or farming may have been the major subsistence. It is, however, very interesting to see that this site overlaps with Pa Tau Kwu (Chiu 1995), a headland site with coast on three sides and should have had fishing as the major subsistence (See site cluster 10/13, Fig 17). It would be likely that the same group of people used both sites, for they are so close with each other and belong to the same period. If this is true, it is probable that this group of people exploited both aquatic and land foods according to the optimal seasonality of foods; for instance, October to April are the best months for fishing in the PRE, while summer is the off-season (Anderson 1970: 55). Despite this, it is still difficult to tell which subsistence activities were more fundamental than others in this case.

As for the 3rd trend, the appearance of several headland sites, i.e., Sha Lo Wan (2-1, 2-2), Po Yue Wan (2-2) and Pa Tau Kwu (2-2), in the Late Neolithic (especially the Late Phase) indicate probable expansion and intensification of food exploitation. This is particularly interesting considering that the headland seems to not be an optimal location for permanent settlement as discussed in Chapter 5.

For instance, the Sha Lo Wan headland site outstands so much into the sea that all its 0.5, 1.0 and 1.25 km site catchments are mostly covered by water (Table 4). Yet, in its 1 km radius there are still nine types of vegetation (Fig. 20). Furthermore, it is argued that various activities would have been carried out and five categories of activity are identified at the site: food procurement and preparation, construction, craft activities, ritual and burial and social activities (Drewett 1995: 52). The author assumes that the site was forested when first settled, and some part of it would have been cleared for the construction of houses. The presence of fire grates suggest cooking at the site. He also points out that the south and eastern slopes of the site may have been terraced for horticulture, perhaps for tubers, legumes or vegetables. If rice had been cultivated, it would have been planted on the wetter, low-lying land at the southeast. Some of the polished stone tools are not locally made, indicating exchange (Drewett 1995: 53-54).

6.3-3 Resources in Site Catchments

In discussing the PRE site catchment resources whether in a regional perspective or in an individual site, landscape changes through history should also be taken into account. As the Hong Kong Vegetation Map prepared by the World Wide Fund For Nature Hong Kong (WWF HK) and the accompanying book (Ashworth *et al.* 1993) have provided very little information on the environmental history, other sources are resorted to.

Much original site ecology may have been destroyed by urban developments. Despite the fact that the sites I have chosen for analysis are in the countryside where ecology is better preserved than in urban areas, many scholars have pointed out that much of the cultivation may well have been a historical development (Davis 1952: 74). "Hong Kong's present vegetation is thus a result of prolonged human impact", although 6,000 years ago "the whole of South China would have been covered in dense forest and Hong Kong would have been no exception" (Ashworth *et al.* 1993: 10). This means that the vegetations the site catchment has revealed may not be the same as those of the Neolithic time.

Since marine water usually has a high percentage among other resources within the PRE site catchment except for the upland site (Table 4), it can be assumed that the main purpose of the peopling of the PRE during the Neolithic was most likely for aquatic resources, particularly fishing. Nonetheless, the types of resource that were consumed the most by the site residents may not necessarily have been the types of resource with the highest percentage or located close-by (Zarky 1976). For example, in the 1 km radius of the Sham Wan site catchment, low shrub with grass account for 34.3%, while water only 29.5% (Table 4; Fig. 21), but it may be unwise to hence conclude that terrestrial resources were more important than aquatic ones for the Sham Wan inhabitants in the Neolithic. It would also be unwise to assume that the percentage of foods exploited is proportional to the percentage of the availability of that food within the site catchment area. A satisfactory answer needs to combine information from different lines.

In 1927, a chemical analysis on 16 soil samples from Hong Kong (mostly from uncultivated land), found that they all had an acidic nature (Davis 1952: 155-169). The only soil sample that is faintly alkaline is from cultivated land, which had recently been limed (Davis 1952: 155-181). This suggests that many, if not most, of the Hong Kong original soils may have not been suitable for farming in the Neolithic. However, if lime is added, the acidic land can become fertile (Davis 1952: 182-183). It is widely believed that lime was made by burning seashells and coral in Hong Kong historically, and many such kind of lime kilns have been found, mainly on islands such as Lantau (e.g., Cameron 1979). Anderson (1968: 37) has indicated that rice produced in historical Hong Kong was of a high grade, and was once traded for larger quantities of lower-grade rice with other regions. But did the PRE people begin to lime or improve the land for farming in the Neolithic? Even if so, farming products would not have contributed significantly to the local diet then, given the rich foraging foods available and the inconvenience or difficulty to improve farming.

Chisholm (2001) has recently done an analysis of the stable isotopes of carbon and nitrogen on 13 human bone samples from the Tungwantsai North site (or Ma Wan as commonly called) of the Late Neolithic (2nd Phase, i.e., 2-2), to obtain information about the diet of the Neolithic inhabitants of the site. Ten out of the 13 samples were accepted, in terms of the quality of extracted collagen. He argues that the analytical results, though not precise and conclusive due to several reasons, can provide a general picture of the paleo-diet of the site's people, and the picture may be improved when a larger human dietary species database for the area is available (Chisholm 2001: 7). Incorporated into this paper are also previous isotopic studies on humans and food species in Hong Kong. The samples pertaining to my discussion include those from three

Middle Neolithic inhabitants of Sham Wan, two historical inhabitants of Pui O, one modern inhabitant of Sham Wan, one Late Neolithic dog of Po Yue Wan, and one dog of the Tang Dynasty (618-907 AD) from Chek Lap Kok (also see Meacham 1990).

The conclusion of the isotopic analysis is that the diet of the Tungwantsai North people of the Late Neolithic was "high in marine species" (about 85% of food protein from marine sources), "although this estimate is uncertain due to the great variation in food species results" (Chisholm 2001: 9). The result is not surprising; given the fact that most of the 1 km catchment area of the site is covered by marine water (Site 12, Fig. 17). However, on the other hand, this would also mean that the Ma Wan people likely consumed a certain amount of terrestrial foods as well.

The author also indicates that the marine intake of the Tungwantsai North inhabitants is higher than that of the Neolithic and more recent inhabitants of Sham Wan and Pui O sites. He concludes that this is because the Ma Wan people dwelled on a small island and had less access to terrestrial resources than the Sham Wan and Pui O people, who lived on a larger island with better access to land foods. In addition, the diet of the latter was more varied than that of the former whose food content was monotonous, without important differences between individuals (Chisholm 2001: 8-9).

Extremely interesting, in the Sham Wan and Pui O cases, Chisholm (2001: 8) has observed that "there was no significant shift in carbon values and hence in diet from the Neolithic to recent times"!

That the diet has changed little from the Neolithic to the present may also be true in other sites of Hong Kong. This is because that the diet species values of both the Late Neolithic dog of Po Yue Wan and the Tang dog of Chek Lap Kok "have a value similar to the Ma Wan humans" (Chisholm 2001: 8). Since dogs tend to eat the leftovers of their owners' diet and thus have the same protein source (Chisholm 2001: 8), the similarity of isotopic values between humans and dogs suggests that the human diet in these sites did not have significant change from the Late Neolithic up to at least the Tang Dynasty.

This argument should be considered carefully. If it points to similarity in diet between the Neolithic Ma Wan inhabitants and the Neolithic, historical or modern people of other sites in Hong Kong, it may well be an indication that these inhabitants consume(d) large amount of marine foods, as it was/is. The site catchments of concerned sites also support this. High marine water coverage occurs in the site catchments of Sham Wan (Fig. 21), Po Yue Wan (Site 23, Fig. 17), and Chek Lap Kok (Sites 2, 9, 10, Fig. 15; Sites 2, 9, Fig. 17).

On the other hand, however, the above isotopic analytical results also imply that low proportion of terrestrial food value may not mean little consumption of land foods in the diet. As the authors (e.g., Meacham 1990; Chisholm 2001) have not supplied information on the economic context from which the above samples were taken, it is not clear whether the people were fishermen or farmers in the historical or modern times, although fishing can be assumed very important for the Neolithic folks.

But other research indicates that even fishermen can have high intake of land foods. Today's highly specialized boat people - pure fishermen - in South China rely heavily on farmers to support them with land products for daily life. For example, the boat people of Hong Kong mainly eat rice, vegetables and fishes for food. "A normal meal consists of rice and topping", and fishes and vegetables are the topping for rice. As rice takes a high percentage in daily meals (eaten in lunches and dinners) it is "indeed the basic food" (Anderson 1970: 28-29, 34-35). If the above-mentioned Sham Wan, Pui O or Chek Lap Kok people of the modern or historical times were more land-based than these boat people, they should have at least the same, probably higher, intake of terrestrial foods than the boat people. Therefore, it seems likely that terrestrial values could be under-reflected or underestimated in isotopic analysis which emphasizes protein. When I dug the Ma Wan site in 1997, I observed that there were cultivated lands around, within 1 km surroundings, though currently there is no way to tell the situations in the Neolithic.

Furthermore, since the PRE people of the Neolithic may have subsisted on broad-spectrum foods and may not have become specialized boat people or land people, they were likely doing both fishing and farming, though perhaps in rudimentary forms, as well as other kinds of foraging. It is not likely that they served as either professional fishermen or farmers, who as nowadays farmers or boat people only cultivate or fish. Also, it is not very likely that certain group of people were fed by another group on certain fixed types of foods, such as the boat people being fed by the land people on rice and vegetables in Hong Kong. Some of today's fishermen in the PRE also farm, while they fish for their major living (Huang 1990: 109-111).

In addition, fishing may not be a more welcome (probably a harder) job than farming, and fish may not be available all year round, as discussed above, thus the PRE people in the Neolithic may have cultivated or foraged for land foods in some seasons of the year. For example, since the summer is the off-season for fishing in the area (Anderson 1970: 55), that may have been a time for hunting, fruit collecting or farming. It may have become more so in the Late Neolithic, when fishing was probably under a larger demand than earlier due to increase of people. This point seems to be supported by the appearance of the upland sites then.

In addition to the upland or inland areas, the low lands around the sand dune sites or bays in the PRE could have been utilized for farming as well. In Hong Kong, some unique salt-tolerant rice can even grow in salty marshes, though less high yielding (Anderson 1968: 37). If this was true in the Neolithic, rice could have been cultivated around the marshes or lagoons behind the sand dune site. Many of the site catchments, such as that of Sham Wan and Yong Lung, are characteristic of this. At both sites the vegetation or settlement pattern has not changed much through the two Neolithic Stages, thus the aquatic and land food resources could have been exploited simultaneously. The possible increase of dependence upon farming products may have been more likely due to relative decrease of foraging resources as a response to population pressure, or to political pursuits, rather than environmental dynamics.

It is also worth noting that domesticates or plants typically do not survive the site environment of sand or acidic soil of the PRE area, and thus are likely underrepresented. This is probably an important shortcoming of unearthed ecofacts that can be compensated or made up by site catchment analysis.

But essentially, the site catchment data can only serve as partial, not sole, evidence among many others for the study of prehistoric subsistence.

Chapter 7. Conclusions

Based on the archaeological material, site catchment and other analytical results, the PRE inhabitants probably subsisted mainly on rich broad-spectrum foraging foods, particularly fish, whilst farming may have never ceased to play a role (even if at a low level) in the subsistence, during the entire Neolithic period. Farming or farming products very likely began to make more important contribution to the local people at the Late Phase of the Middle Neolithic, and reached its peak of influence in the Late Phase of the Late Neolithic.

If there were ever a Pearl River Estuary (PRE) 8,000 years ago, it would have been on a place where the current continental shelf of South China Sea is located, under deep marine waters, because the sea level then was some 20 meters below that of today (Li *et al.* 1991: 67). The current PRE was just formed some 6,000 years ago, some 2,000 years after agriculture had existed in North, Middle and probably South China.

When the modern PRE was formed in 6,000 BP, people would have been drawn to this place by its abundant (particularly the aquatic) resources, back from earlier coasts with their retreat from the sea, or down from the upland/inland of Guangdong and Guangxi. Archaeological materials of the Early and Middle Neolithic periods seem to well support this argument.

The Early Phase of the Middle Neolithic (1-1) seems to have been a settling in period for the PRE inhabitants to adjust to this new environment, as suggested by the unearthed material and site catchments. The population was likely low, with none of the site catchments overlaps at the 1 km radius. Aquatic foods would have accounted for the staple part of their diet. In the meantime, their tie with the mainland was strongly maintained, and no sites are present in the distant outer marine part of the estuary. They maintained an intimate tie with the Pearl River Delta and shared many common characteristics with the people there. They also very likely had relationships with the Middle Yangzi River Valley. Their close connection with the pre-Shixia people in northern Guangdong, who were farming, implies the possible role of agriculture in the life of the PRE inhabitants in this phase. The lack of features such as burials or houses discovered probably points to a relatively transitory seasonal nature of the sites, which may mean that resources might have been more abundant than the site catchment would suggest, for a mobile group of people would have been able to consume foods from more than one site.

The role of agriculture for subsistence would have been enhanced during the Late Phase of the Middle Neolithic (1-2), possibly with increase of people leading to stress on foraging foods. Several sites are located at the southernmost fringe of the outer part of the estuary, implying the maximum exploitation of the PRE marine resources. Sites in a likely non-marine or farming setting, such as the uphill Sai Wan site, have been found, maybe due to more farming than the last phase. Site catchment analysis indicates that two clusters of overlapping sites (three sites for each cluster) are seen, probably indicating more intensive foraging. Communication was likely expanded as well, with the appearance of artifacts of the exotic style of the Lower Yangzi River Valley. In addition, the probable increase of sedentism revealed by the discovery of a considerable amount of burials might have led to a relative reduction of food resources, since the inhabitants of a site might have been confined to subsist within only one site catchment.

Interestingly, the least number of sites are present in the Early Phase of the Late Neolithic, and most of them scatter far apart, having the most distance, from each other, in the whole Neolithic period. This may have been due to dramatic social impacts resulting from the intrusion of the rice farming Shixia Culture during this phase, though it is yet hard to confirm this point.

The Late Phase of the Late Neolithic (2-2) saw the peak of social developments in the PRE area in the entire Neolithic period. Most sites are found, and there is the least distance between sites, indicating an increase of population. The largest number of overlapping site catchment clusters (four clusters) are seen, indicating an increasing pressure on resources. Largest amount of burials, houses, and largest number of artifacts of most diversity are present, suggesting considerable increase of sedentism. All this, plus the appearance of more prestigious or ceremonial goods, seems to point to important economic and social developments. The increase of population and sedentism would have increased the competition for foraging foods. Site catchment analysis also indicates intensification of foraging and possibly of farming, with the appearance of more upland and headland sites. With the PRE/Pearl River Delta becoming more and more influential in the whole South China during this late phase of the Neolithic as suggested by unearthed archaeological materials, the PRE seems to have become more complicated socially than before, and probably needed foods besides only foraging ones, for eating and social affairs. Farming would have become more important when foraging resources became less abundant or less easy to obtain than before, or even more difficult to procure than farming ones; or farming products were rendered necessary for social or political, rather than just subsistence, purposes.

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Abbreviations and Translation of Chinese Journal Names

AMO --- The Antiquities and Monuments Office of Hong Kong
GCRT --- Guangxi Cultural Relic Team
GDPM --- Guangdong Provincial Museum
HIA --- Hunan Provincial Institute of Archaeology
HKAS --- Hong Kong Archaeological Society
Huanjing Kaogu Yanjiu --- Journal of Environmental Archaeology Study
IA CASS --- The Institute of Archaeology, The Chinese Academy of Social Sciences
JHKAS --- Journal of Hong Kong Archaeological Society
Kaogu --- Journal of Archaeology
Kaogu Xuebao --- Journal of Archaeological Reports
Kaogu Yu Wenwu --- Journal of Archaeology and Cultural Relics
MCA --- Managing Committee of Antiquities
Nanfang Wenwu --- Relics From South
Nongye Kaogu --- Journal of Agricultural Archaeology
QCCB --- Qujiang County Cultural Bureau
Wenwu --- Journal of Cultural Relics
Wenwu Jikan --- Journal of Thematic Cultural Relics
Zhongguo Wenwu Bao --- Newspaper of China's Cultural Relics
ZUGD --- Zhongshan University Geography Department

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Periods	Years (BP)	Site Type (importance decreases in order)	Characteristic Artifacts	Features /Ecofacts
Late Neolithic	3,500-5,000	sand dune, hillside, tableland	soft geometric stamped pottery, ceremonial tools	burials, houses, fish bones, shells,
Middle Neolithic	5,000-6,000	sand dune, hillside, tableland, shell midden	painted pottery, stone bark cloth beaters	few burials, ash pits, few fish bones
Early Neolithic (only present in northern Lingnan)	7,000-10,000	limestone cave, shell midden, tableland, hillside	coarse pottery, perforated shell and stone tools, polished stone celts,	burials, domesticated pigs, lots faunal/floral remains

Table 1. Brief Summary of the PRE/Lingnan Neolithic

Stages	Phases	Circa Time (BP)	Main Characteristics
1st: Middle Neolithic	Early	6,000-5,600	Painted fine pottery, bark cloth beater, white pottery rare
	Late	5,600-5,000	Incised patterns on coarse and fine pottery, white pottery, bark cloth beater, burials, painted pottery rare
2nd: Late Neolithic	Early	5,000-4,300	Geometric stamped pottery, with leave-vein as major pattern, fire grate, houses and burials
	Late	4,300-3,500	Geometric stamped pottery with various complicated patterns, large houses and burials

Table 2. Summary of the Middle and Late Neolithic in the PRE

Table 3. Major Dates of the PRE and Neighboring Sites

C-14 Dates:

No.	Site	Layer/Phase	C-14 Date (BP), uncalibrated	Lab. Code	Sample material	Ref.
1	Dahuangsha	L4	5600±200	ZK2513	carbonzied food	1, 18
2	Yankezhou	Mid Neolithic	5130±100	KWG-817	human bone	5, 18
3	Jinyan, Xiqiaoshan	L3	4290±100	PV848	charcoal	17
4	Jinyan, Xiqiaoshan	L3	4270±80	PV849	charcoal	17
5	Duoshigang, Xiqiaoshan	L2	4330±90	PV851	charcoal	2, 17
6	Duoshigang, Xiqiaoshan	L3	3690±70	PV853	charcoal	2, 17
7	Hedang	L2, lower part	3980±80	ZK-0647	charcoal	3, 18
8	Hedang	Late Neolithic	3730±100	ZK-548-0	human bone	5, 18
9	Hedang	Late Neolithic	3500±100	ZK-547-0	human bone	5, 18
10	Maogang	AreaB, L3	4165±100	ZK-710	wood piece	4
11	Maogang	AreaB, L3	4140±90	ZK-708	wood pile	4
12	Maogang	AreaA, L2	3950±100	ZK-707	charcoal	4
13	Youyugang	Late Neolithic	3550±70	BK88009	charcoal	5, 17
14	Youyugang	Late Neolithic	3240±80	BK88008	charcoal	5, 17
15	Hai Dei Wan	Lower Layer	5100±100	HAR2522	charcoal	7, 18
16	Yung Long	L3	5490±220	BETA60315	charcoal	8
17	Yung Long	L2B	5450±150	BETA54627	charcoal	8
18	Yung Long	L2B	5230±100	BETA54626	charcoal	8
19	Yung Long	L2B	4880±170	BETA62188	charcoal	8
20	Yung Long	L2B	4710±130	BETA62189	charcoal	8
21	Yung Long	L2B	4700±120	BETA60313	charcoal	8
22	Yung Long	L1B	4520±130	HAR8562	charcoal	8, 17
23	Yung Long	L1B	4180±80	HAR8565	charcoal	8, 17
24	Yung Long	L1B	4170±080	BETA54625	charcoal	8
25	Yung Long	L1B	4030±070	BETA54624	charcoal	8
26	Yung Long	L1B	3990±60	HAR8564	charcoal	8, 17
27	Yung Long	L1B	3980±60	BETA62219	charcoal	8
28	Yung Long	L1B	3970±90	BETA60312	charcoal	8
29	Yung Long	L1B	3900±80	BETA62190	charcoal	8
30	Yung Long	L1B	3810±70	BETA62218	charcoal	8
31	Tung Wan	CL4	5060±150	GAK15944	charcoal	17

32	Tung Wan	CL4	4740±90	BETA33229	charcoal	17
33	Tung Wan	L3	3270±90	ANU2222	charcoal	14, 15
34	Fu Tei	Mid Neolithic	5050±100	BETA42857	charcoal	8
35	Fu Tei	Mid Neolithic	4830±160	BETA42858	charcoal	8
36	Kwo Lo Wan	Mid Neolithic	4610±90	BETA60795	charcoal	8
37	Kwo Lo Wan	Mid Neolithic	4410±80	BETA45150	charcoal	8
38	Chung Hom Wan	Mid Neolithic	4570±130	I-8827	charcoal	9, 18
39	Sai Wan	Mid Neolithic	4220±100	HAR6842	charcoal	10, 17
40	Sham Wan	LF	4000±300	R-4585/1	charcoal	11, 18
41	Lung Kwu Sheung Tan	L3	4090±100	BETA40991	charcoal	12
42	Lung Kwu Sheung Tan	L3	4020±110	BETA40990	charcoal	12
43	Hai Dei Wan	Mid Layer	3360±80	HAR3589	charcoal	13
44	Hai Dei Wan	Mid Layer	3200±160	ANU2233	charcoal	13
45	Tai Wan	CL1	3670±80	BETA42860	charcoal	17
46	Hac Sha	Mid Neolithic	6100±200	BETA-4411	charcoal	18

Thermoluminescence Dates:

No.	Site	Layer/Phase	Years (BP)	Lab. Code	Sample material	Ref.
47	Houshawan	L2	3898±390	TL89038	geometric potsherd	16
48	Houshawan	L4	4248±425	TL89040	geometric potsherd	16
49	Houshawan	L4	5000±500	TL89041	quartz sand	16
50	Houshawan	L6	4818±482	TL89035	painted potsherd	16
51	Houshawan	L6	5288±529	TL89043	quartz sand	16
52	Yankezhou	Mid Neolithic	5680±284	TL87021	potsherd	5
53	Cuntou	Late Neolithic	4350±440	TL-8976	burned clay	5
54	Cuntou	Late Neolithic	3384±340	TL89069	potsherd	5
55	Dongaowan	Late Neolithic	3750±186	TL87022	potsherd	5

Note:

I. Shell C-14 dates have not been included in this table, due to problems in the accuracy of C-14 dating on shells.

II. The half-life of 5730 BP are used for some of the C-14 dates, and that of 5568 (or 5570) BP for others.

III. For the convenience of checking, the references are put right next.

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Site (Fig.)	Radius	1	2	3	4	5	6	7	8	9	10	11	12	Total %
Yung Long	0.5km	32.30%	32.30%	12.50%	8.60%	5.90%	3.60%	0.60%	3.70%	0.50%				100%
(Fig. 18)	1.0km	37.40%	19.70%	10.30%	6%	3.40%	2.10%	0.70%	14.70%	3.40%	2.30%			100%
	1.25km	44.30%												
Fa Peng Deng	0.5km		7.90%			1.30%			1%	17.20%		72.60%		100%
(Fig. 19)	1.0km	1.70%	10.40%	1.80%		0.50%	2.80%	0.80%	0.30%	15.40%		66.30%		100%
	1.25km	12.20%												
Sha Lo Wan	0.5km	83.20%	0.80%		11.10%								4.90%	100%
(Fig. 20)	1.0km	76%	2.90%	0.70%	5%	5.70%		5.40%		0.40%	1.30%		2.60%	100%
	1.25km	75.60%												
Sham Wan	0.5km	21.40%	49.80%	0.90%		4.30%	19.40%		1.80%	2.40%				100%
(Fig. 21)	1.0km	29.50%	34.30%	0.60%		0.90%	12.40%	0.10%	3.10%	11.30%		7.80%		100%
	1.25km	31.20%												

Table 4. Resource Distribution in Site Catchments (for Fig. 18 - Fig. 21)

Vegetation Type --- 1 Blue: Water
2 Yellow: Low shrub with grass
3 Brown: High density urban
4 Grey: Low shrub
5 Pink: Low density urban
6 Dark Yellow: Tall shrub
7 Green: Woodland
8 White: Bare soil
9 Dark Blue: Tall shrub with grass
10 Amber: Cultivation
11 Creamy: Grassland
12 Dark Green: Plantation woodland

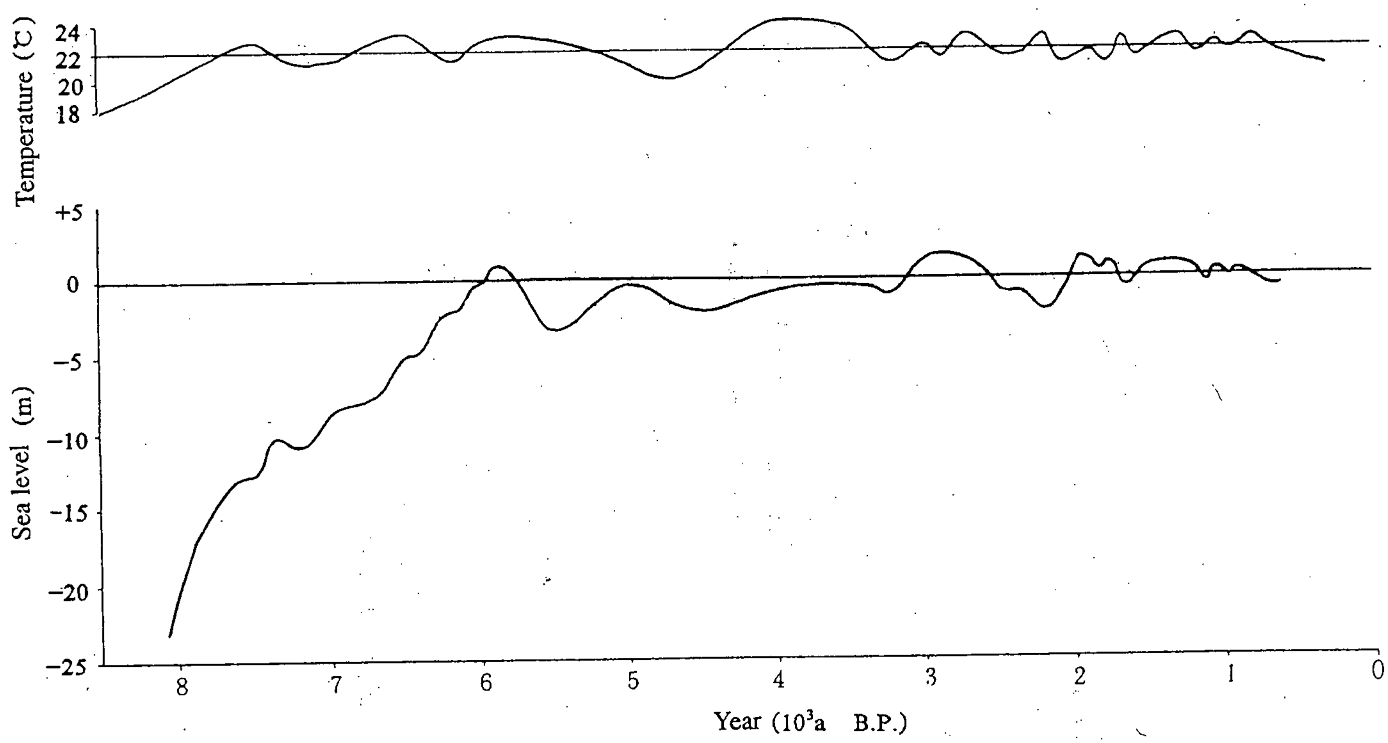


Figure 1. Curve of sea level changes in PRD since 8,000 BP (after Li *et al.* 1991: Fig.3-1)

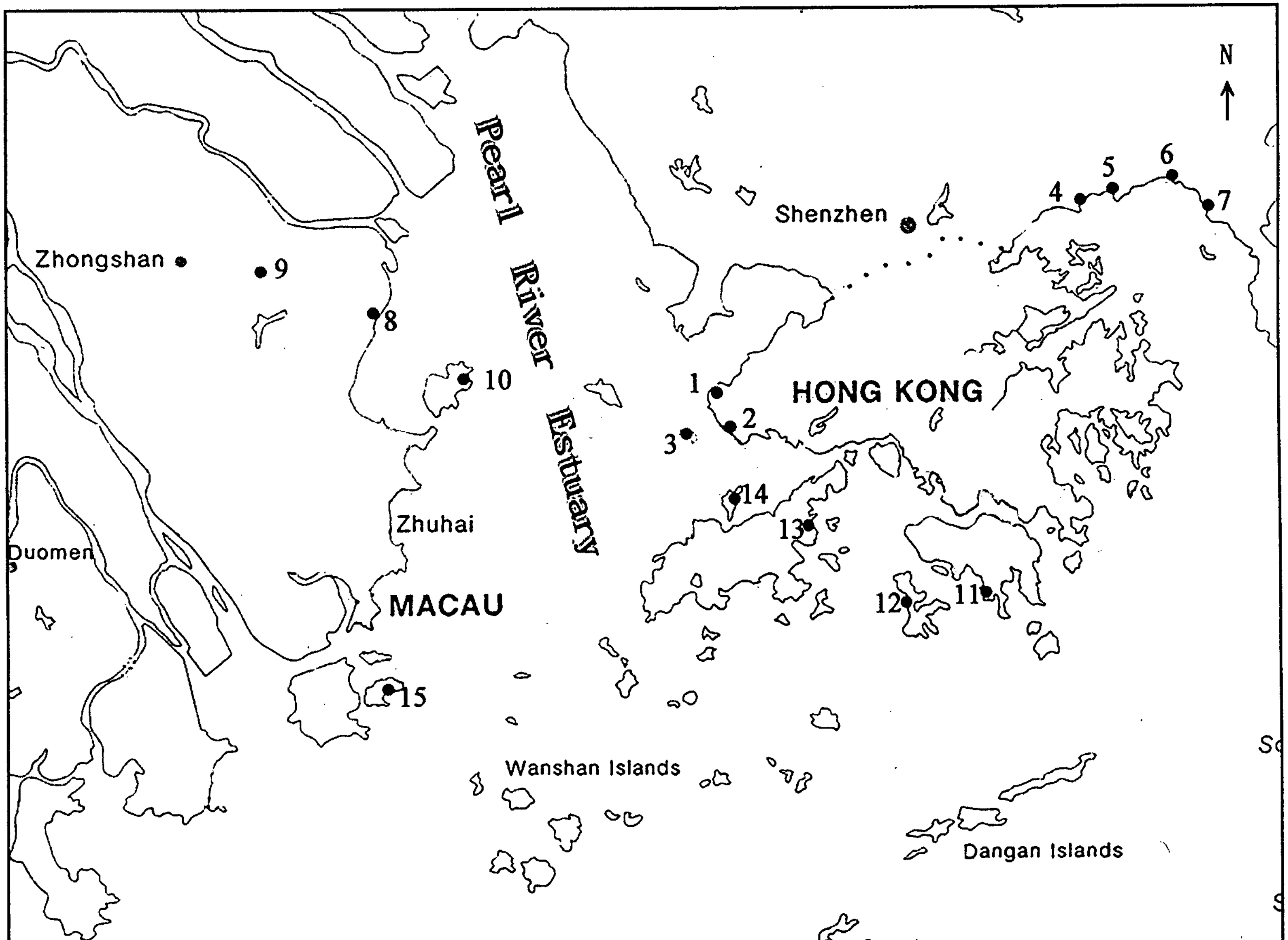


Figure 2. Sites of Early Phase, Middle Neolithic (1-1)

1. Yung Long
2. Lung Kwu Tan
3. Tung Kwu
4. Dameisha
5. Xiaomeisha
6. Dahuangsha
7. Xiantouling
8. Longxue
9. Baishuijing
10. Houshawan
11. Chung Hom Wan
12. Tai Wan
13. Hai Dei Wan
14. Sham Wan Village
15. Hac Sa Wan

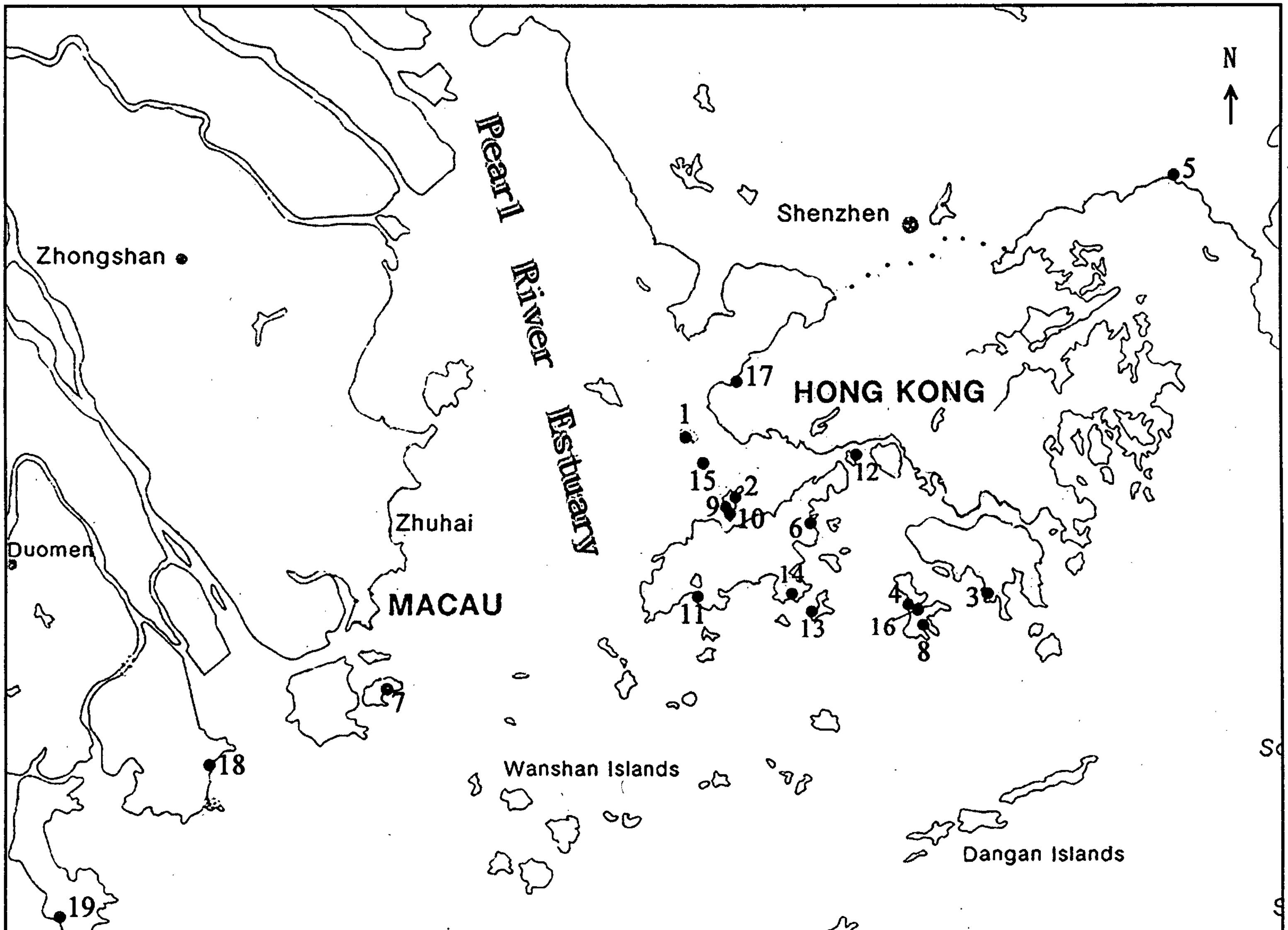
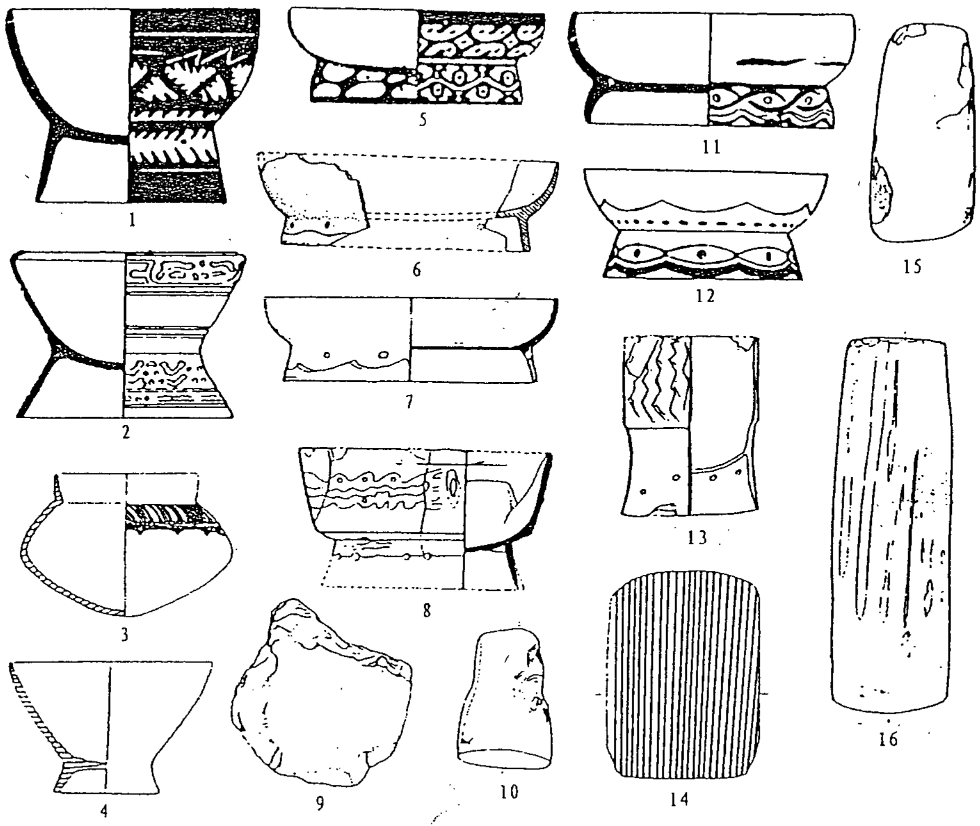


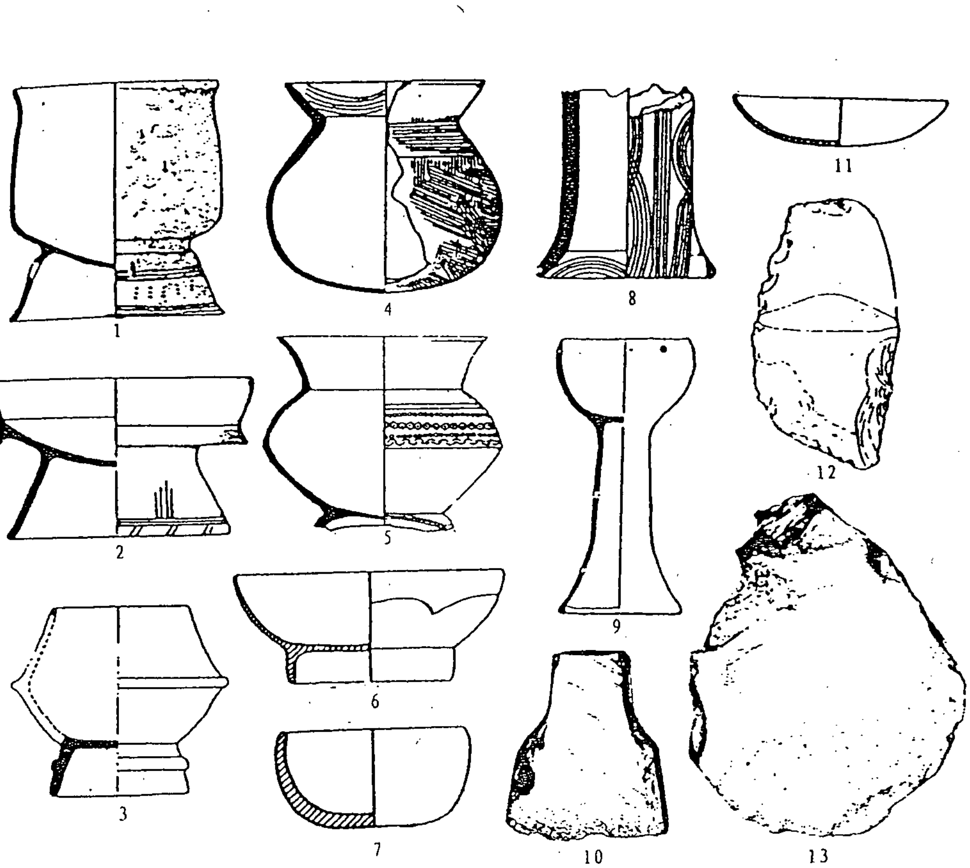
Figure 3. Sites of Late Phase, Middle Neolithic (1-2)

1. Tung Kwu
2. Sham Wan Village
3. Chung Hom Wan
4. Tai Wan
5. Dahuangsha
6. Hai Dei Wan
7. Hac Sa Wan
8. Sham Wan
9. Fu Tei
10. Kwo Lo Wan
11. Tung Wan
12. Tungwantsai North
13. Sai Wan
14. Tai Long
15. Sha Chau
16. Lo So Shing
17. Ngkayuen
18. Caotangwan
19. Baojingwan



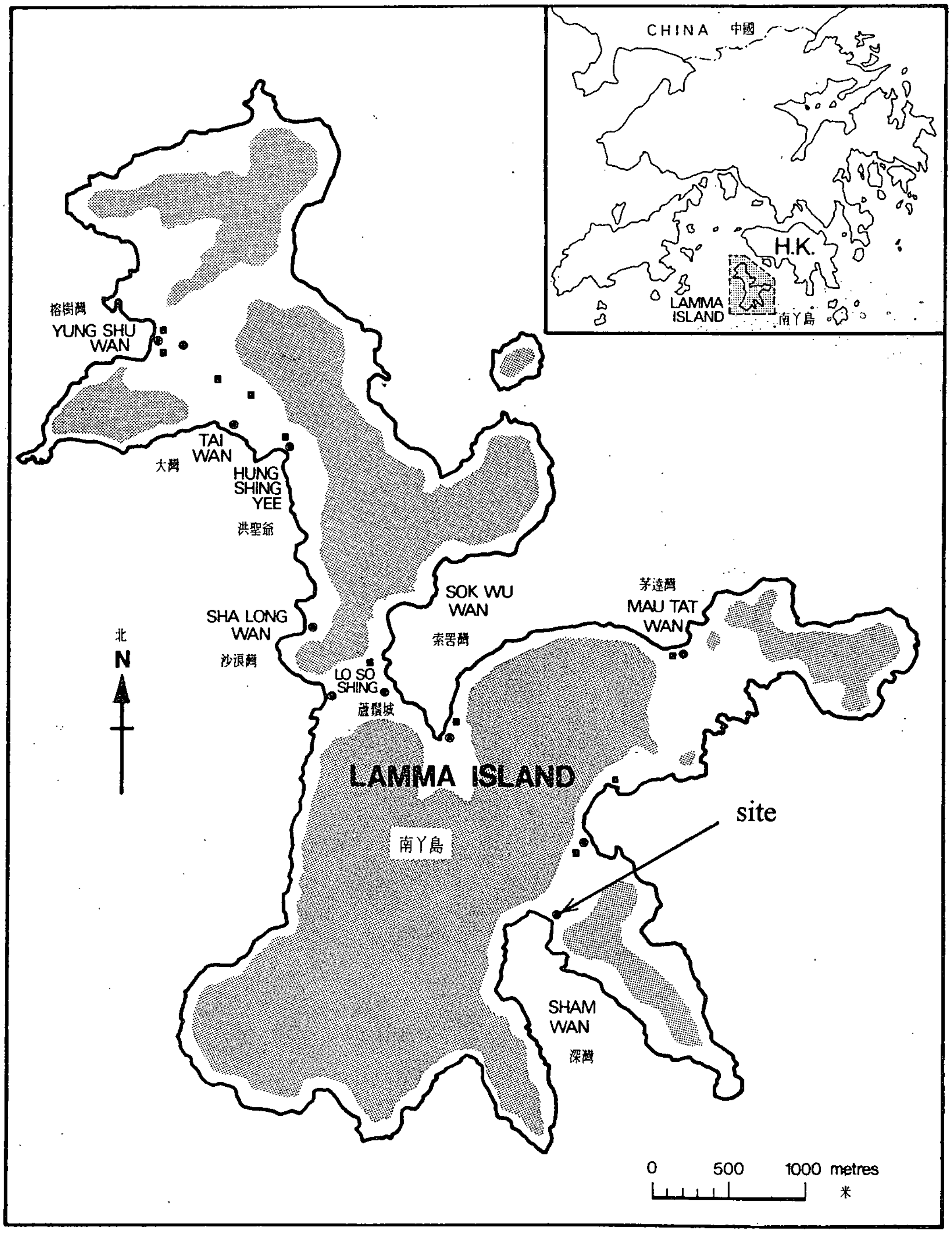
1. Painted pottery bowl (Longxue), 2. Painted pottery bowl (Houshawan), 3. Coarse pottery *fu* pot (Xiantouling), 4. Pottery *dou*, (Xiangtouling), 5. Painted pottery basin (Dameisha), 6. Painted pottery basin (Tai Wan), 7. Painted pottery basin (Hac Sha Wan), 8. Painted pottery basin (Chung Hom Wan), 9. Oyster pick (Sham Wan F horizon), 10. Stone aze, 11. Painted pottery basin (Houshawan), 12. Painted pottery basin (Tai Wan), 13. Painted pottery cup (Chung Hom Wan), 14. Stone bark cloth beater (Xiantouling), 15. Stone axe (Dahuangsha), 16. Stone bark cloth beater (Xiantouling).

Figure 4. Artifacts of Early Phase, Middle Neolithic (1-1)
(modified from Shang and Mao 1997)



1. Pottery pot (Kwo Lo Wan Upper), 2. Pottery *dou* (Fu Tei), 3. Pottery pot (Fu Tei), 4. Coarse pottery *fu* pot (Fu Tei), 5. Pottery pot (Kwo Lo Wan Upper), 6. Pottery basin (Dahuangsha), 7. Pottery bowl (Dahuangsha), 8. Pottery stand (Fu Tei), 9. Pottery *dou* (Fu Tei), 10. Stone adz (Fu Tei), 11. White pottery bowl (Dahuangsha), 12. Sharpen stone tool (Chaotangwan), 13. Oyster pick (Fu Tei).

Figure 5. Artifacts of Late Phase, Middle Neolithic (1-2)
(modified from Shang and Mao 1997)



circles : archaeological sites

squares : present villages

shaded ; land above 50 m. elevation

Figure 6. Sham Wan sand dune site (after Meacham 1978: Fig. 1–1)

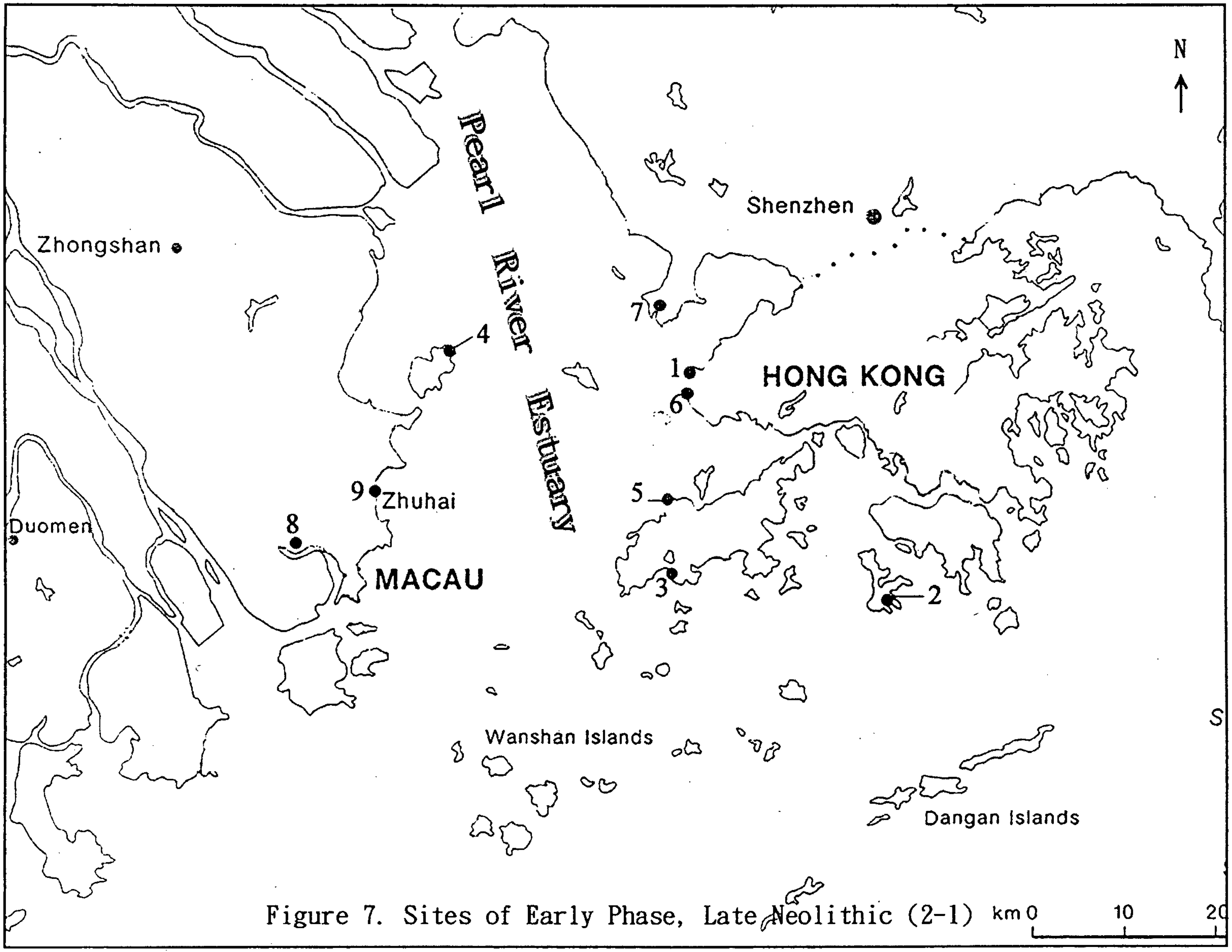


Figure 7. Sites of Early Phase, Late Neolithic (2-1)

1. Yung Long
2. Sham Wan
3. Tung Wan
4. Houshawan
5. Sha Lo Wan
6. Lung Kwu Sheung Tan
7. Chiwan
8. Nanshawan
9. Lengjiaozui

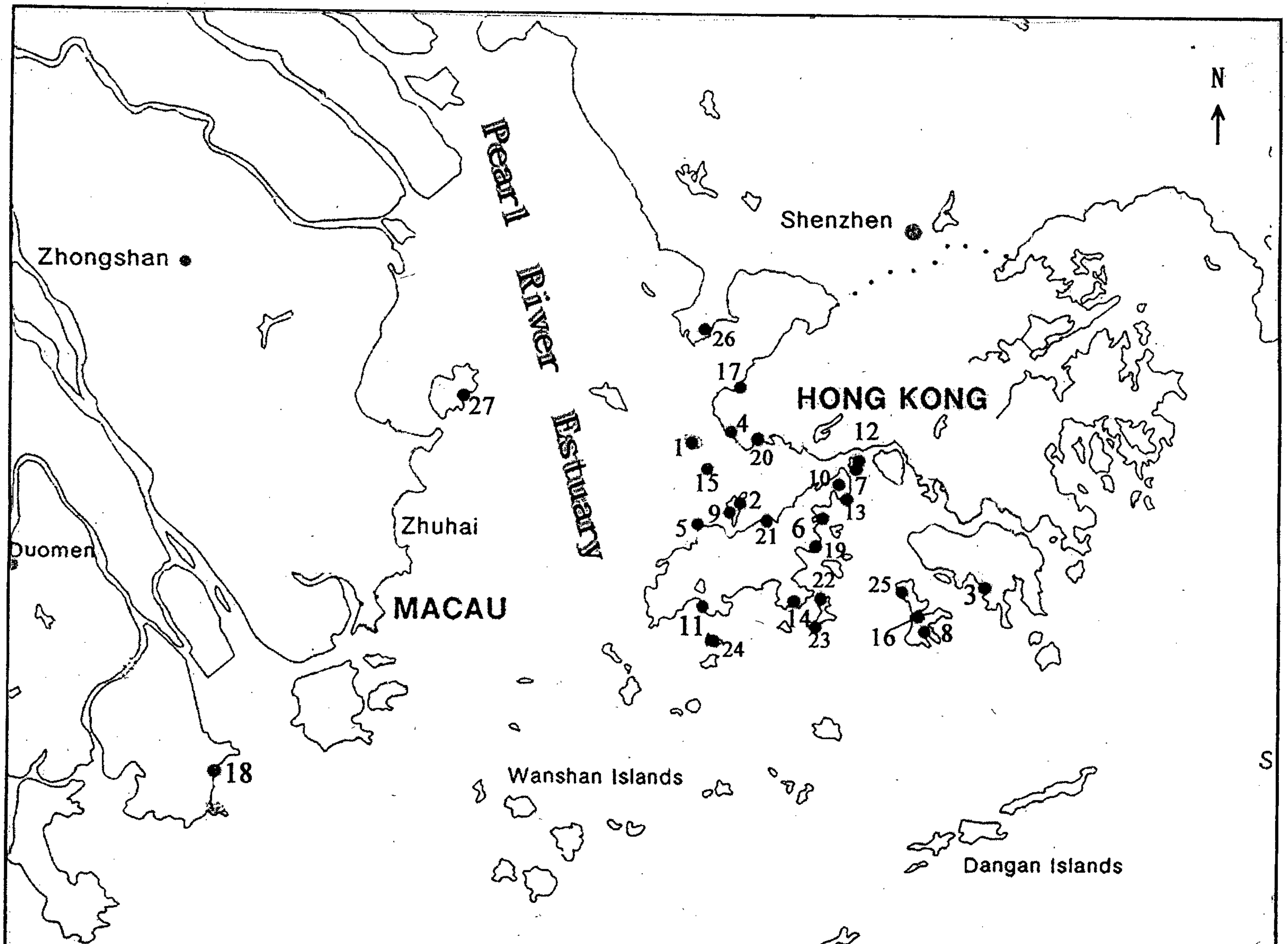
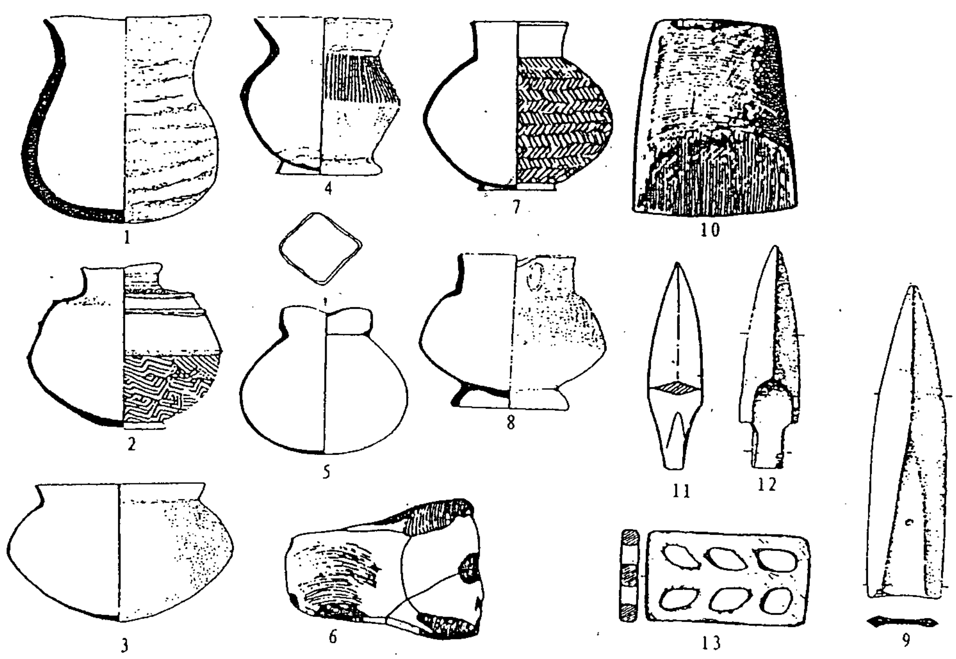


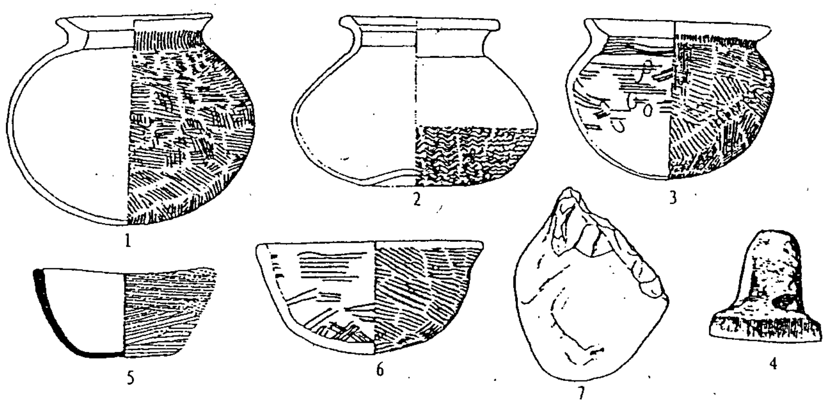
Figure 8. Sites of Late Phase, Late Neolithic (2-2)

1. Tung Kwu
2. Sham Wan Village
3. Chung Hom Wan
4. Long Kwu Tan
5. Sha Lo Wan
6. Hai Dei Wan
7. Sha Lao Tong Wan
8. Sham Wan
9. Fu Tei
10. Fa Peng Deng
11. Tung Wan
12. Tungwantsai North
13. Pa Tau Kwu
14. Tai Long
15. Sha Chau
16. Lo So Shing
17. Ngkayuen
18. Caotangwan
19. Man Kwo Tsui
20. Shek Kwo Tsui
21. Pa Mong
22. Tai Kwai Wan
23. Po Yue Wan
24. Siu A Chau
25. Sha Po Tsuen
26. Hedishan
27. Dongaowan



1. Pottery *fu* pot (Sha Lo Wan), 2. Pottery *dou* (Sha Lo Wan), 3. Pottery *fu* pot (Yung Long South 1B), 4. Pottery pot (Sha Lo Wan), 5. Pottery pot (Yung Long South 1B), 6. Stone axe (Chiwan), 7. Pottery pot (Chiwan), 8. Pottery pot (Yung Long South 1B), 9. Stone arrowhead (Sha Lo Wan), 10. Stone adz (Chiwan), 11. Stone adz (Chiwan), 12. Stonê arrowhead (Sha Lo Wan), 13. Pottery fire grate (Chiwan).

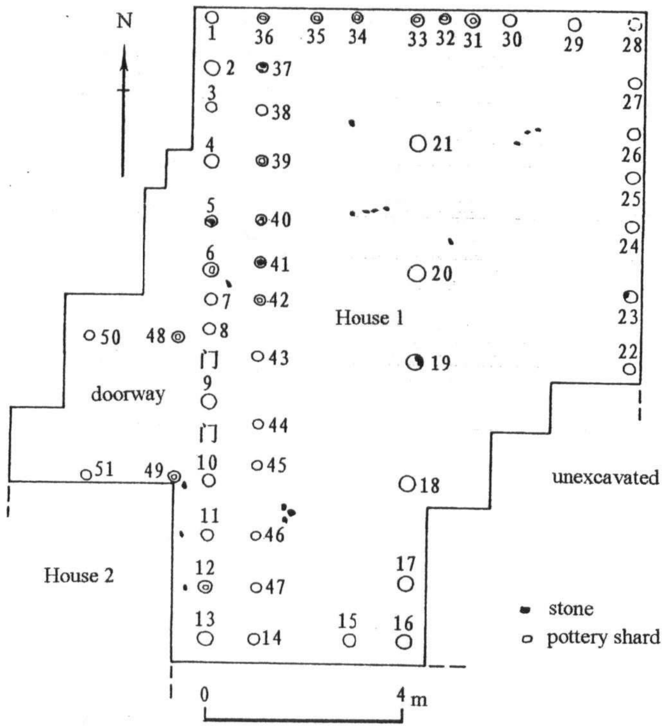
Figure 9. Artifacts of Early Phase, Late Neolithic (2-1)
(modified from Shang and Mao 1997)



1. Pottery *fu* pot (Pak Mong), 2. Pottery pot (Pak Mong), 3. Pottery *fu* pot (Pak Mong), 4. Stone adz (Hedishan), 5. Pottery bowl (Sha Lo Wan), 6. Pottery bowl (Pak Mong), 7. Oyster pick (Sham Wan horizon C).

Figure 10. Artifacts of Late Phase, Late Neolithic (2-2)
(modified from Shang and Mao 1997)

Earth-rammed house floors of House 1 and 2 (from southwest to northeast)



House plans of House 1 and 2

1-51: postholes

Figure 11. Ngkayuen house floor (after HKAS 1999)

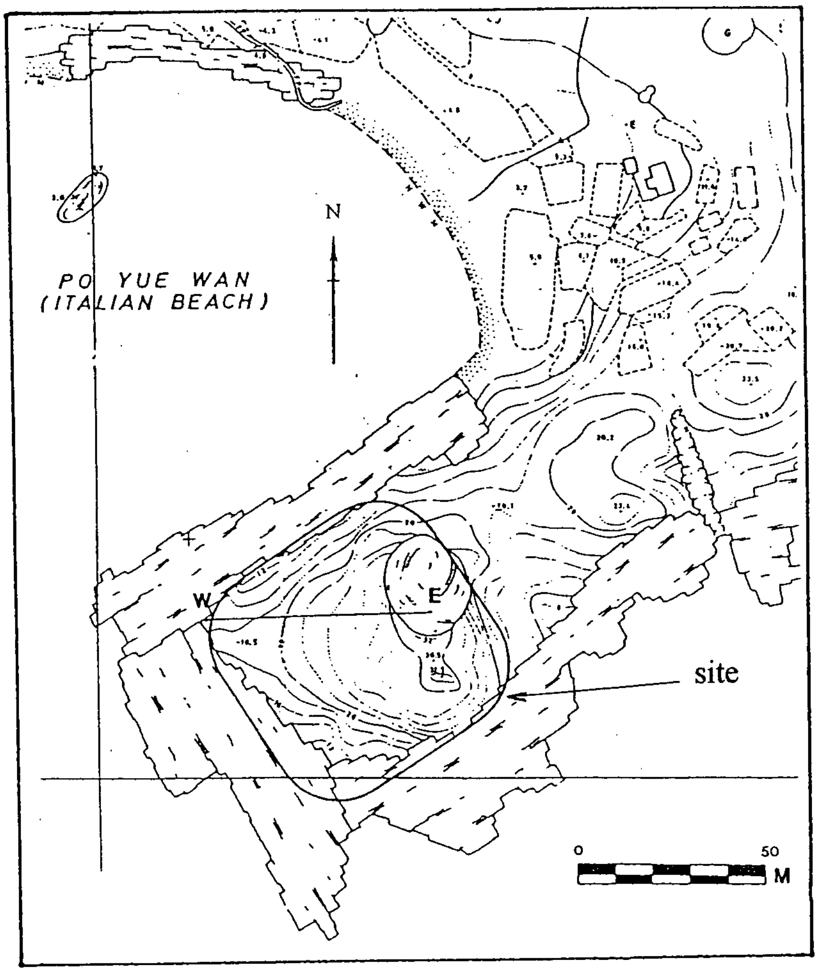


Figure 12. Po Yue Wan headland site (after Wellings 1993: 56)

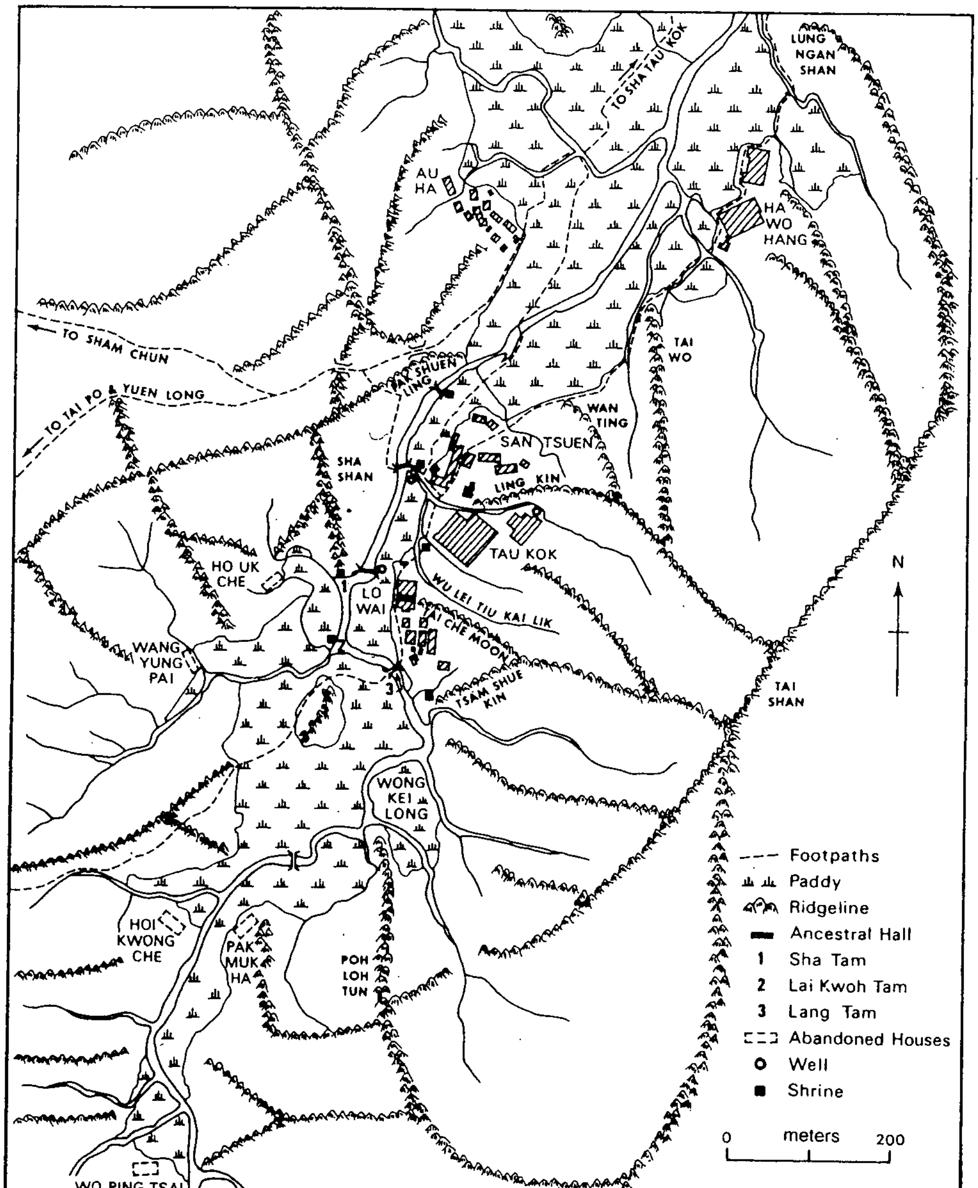


Figure 13. Sheung Wo Hang village area (after Hase and Lee 1992: Figure. 5.4.)

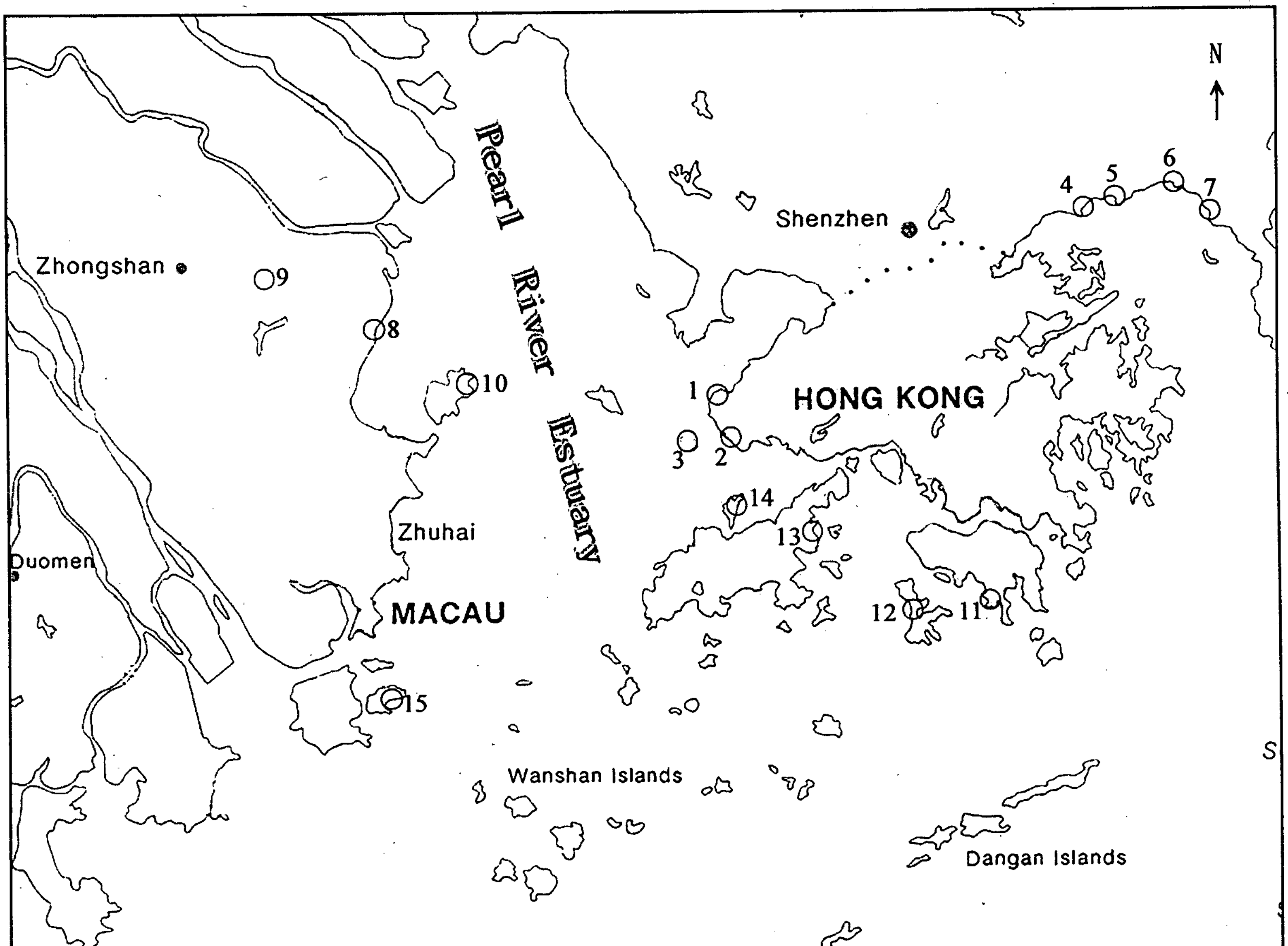


Figure 14. Primary site catchments of PRE area (1-1)

1. Yung Long
2. Lung Kwu Tan
3. Tung Kwu
4. Dameisha
5. Xiaomeisha
6. Dahuangsha
7. Xiantouling
8. Longxue
9. Baishuijing
10. Houshawan
11. Chung Hom Wan
12. Tai Wan
13. Hai Dei Wan
14. Sham Wan Village
15. Hac Sa Wan

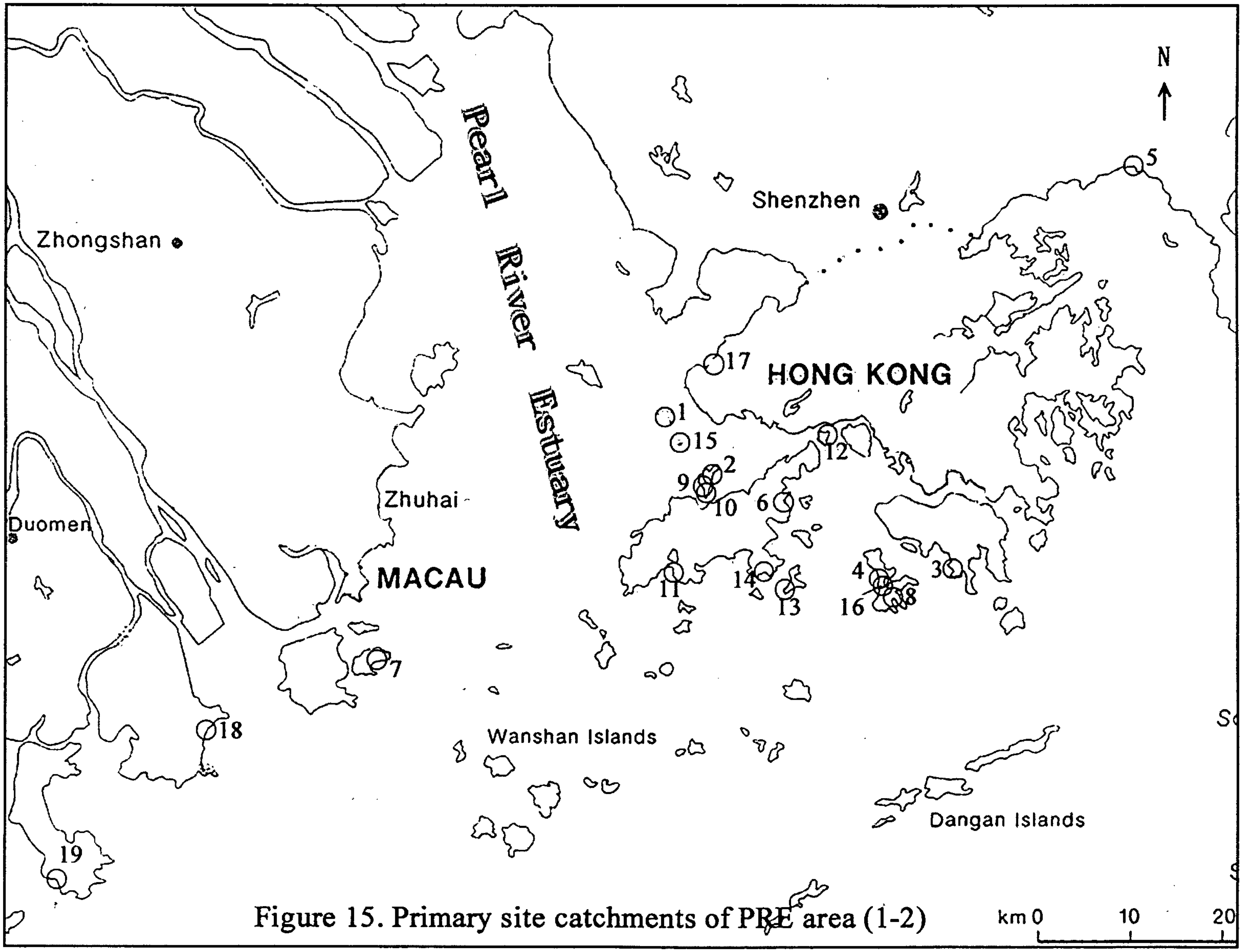


Figure 15. Primary site catchments of PRE area (1-2)

1. Tung Kwu
2. Sham Wan Village
3. Chung Hom Wan
4. Tai Wan
5. Dahuangsha
6. Hai Dei Wan
7. Hac Sa Wan
8. Sham Wan
9. Fu Tei
10. Kwo Lo Wan
11. Tung Wan
12. Tungwantsai North
13. Sai Wan
14. Tai Long
15. Sha Chau
16. Lo So Shing
17. Ngkayuen
18. Caotangwan
19. Baojingwan

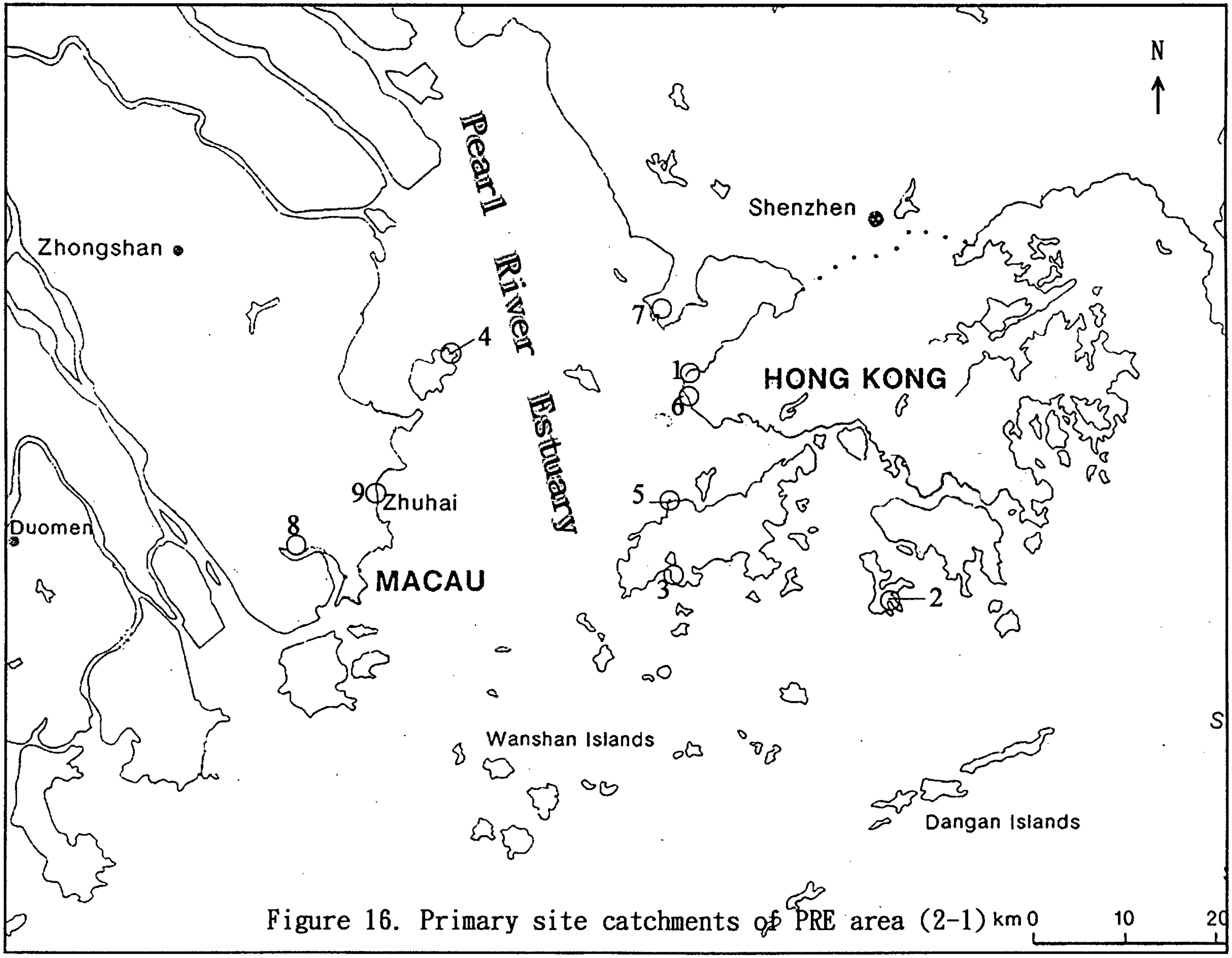


Figure 16. Primary site catchments of PRE area (2-1)

1. Yung Long
2. Sham Wan
3. Tung Wan
4. Houshawan
5. Sha Lo Wan
6. Lung Kwu Sheung Tan
7. Chiwan
8. Nanshawan
9. Lengjiaozui

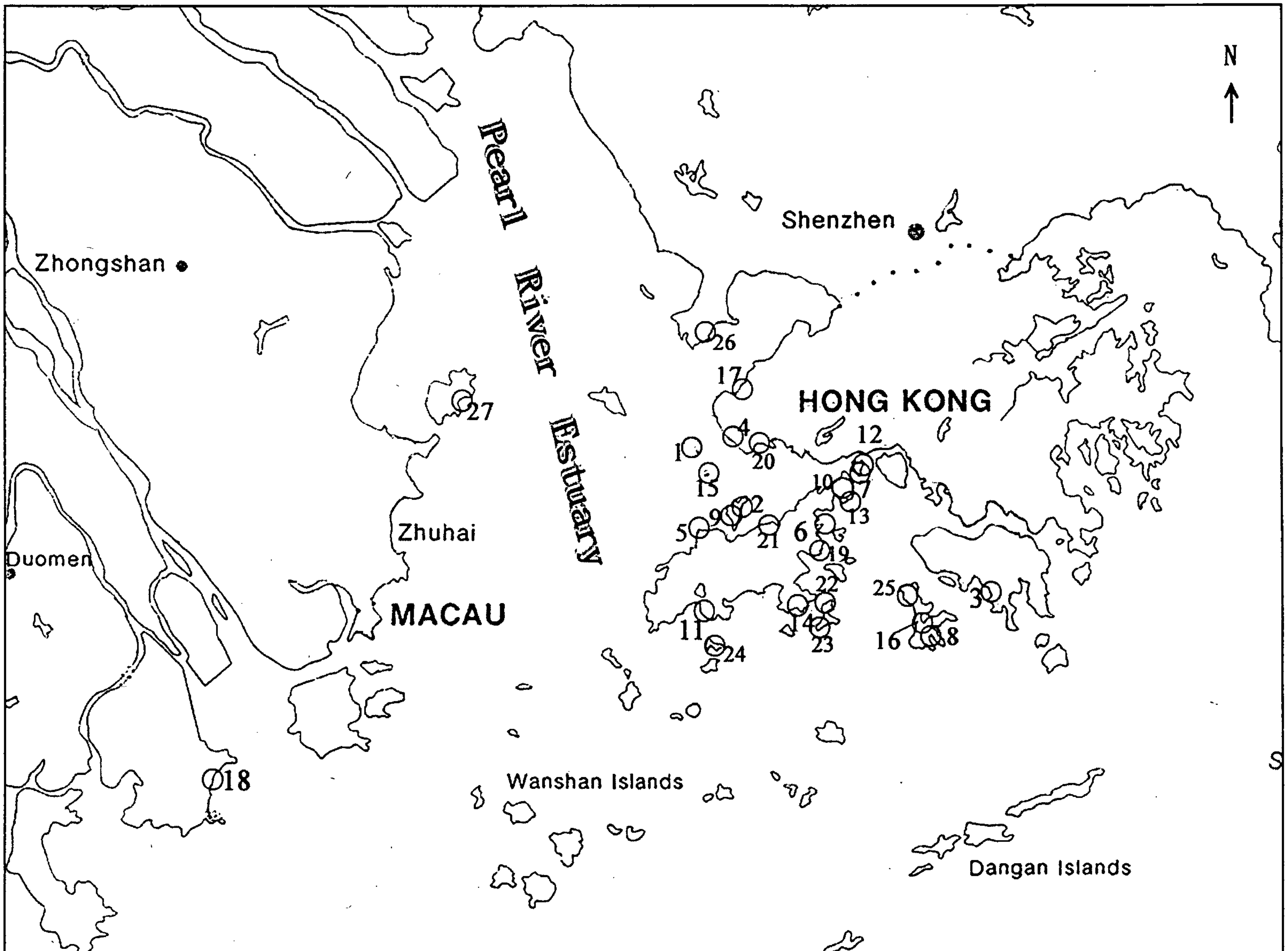


Figure 17. Primary site catchments of PRE area (2-2)

1. Tung Kwu
2. Sham Wan Village
3. Chung Hom Wan
4. Long Kwu Tan
5. Sha Lo Wan
6. Hai Dei Wan
7. Sha Lao Tong Wan
8. Sham Wan
9. Fu Tei
10. Fa Peng Deng
11. Tung Wan
12. Tungwantsai North
13. Pa Tau Kwu
14. Tai Long
15. Sha Chau
16. Lo So Shing
17. Ngkayuen
18. Caotangwan
19. Man Kwo Tsui
20. Shek Kwo Tsui
21. Pa Mong
22. Tai Kwai Wan
23. Po Yue Wan
24. Siu A Chau
25. Sha Po Tsuen
26. Hedishan
27. Dongaowan

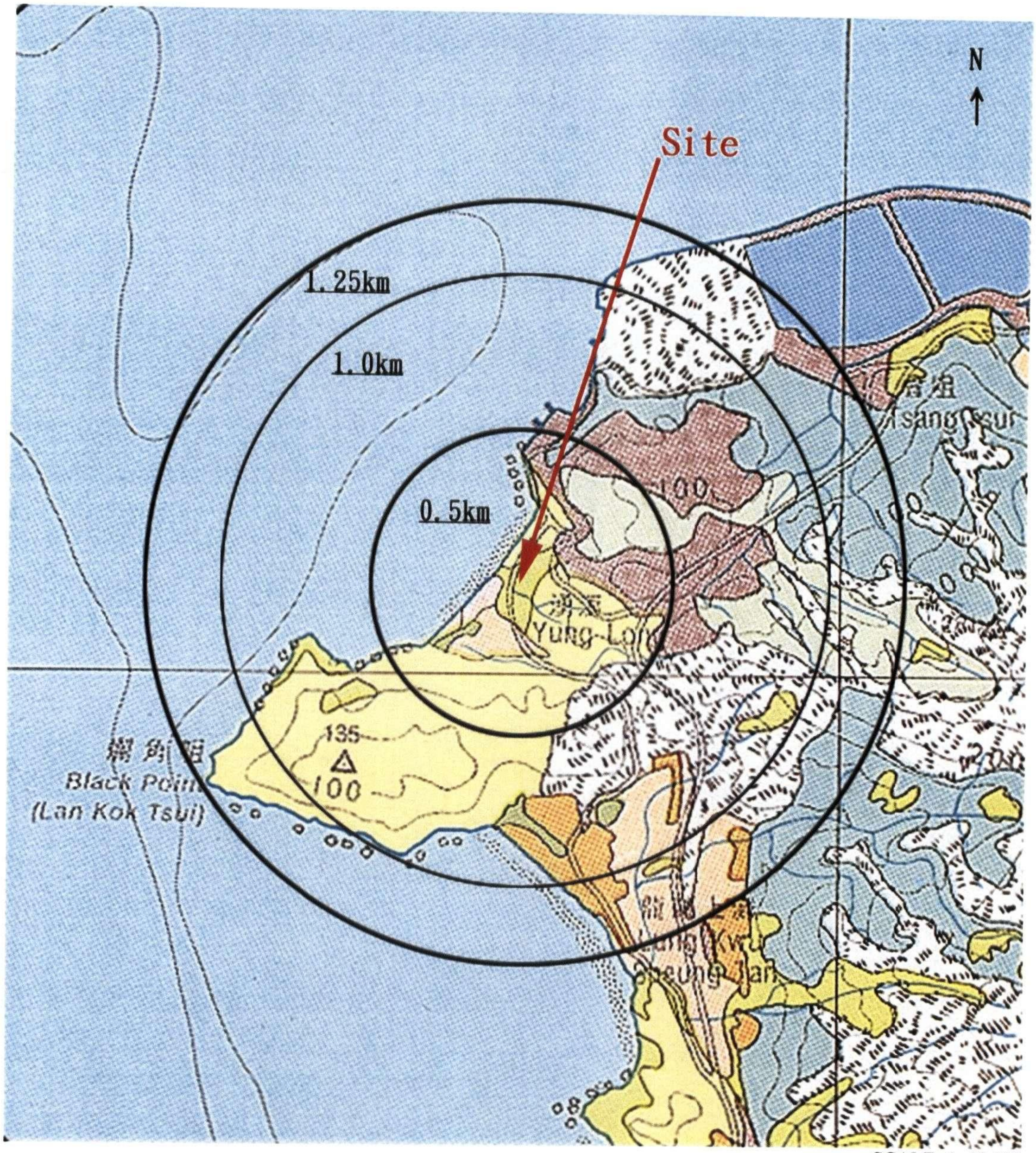
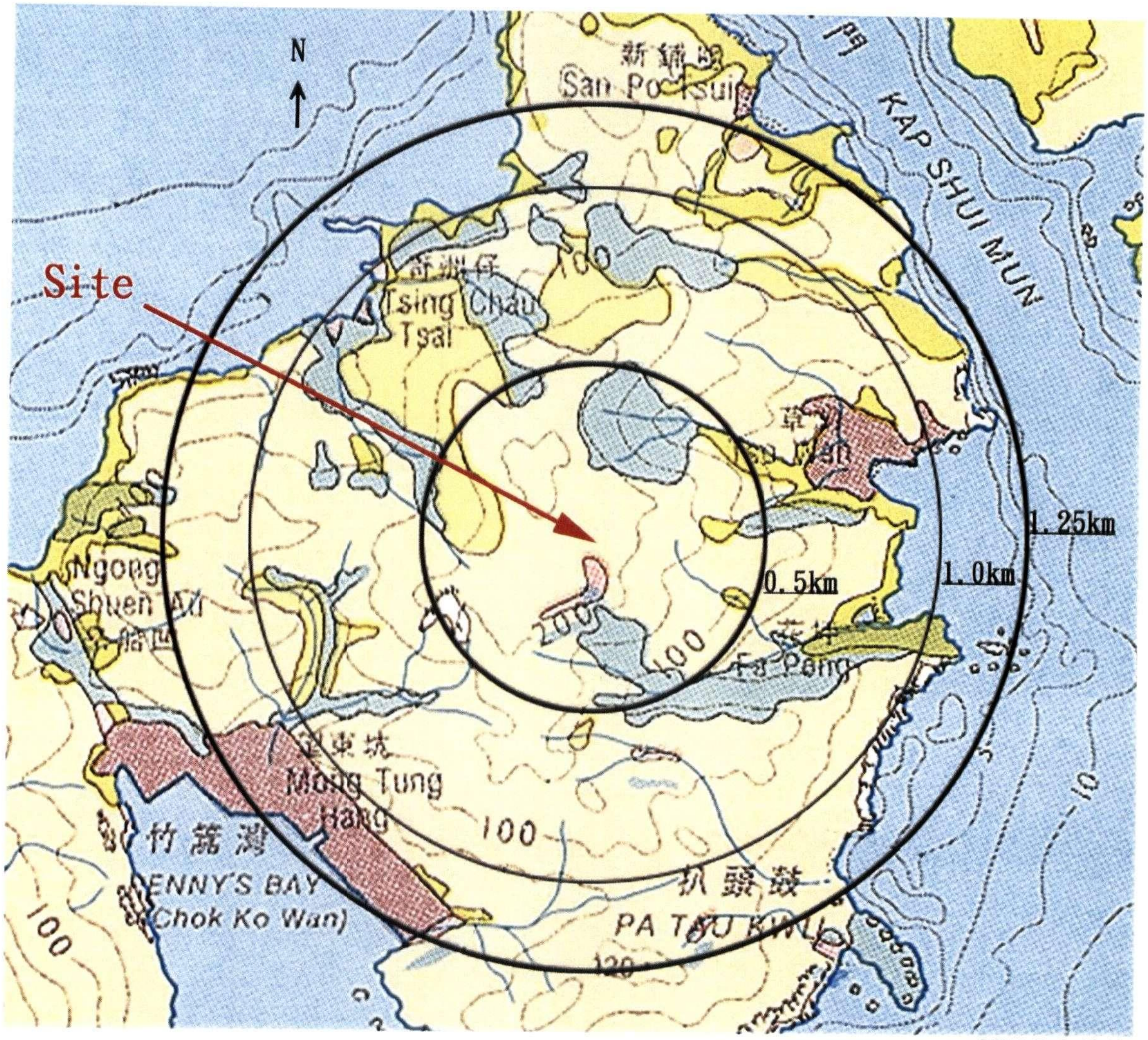


Figure 18. Yong Lung (sand dune) site catchment



SCALE: 1: 50,000

Figure 19. Fa Peng Deng (upland) site catchment

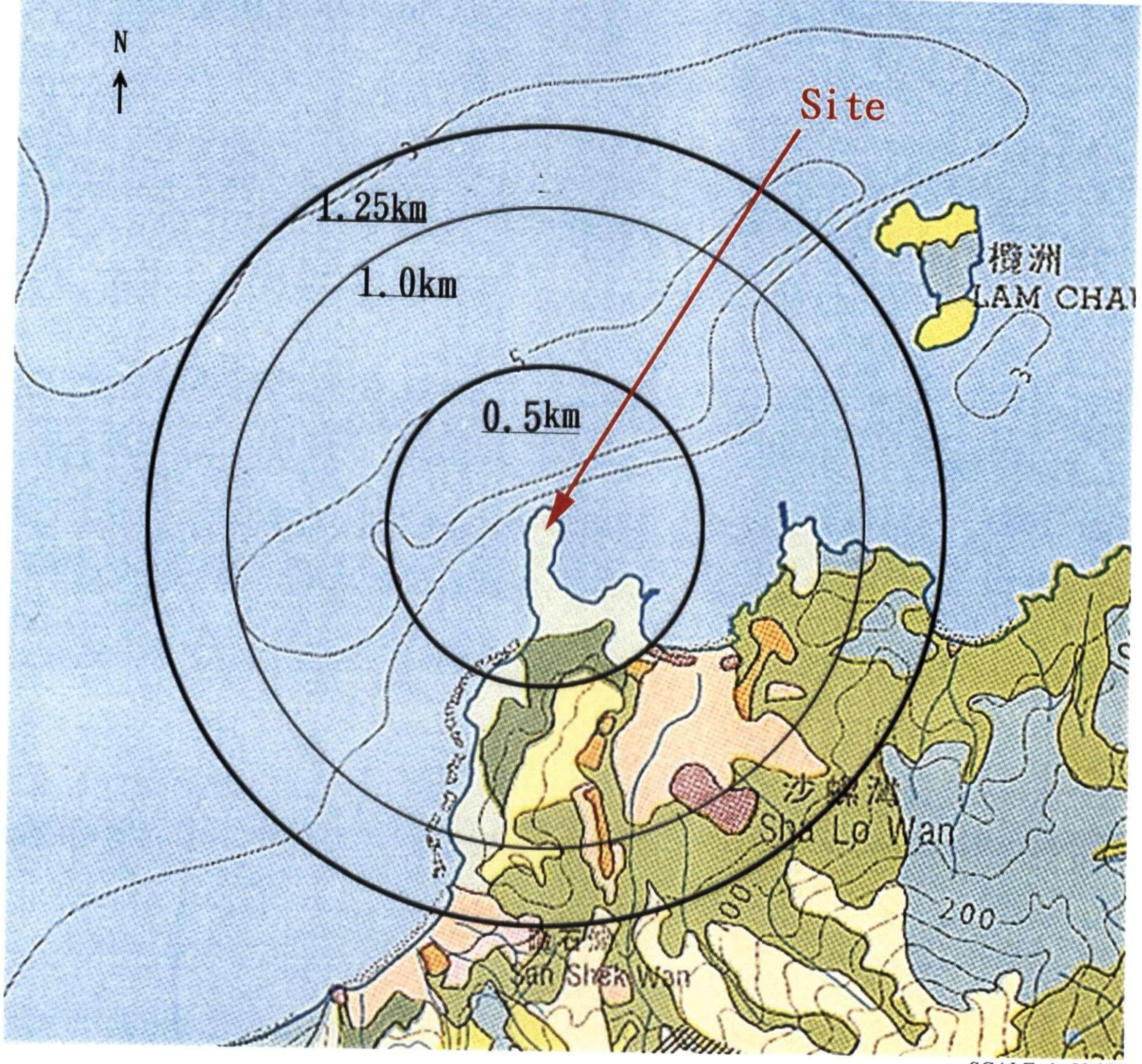
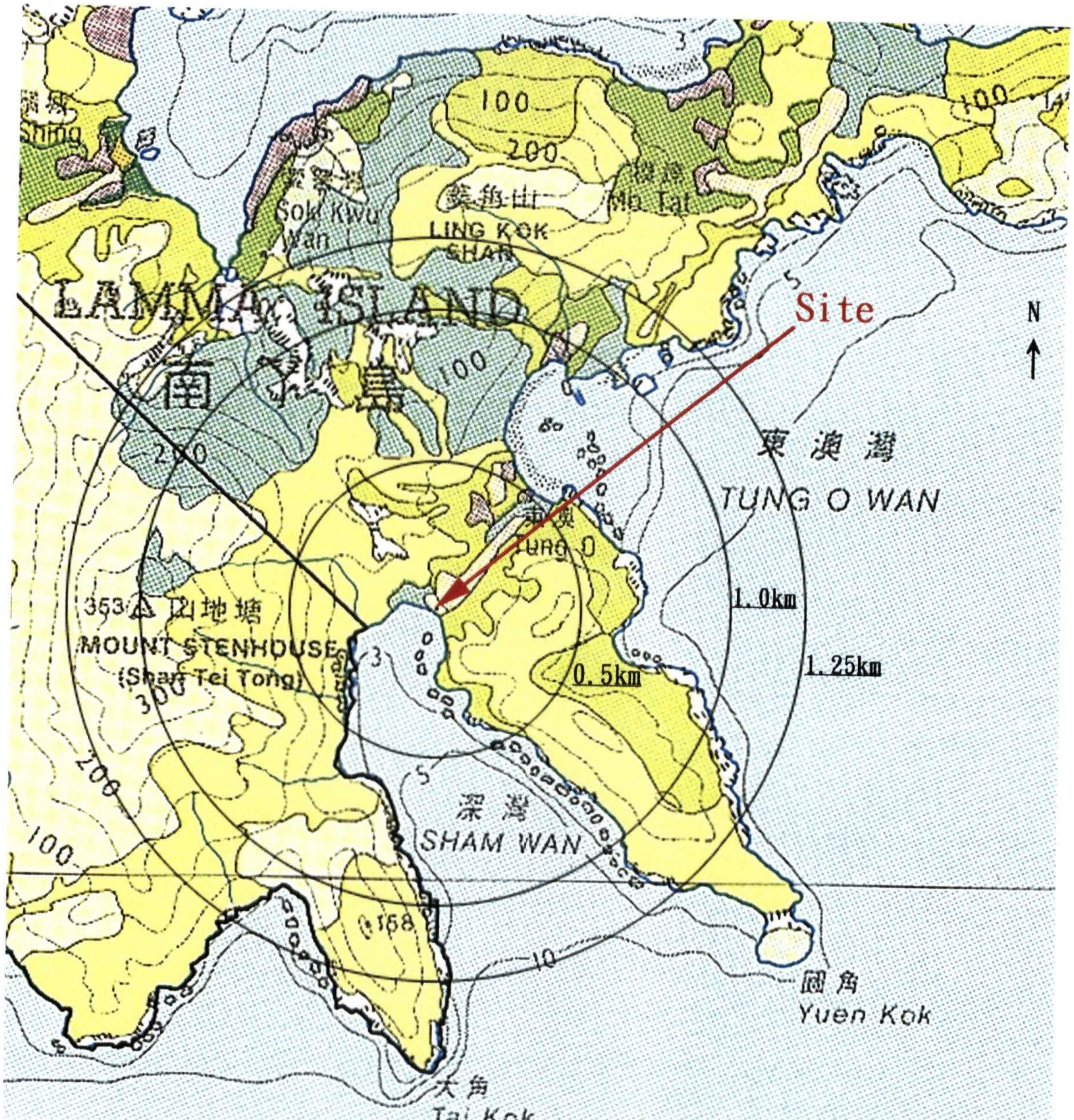


Figure 20. Sha Lo Wan (headland) site catchment



SCALE: 1: 50,000

Figure 21. Sham Wan (sand dune) site catchment