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IMPROVING SANITATION IN COASTAL COMMUNITIES WITH SPECIAL REFERENCE TO PUERTO PRINCESA, PALAWAN PROVINCE, PHILIPPINES

RACHELLE G. NAVARRO

School of Architecture
McGill University
Montreal
July, 1994

A Thesis Submitted
to the Faculty of Graduate Studies and Research
in Partial Fulfillment of the Requirements
of the Degree of Master of Architecture

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Rachelle

Montreal
July, 1994

ABSTRACT

The sanitary collection, transportation, treatment and disposal of human waste promotes health, improves the quality of the environment and thus, the quality of life in a community. Some poor communities in developing countries, rarely consider inadequate excreta disposal a problem. In absence of sanitation facilities, these communities rely on natural processes to dispose of their waste, wherein the practice of defecating in the open fields or on surface water is prevalent.

In communities occupying coastal, waterfront and low-lying areas, human waste is directly disposed of into the surface water such as rivers, canals and sea or in the mudflat to await the tide. These surface waters, however, are often the communities' sources of food, and water for drinking, domestic and personal cleaning. Studies on sanitation show that contaminated water and human wastes are major factors in the transmission of serious diseases in the developing world.

This thesis aims to contribute to the process of selecting appropriate sanitation technologies for the low-income coastal and waterfront communities. The thesis analyzes sanitation and environmental conditions in the coastal communities of Puerto Princesa, Palawan Province, Philippines, to identify the important considerations for the provision of sanitation systems in these communities and hence, determine the feasible sanitation options.

RESUMÉ

Le collecte, le transport et le traitement hygiéniques des excréments humains contribuent à la santé, améliorent la qualité de l'environnement et par le fait même la qualité de vie d'une communauté. Dans les pays en voie de développement, les populations les plus défavorisées portent souvent peu d'attention à l'évacuation hygiénique des excréments. En l'absence d'équipement sanitaire, ces populations s'en remettent à des procédés dits naturels pour l'élimination de leurs déchets et les pratiques de défécation directe dans l'environnement immédiat ou sur les plans d'eau sont courantes.

Dans les communautés côtières, établies aux abords des cours d'eau et sur les terres basses, déchets et excréments sont déposés directement à la surface de l'eau et abandonnés au hasard des marées. Pourtant, les eaux de surfaces constituent souvent la source d'eau pour la lessive, le bain et la consommation, ainsi que de nourriture de ces populations. De nombreuses études ont démontré que l'eau contaminée et les excréments humains sont des facteurs importants dans la transmission de maladies dangereuses dans les pays du Tiers-monde.

Cette thèse a pour but de constribuer au développement d'un processus de sélection d'équipements sanitaires appropriés pour les populations côtières et riveraines moins favorisées. La thèse analyse la condition de l'hygiène et de l'environnement dans la communauté côtière de Puerto Princesa, dans la province de Palawan aux Philippines, en vue d'identifier les critères les plus importants dans la sélection d'équipements sanitaires dans ces communautés, et donc de déterminer les options réalistes offertes.

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Chapter 1
INTRODUCTION

Proper sanitation promotes health, improves the quality of the environment and thus, the quality of life in a community. Sanitation refers to the safe collection, transportation, treatment and disposal of human wastes. In developing countries, improvements in practices of disposing of human excreta are crucial to raising levels of public health. An increasing amount of literature suggests that health problems result from the lack of sanitation facilities, especially among the urban poor living in overcrowded informal settlements. Invariably, it is the poor who suffer the most from the absence of safe water and sanitation because they lack not only the means to provide such facilities but also the information on how to minimize the ill-effects of the unsanitary conditions in which they live.[1] As a result, the negative effects of unsanitary living conditions lower the productive potential of the people who can least afford it.

In industrialized nations, the conventional waterborne-sewerage is the usual method for the disposal of human waste and wastewater. For this system to function successfully, a huge amount of capital for investment and a large amount of water must be available. In poorer countries, where funds are limited and where water is less accessible, the application of the sewerage system is not usually feasible.

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[1] John M. Kalbermatten, et. al., Appropriate Technology for Water Supply and Sanitation : A Planner's Guide (World Bank : Washington, 1980), p.1.

Early in the mid-1970s, international agencies and national governments identified alternative low-cost sanitation technologies that could be adequately applied in rural and low to medium density urban settlements.[2] The search for alternatives has been partly motivated by the need for an incremental approach to sanitation that is perceived as economic since very few cities in developing countries have the resources to build a complete sewerage system for the entire population in one construction project.[3] There have been developments in modifying the various technologies with the goal of making them simpler in installation, use and maintenance, and in eliminating or reducing the handling of fresh excreta. By far, there are over twenty generic types of systems for human waste disposal offering different degrees of user convenience, protection against the spread of diseases and water demand for their operation.[4]

In some poor communities in developing countries, an inadequate excreta disposal system is rarely considered a problem by the people. In rural areas, people seek to dispose of their excreta as cheaply as possible; and in those areas where population density is low, this activity is carried out without any large investments in waste disposal systems.[5] In the absence of sanitation systems, some communities rely on natural processes; defecation takes place in the open fields or on surface waters. In the latter option, human waste is directly disposed of into the rivers, canals and sea for transport and eventual dilution, or in the tidal mudflat to await the tide. This is one of the few options left for poor communities in developing countries, occupying coastal, waterfront and low-lying areas. Such communities are located along the seacoasts, on marshlands, on riverbanks and most often built above the surface water.

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[2] Gehan Sinnatamby, "Low Cost Sanitation" in The Poor Die Young: Housing and Health in Third World Countries, eds., Sandy Cairncross, Jorge E. Hardoy and David Satterthwaite, (London: Earthscan Publisher Limited, 1990), p.132.

[3] Amirali Karim Pirani, Cultural Influences on the Choice of Rural Sanitation Technology in Islamic Countries, (M.Arch. Thesis, McGill University, March 1989), p.5.

[4] Sinnatamby, 1990, p.132.

[5] Pirani, 1989, p.2

The proliferation of communities along the coastal fringes and low-lying areas can be attributed to economic, social and cultural reasons. Some cities are located along coasts or riverbanks, where rivers or canals play a vital role in the transportation of people, goods and services. In most urban areas, marshlands, swamps and other low-lying areas are cheap sites for settlement of the urban poor. In rural communities engaged in fishing, it is necessary for them to settle along the seacoast or above the sea.

The disposal of untreated human waste into water or tidal mudflats, practiced in most coastal and waterfront communities, is satisfactory from the public health point of view, if the water is saline enough to prevent its use for drinking, if the feces are always deposited into the waters and not on land, and if there is sufficient current for dilution.[6] However, these criteria are not always observed. The rivers, lakes and bays over which these communities are built are often the people's source of food and water for drinking, domestic and personal cleaning.[7]

Studies on the health aspects of sanitation show that water and human wastes are major factors in the transmission of more serious types of diseases in the developing world.[8] There are 20 to 30 different communicable water-related diseases. These diseases are classified according to the mode of spread: first, water-borne diseases which are infections spread through water-supplies; 2) water-washed diseases which are due to the lack of water for personal hygiene; 3) water-based diseases which are infections through aquatic invertebrate animals; 4) water-related insect vectors.[9] Excreta, both feces and urine, contain an array of pathogenic viruses, bacteria, protozoa and helminths and are

[6] Michael G. McGarry, "Waste Collection in Hot Climates: A Technical and Economic Appraisal" in Water, Waste and Health in Hot Climates, eds. Richard Feacham, Michael McGarry and Duncan Mara, (London: John Wiley & Sons, Ltd., 1977), p.247-248.

[7] Ibid., 1977, p.248.

[8] Kalbermatten, et.al, 1980.

[9] David J. Bradley, "Health Aspects of Water Supplies in Tropical Countries" in Water, Waste and Health in Hot Climates, eds. Richard Feacham, Michael McGarry and Duncan Mara, (London: John Wiley & Sons, Ltd., 1977), p.6-7.

principal vehicle for the transmission and spread of a wide range of communicable diseases.[10]

Sanitary disposal of human waste is necessary for the following reasons: to eliminate the causative agents of those water and excreta-related diseases; to convert waste into readily re-usable resources and so conserve both water and nutrients; and to prevent the pollution of any body of water (ground water or surface water) to which the effluent escapes after re-use or into which it is discharged without re-use.[11] The organic pollution of water is especially undesirable as it interferes with the use of water for drinking and other domestic, industrial or agricultural purposes; it interferes with aquatic life and it may drastically disrupt the ecology of the surrounding area.[12]

In communities where there is constant contact with the polluted environment, sanitation is an important concern. As these communities continue to grow and practice the unsanitary means of waste disposal, their presence in these coastal and waterfront areas can pose harm to themselves and to their environment. Therefore,the proper collection, transportation, treatment and disposal of human excreta are crucial in the protection of community health and in the improvement of their environment.

1.1 THESIS RATIONALE

This thesis focuses on improving sanitation in coastal and waterfront communities and communities in low-lying areas. In these communities, health and environmental problems are attributed to the lack of sanitary means of disposing of human waste. This assumption raises the following issues: *How can human waste be properly and safely disposed of in coastal and waterfront communities? Among the available low-cost*

[10] Richard G. Feacham, et.al., Health Aspects of Excreta and Sullage Management: A State-of-the-Art Review, (Washington D.C.: World Bank,1980).

[11] Duncan D. Mara, "Wastewater Treatment in Hot Climates" in Water, Waste and Health in Hot Climates, eds. Richard Feacham, Michael McGarry and Duncan Mara, (London: John Wiley & Sons, Ltd. 1977), p. 265.

[12] Ibid., 1977.p.256.

sanitation systems identified for developing countries, are there systems appropriate for these communities? Which have been used in these communities? What are the problems met in their application? If there are no appropriate systems, what are the limiting factors? What are the guiding factors to determine the appropriate system for these communities?

In determining the appropriate low-cost sanitation systems for any community, World Bank studies on appropriate technology for water supply and sanitation developed a program for sanitation planning. This program is the process by which the most appropriate sanitation technology is identified, designed and implemented.[13] In this context, appropriate technology is considered as that which provides the most socially and environmentally acceptable level of service at the most economic cost. More recent studies on actual sanitation projects show that sanitation is more than simply a technical and economic approach. There is an element of deep-rooted cultural values that needs to be addressed in the process.[14] *In the case of the coastal communities, what specifically are these environmental, social and economic factors influencing the selection of sanitation systems? How are these factors to be determined?*

1.2 GOALS AND OBJECTIVES OF THE THESIS

This thesis attempts to contribute to the process of selecting appropriate low-cost sanitation systems for low-income coastal and waterfront communities. The goal of this study is to analyze their sanitation and environmental conditions to be able to identify the essential factors in the provision of sanitation systems in these communities.

The main objectives of the study are as follows:

1. To analyze sanitation and environmental conditions in low-income communities located on coastal, waterfront and low-lying areas;

[13] John M. Kalbermatten, et.al., Appropriate Technology for Water Supply and Sanitation: A Summary of Technical and Economic Options, (Washington, D.C.: World Bank, 1980), p.3.

[14] May Yacoob, Barri Brady and Lynda Edwards, Rethinking Sanitation: Adding Behavioral Change to the Project Mix, WASH Technical Report No. 72, Prepared for the Office of Health, Bureau for Research and Development, Under the WASH Task No. 063, (Washington D.C.: World Bank, 1992), p.v.

2. To determine what sanitation systems have been used in these communities and identify problems associated with their application;
3. To study a prototypical coastal community and be able to define sanitation and environmental problems comprehensively;
4. To identify key considerations in the provision of sanitation systems in the case study;
5. To review available low-cost sanitation systems and determine their potentials and limitations in their application to coastal communities.

1.3 RESEARCH METHODOLOGY

The methodology used for this research includes the literature review and field survey as a primary resource data. The various tasks involved in the research include the following:

Task 1: Literature review of low-income communities located on waterfront, coastal and low-lying areas with emphasis on developing countries to develop a general scenario of sanitation and environmental conditions in these communities.

Task 2: Literature review of low-cost sanitation systems and community sanitation planning.

Task 3: Preparation for field survey for the case study

Task 4: Field survey in the coastal communities of Puerto Princesa, Palawan Province, Philippines as a source of primary data. The detailed methodology for this task is discussed in Chapter 4.

Task 5: Analysis of data from the field survey

This task involves the analysis of sanitation and environmental conditions in the case study and the identification of key considerations for the provision of sanitation systems for the community.

Task 6: Synthesis of data from literature review and field survey

This task involves the analysis of the potentials and limitation of the sanitation systems reviewed based on the derived factors from findings of the case study.

Task 7: Final conclusions and recommendations

1.4 SCOPE AND LIMITATIONS OF THE STUDY

The scope of analysis of sanitation is not limited to the operational definition of proper disposal of human waste and the construction of latrines. The study encompasses other elements such as water supply, disposal of wastewater and solid waste, community hygiene and health, and environmental conditions. It is beyond the scope of this study to recommend the most appropriate technology for the coastal community analyzed since detailed economic analysis and institutional requirements are not included in the research. The study is limited to the preliminary stage of the selection process that involves the identification of problems related to environmental, technical, social, cultural, and health aspects of the community. It focuses on the selection process involved and the issues relevant to the provision of sanitation systems for the community. Since specific findings are based on the case study, it must not be assumed that they are applicable in other coastal communities. Only general recommendations are provided in the larger context.

1.5 ORGANIZATION OF THE THESIS

The thesis comprises seven chapters. The second chapter gives an overview of the sanitation and environmental conditions in coastal communities based on the literature review. It discusses the environment of these communities, why they have settled in such areas and sanitation and environmental problems met. The third chapter focuses on interventions done to solve sanitation conditions in the communities discussed in the previous chapter by identifying the sanitation systems introduced and implemented. It determines if the systems used were as effective as they were envisioned. The fourth chapter introduces the case study-the coastal communities of Puerto Princesa, Palawan Province, Philippines- and discusses in detail the research methodology used to analyze the community. The fifth chapter presents the result of the case study by discussing existing sanitation problems and the significant implications on the health of the community and on the environment. Based on these results, essential factors to be considered in the provision of sanitation systems are identified in Chapter 6. These factors are used to analyze the various low-cost sanitation systems. The last chapter summarizes the findings of the study, both from the literature review and the case study, and presents the recommendations.

Chapter 2
GENERAL SCENARIO OF SANITATION PROBLEMS IN COASTAL AND WATERFRONT COMMUNITIES-- A LITERATURE REVIEW

The terms "coastal and waterfront communities" refer to settlements built along the seacoasts, estuaries, mangrove swamps, lakeshores, riverbeds and in most cases extended right above the surface waters. Communities built on low-lying areas include those on swampy sites, marshlands and other flood prone areas. A general term that encompasses these coastal and low-lying areas is "wetland." "Wetland" is defined as those transitional areas between dry land and open water, which are characterized by low topography, standing waters and poor drainage.[1] Recent studies on wetlands indicate the difficulty to define these sites precisely, not only because of their great geographical extent, but also because of the wide variety of hydrologic conditions in which they are found. As illustrated in Figure 2.1, the distinguishing feature of all these types of wetlands is the interplay between land and water and the sharing of the characteristics of both.[2] From these definitions, no matter how diverse the environmental conditions are in coastal and waterfront communities, the presence of water in their environment is the main factor linking them.

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[1] Erley, Duncan, et.al., Performance Control for Sensitive Lands: A Practical Guide for Local Administrator, (Washington, D.C. 1975), p.38.

[2] Michael Williams, "The Human Use of Wetlands," Progress in Human Geography (1991), 15(1), pp. 2-3.

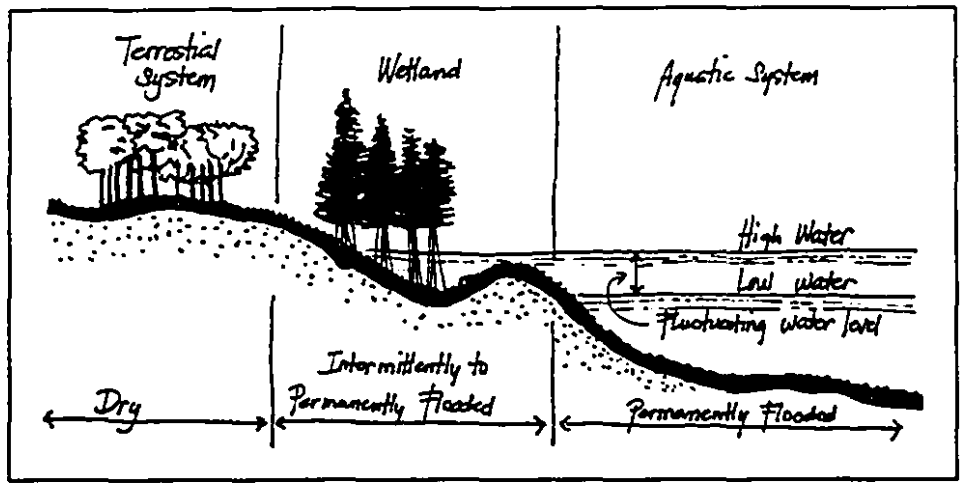

Figure 2.1: Wetlands are transitional areas between the dry terrestial ecosystems and the permanently wet aquatic ecosystems (adapted from Mitsch and Gossenlink, 1986).

This chapter presents a background on sanitation conditions in coastal and waterfront communities and those occupying low-lying areas. The discussion is based on several examples of these communities in developing countries. The selected communities discussed in this chapter vary in cultural, social, political and economic factors and to some extent, physical conditions. The main objective of this discussion is to characterize the sanitation problems due to their location and environment.

The chapter comprises three parts. The first part cites several examples of coastal and waterfront communities and discusses why they are located on such sites. The second part identifies the sanitation problems prevalent in these communities. The last part discusses the implications of sanitation problems to the health of the people and to the environment.

2.1 REASONS FOR SETTLING ON COASTAL, WATERFRONT AND LOW-LYING AREAS

The settling of communities on coastal, waterfronts and low-lying areas as well as on surface water can be attributed to several reasons. In the historical development of cities in developing countries, most cities are located on coasts or large rivers for trade, transportation, communication and defense reasons, as selected by the former colonial powers. In these

countries, the rivers or canals play a vital role in the movement of people, goods and services. In most urban areas, low-lying and flood prone areas are cheap alternatives for settlement sites. For rural regions, livelihoods such as fishing or rice cultivating, require settling on seacoasts or on the sea itself. For some communities, culture and tradition are significant reasons. The following discussion explains these reasons and cites specific examples of communities.

a. Strategic Locations for Cities and Towns

Most major cities in developing countries occupy sites selected by the former colonial powers, with an eye to trade and defense. For this reason, the historical locations of most cities are on the coast or large rivers and are protected by limited access on the landward side. Cities such as Bangkok, Manila, Lagos and Abidjan are examples of these.

Banjarmasin, the largest city in south Kalimantan, Indonesia, has earned the reputation as the "Venice of Indonesia." Its river systems comprising the Martapura River and the Barito River and other connecting canals, provide the major thoroughfares of the city, carrying thousands of watercrafts in and out of the city daily. [3] In Bangkok, a similar scenario exists. Canals and rivers have been used for trading activities, hence, floating markets are a common sight within the city.

In China, traditional water towns with a historical origin still exist. Examples of these are found in the southern parts of Jiangsu province. They are: Zhou-Zhuang, Tong-Li, Qian-Deng, Cheng-Me, Lue-Zi, Sha-qi and Tai-Chang counties. These towns are all located on the plain of the lower Yangtze, on the eastern coast of China. This land is in the subtropical zone with plenty of rainwater and fertile soil. As shown in Figure 2.1, most of these towns are fishing villages which depend on the natural water resources around them.[4]

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[3] Ginny Bruce, Indonesia: A Travel Survival Kit, (Australia: Lonely Planet Publications, 1986),p.231.

[4] Zhang Zhi-Zhong, and Cheng Qui-Guang, "Tradition and Innovation: Planning and Reconstruction of Watertowns in Southern Jiangsu", Open House International, (1989), 14 (1) pp.3-4.

Figure 2.2: Zhou-zhuang fishing village, Jiangsu province, China. (Wang, 1992)

b. Cultural Reasons

In some Asian and African countries, characterized by a coastal environment, cultural tribes have long inhabited the waters. Living within the coastal, swampy shores and the waters of Riau province of Indonesia, are the *Bugis orang laut.* The *Bugis* are renowned seamen in self-imposed exile from their native Sulawesian homeland, living aboard wooden sailing craft, and trading throughout the archipelago or adjacent seas. Although they have maritime settlements from Burma to the Philippines they more commonly sail or row their boats through a labyrinth of inter-island channels and mangrove swamps, fishing and trading.[5] In the Philippines, sea-gypsies known as *Badjaus* are scattered over thousands of square miles, from the Sulu Sea to Eastern Indonesia. The *Badjaus* follow the nomadic life of their ancestors, while others settle at the water's edge.[6]

[5] Bruce, 1986, p.223.

[6] Anne de Henning Singh, "Life Ashore Beckons the Bajaus: Sea Gypsies of the Philippines", National Geographic Magazine, (May 1976), 149 (5), p.659.

c. Source of Livelihood

In the most basic sense, because coastal areas are considered among the most productive ecosystems, many communities have depended on these areas for their livelihood and as their source of food, water and resources. The dependence on fish protein is much greater in coastal tropical and subtropical countries than in temperate areas of the world. According to the Food and Agricultural Organization, 60% of the people in developing countries obtain 40-60% of their animal protein from fish. In general, the poorest are the most dependent, since fish is the only protein item within their economic reach.[7] Thus, in rural regions, several fishing communities have occupied the riverbanks and coasts of bays and lakes for their proximity to the fishing waters. In several cases, communities extend towards the lakes or bays by building their settlements right above the shallow waters. Several examples of these communities are discussed below.

For centuries, the people living along the coast of West Africa have fished in the waters of the Atlantic. Many villages of small houses made from bamboo and the palm leaves are built on the shore of the ocean, in which fishermen practice their craft in the traditional manner. On the northwestern shore of Lake Nokwe in southern Dahomey, is a lake dwelling village, called Ganvie. It is a small town devoted to fishing which is entirely built on the lake and the only means of access is by canoe.[8]

In some countries which are made up of several islands and islets, similar types of fishing communities have proliferated along the tidal foreshore of some of the country's coastal regions. In these fishing villages, houses are supported by stilts embedded in mudflats, with many homes located as far as a kilometer from the nearest firm ground. At the northern corner of South Sumatra Province, in Indonesia, lies the Banyuasin Sembilang mangrove swamps which have been occupied by communities engaged in fishing, agricultural activities, husbandry

[7] O. Linden, "Human Impact on Tropical Coastal Zones", Nature and Resources, (1990), 26 (4), pp. 4-5.

[8] Miles Danby, "Ganvie, Dahomey", in Shelter in Africa, ed., Paul Oliver, (London: Barrie & Jenkins, 1971), pg. 36.

of forest products, hunting and trade in wildlife and artisan fisheries.[9] In the southern provinces of the Philippines, fishing villages exist along seacoasts and on the water itself. Gameranga, Bangladesh, a Muslim village consisting of 202 households, occupies a piece of land densely cut by canals and richly dotted with ponds of varying depths and sizes. Villagers depend on rice cultivation, fishing and tapping of date palms.[10]

In the case of the coastal communities discussed above, which are mostly rural in nature, the coastal environment is considered a productive source of livelihood. In urban areas, the coastal and low-lying sites are perceived as idle lands with limited land use alternatives. These areas are prone to squatter invasions.

d. Low-lying Areas as Settlement Sites for the Urban Poor

Some cities in developing countries are seaports, located on coasts. Many are on estuaries of rivers which served as commercial arteries for the transport of goods to and from the hinterland. The flat estuarine terrain and soft, often impermeable alluvial soil make drainage difficult. Furthermore, such coastal regions of the world are where the highest average rainfall is found.[11] Thus, in urban areas in most developing countries, low-lying land, such as marsh lands, banks of rivers and canals are considered wastelands because they have low commercial value or limited alternative land use. These idle sites, which may be private or public properties, are occupied by the urban poor. Such locations are cheap alternatives for settlement sites. For the urban poor, proximity to place of work, accessibility to the urban center and its services overrule the physical hazards of settling in flood-prone sites or in areas characterized by stagnant polluted waters.

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[9] Verheugt, W.J.M., et. al. "Integrating Mangrove and Swamp Forest Conservation with Coastal Lowland Development: the Banyuasin Sembilang Swamp Case Study, South Sumatra Province, Indonesia, Landscape Urban Planning, (1991), 20, p. 85-91

[10] Pirani, 1989, p.32-33.

[11] Gerald Krausse, " Intra-Urban Variation in Kampung Settlements of Jakarta: A Structural Analysis", in The Journal of Tropical Geography, (1976) p. 25.

Many cities in developing countries are faced with problems of slums proliferating in these low-lying areas which are prone to flood or tidal inundation. Examples of these include Guayaquil (Ecuador), Recife (Brazil), Monrovia (Liberia), Lagos and Port Harcourt (Nigeria), Port Morsby (Papua New Guinea), Delhi (India), Bangkok (Thailand), Jakarta (Indonesia), Buenos Aires and Resistencia (Argentina) and Accra (Ghana).[12]

In the central city of Jakarta, urban slums known as *kampungs* occupy the sloping embankments and terraces along the river, as well as the coastal marshlands in the northern periphery of the city. Among the sites occupied by the urban poor in Jakarta, marshlands and coastal areas usually provide sites for rentfree accommodations.[13] In Guayaquil, Ecuador, squatter communities are built over tidal swamplands.[14] Although the site is over an hour by bus from the city center and is located on floodlands, the inhabitants have moved there because of its access to employment and educational establishments and the advantage of owning *de facto* a plot of land.[15] A similar scenario exists in the southern fringes of Port Harcourt metropolis, Nigeria. The area is characterized by squatter housing units developed on reclaimed land. These settlements have developed on land below the three meter contour marked as unsuitable for development. There are about 14 such waterfront squatter housing areas around the city, comprising 4,331 dwelling units with an estimated population of about 30,000 in 1985.[16]

In other cities, canal right-of-ways, riverbanks and in some cases on the river itself, have been the sites of squatter settlements. In the eastern suburbs of Bangkok, squatter communities, known as *klong* settlements, build their homes along the canal right-of-way. The

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[12] Jorge Hardoy and David Satterthwaite, Squatter Citizen: Life in the Urban Third World, (London: Earthscan, 1989), p.53.

[13] Krausse, 1975, p. 25

[14] Hardoy, 1989, p. 76.

[15] Caroline O.N. Moser, "A Home of One's Own: Squatter Housing Strategies in Guayaquil, Ecuador", in Urbanization in Contemporary Latin America, ed. A. Gilbert, J.E. Hardoy and R. Ramirez, (New York: John Wiley & Sons Ltd., 1982), p. 167.

[16] Chukudi V. Izeogu, "Public Policy and Affordable Housing for the Urban Poor in Nigeria: A Study of Squatter Redevelopment Programs in Port Harcourt," Habitat International, (1993) 17(2) p. 27.

canal right-of-way is a strip of land with an average width of twenty meters which runs alongside the canals and originally served as a maintenance strip. Some 68 squatter communities have been identified with an estimated total number of 44,000 inhabitants. About 7,390 houses are built on the canal banks or protrude into the canals. The majority of the squatter population lives alongside four major canals in the area: Klong Premprachakorn, Klong Lad Phrao, Klong Bang Sue and Klong Bang Khen.[17] In *klong* settlements, proximity to urban sub-centers, accessibility of the sites and available infrastructure are of importance. Being close to the port area, the site has also attracted dock laborers. Figure 2.3 illustrates this example.

Figure 2.3: Klong or canal settlements, Bangkok, Thailand.

[17] Harry Roovers, et.al., Alternatives to Eviction of Klong Settlements in Bangkok, Third World Planning Review (1989), 11(2), p. 3-4

In the same way, the Sabarmati riverbank squatter settlement in Ahmadabad, India, developed to accomodate the needs of workers in the nearby textile mills. It also provided a refuge for Muslims forced from their homes by riots in 1969. Further growth resulted to more than two dozen squatter settlements to be found on the eroding banks of the river and some even on the riverbed itself. This settlement has a density reaching as high as 2,000 persons per hectare.[18] An example of a large community built on the river is *Kampong Ayer* in Bandar Seri Begawan, the capital of Brunei. In this water village, there are about 27,000 inhabitants which is approximately 32% of the total population of the city. As shown in Figure 2.4, this community is built on the Brunei River itself, near the city's central business area.[19]

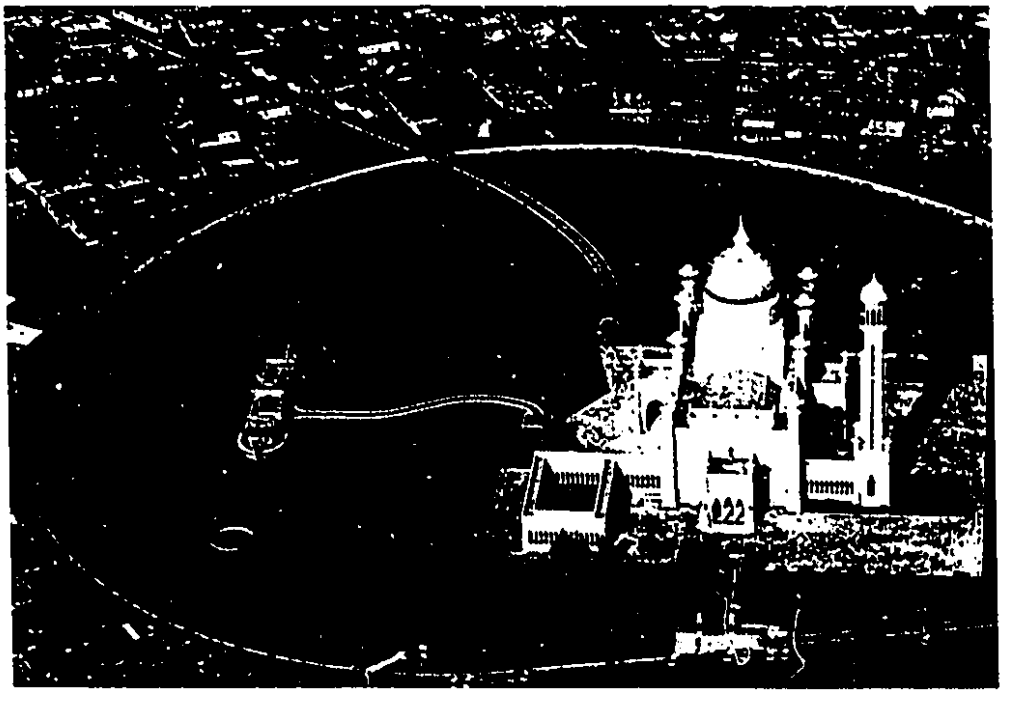

Figure 2.4: Kampong Ayer, a water village in Bandar Seri Begawan, Brunei (Ling, 1988).

[18] UNCHS, Survey of Communities and Squatter Settlements, (Dublin: Tycooly International Publishing Ltd., 1982), p.33.

[19] Arthur Ling, ed., Urban and Regional Planning and Development in the Commonwealth, (England: Howell Publications, 1988), p. 176.

In Port Moresby, Papua New Guinea, Koki squatter settlements are built mainly over the sea. The people all came from coastal villages 100 miles east of Port Moresby where they traditionally live in houses built on piles in coastal lagoons. The community started to come to Port Moresby in the late 1950's to sell their products. They moored their canoes near the city's main market. Many obtained jobs in the city, and the settlement evolved from what had been a canoe landing ground. In 1979, there were 225 houses and a population of 1,800. The people retained their strong traditional links with the sea and with their home villages.[20]

2.2 SANITATION PROBLEMS

Coastal and waterfront communities are faced with a wide range of problems caused by their location and environment. Sanitation is a predominant concern. Though sanitation in this thesis refers to the sanitary means of disposing of human waste, the discussion of other related aspects such as water supply, wastewater and garbage disposal are considered significant. Among the communities reviewed, sanitation problems are more complex in high-density urban squatter settlements occupying the low-lying areas such as riverbanks, coastal areas and marshlands than those communities with low-density in rural areas. These problems are associated with a contaminated water supply and a lack of sanitation facilities, specifically, toilets with proper waste treatment. To illustrate the extreme conditions of these problems, the following discussion focuses on the sanitation problems in high-density poor communities

a. Lack of Sanitation Facilities

In most of the communities reviewed, sanitation facilities are absent and direct defecation into the surface water has been the traditional practice. For instance, the people of the Koki squatter settlement, in Port Moresby, Papua New Guinea, relieve themselves in the

[20] Peter J. Swan, The Practice of People's Participation: Seven Asian Experiences in Housing the Poor, (Thailand: Human Settlements Division, Asian Institute of Technology ,1980) pp.111,113.

open sea.[21] Such traditional practice of 'visit or swim to the sea' is also prevalent in communities found in small islands such as those in the South Pacific.[22]

In other communities, the overhung latrine is commonly used. These are simply superstructures with the toilet seat or floor hole built above the tidal flat, river, canal, lake or swamplands. Defecation takes place directly into the water for transport and eventual dilution, onto the mudflat or the beach to await the tide. In worse conditions, excreta is disposed of into the stagnant waters or simply on the ground underneath the built toilet. In Guayaquil, human waste is directly disposed into the mud and polluted waters. Approximately 83% of the inhabitants of the marshlands use a hole on the floor boards for the family toilet, while the remaining 17% has a separate structure at the back of the house.[23] In Jakarta, most people use latrines, private or communal, with outlets to or built directly into swamps and canals.[24] In Gameranga, Bangladesh, the village does not have proper excreta disposal system. A latrine basically consists of a bamboo construction over a hole or pit in an undergrowth behind a hut. Sometime this type of structure is built over a pond and is covered by old mats.[25]

The practice of directly disposing of human waste into bodies of water is considered satisfactory as long as the water is saline enough to prevent its use for drinking, if the feces are dumped into the water and not on the land, and if there are sufficient currents for dilution.[26] This practice, while considered a hygienically acceptable and satisfactory traditional habit, can be a problem with expanding populations. In worse cases, particularly in fresh water rivers over which such latrines are built, the water is used for domestic and personal washing as well as for drinking.

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[21] Ibid., 1980. p.111,113.

[22] Tony Marjoram, "Pipes and Pits Under the Palms: Water Supply and Sanitation in the South Pacific", Waterlines, Volume 2, No. 1, July 1983, p.16.

[23] Moser, 1982: p. 174.

[24] Lars Marcussen, Third World Housing in Social and Spatial Development: The Case of Jakarta, (England: Avebury Grover Publishing Company Ltd.,1990) p. 132.

[25] Pirani, 1989, p.34

[26] McGarry,1977, p. 247.

b. Water Supply

Contaminated drinking water supply is another problem related to sanitation. Due to geographical location, the water supply from the site may be either contaminated or with high saltwater content. Hence, in these communities, water is retrieved from another area. The practices of water fetching, sometimes illegally tapping the nearest municipal lines, and water vending are prevalent in these communities.

The nearer the source of water is to the sea, the more chance there is of saltwater intrusion in the ground water. In the case of *kampung* settlements occupying the seaward side of Jakarta, the groundwater is brackish and contaminated by the subsurface encroachment of salt water from the ocean. Thus, their sources are the waterlines, self-constructed wells, communal faucets, or hand pumps, on the mainland. They acquire water from these sources by either buying it from street vendors or fetching the water themselves. Within the city, several water reservoirs at strategic locations were built, where hundreds of water vendors get their water daily and sell it to families in neighboring *kampungs*.[27]

In communities where waterlines are available, problems related to water contamination due to poor pipe connections and maintenance of lines occur. In Klong Khum, Bangkok, pipes are laid bare on swampy land or on the wastewater pool. In most of the houses, water supply pipes leak, are not properly connected and are rusted. When these pipes are empty, foul materials from exposed wastewater and latrine waste seep through them.[28]

In the communities of small islands of the South Pacific, the adequate supply of safe water is a problem since the islands are too small to ensure rainfall and too flat and porous to have surface water. In these communities, the people rely on roof catchment and domestic storage of rainwater for drinking, and they use groundwater or seawater for washing.[29]

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[27] Krausse, 1978: p. 21.

[28] Ali Syed Monsoor, "Adverse Effects of the Environment on the Health of Slum Dwellers: A Case Study of Klong Toey Slum, Bangkok," (Master of Engineering Thesis, Asian Institute of Technology, Bangkok, Thailand, 1990), p.27.

[29] Marjoram, 1983, p.15.

Contamination of the drinking water supply and the absence of sanitation facilities has implications on the health of the people and a negative impact on the environment. This is amplified by other environmental problems caused by the improper disposal of solid waste. The following discussion covers the health and environmental problems that arise in these communities.

2.3 HEALTH AND ENVIRONMENTAL CONDITIONS

The lack of sanitary means of disposing of human wastes, results in a high probability that inhabitants of coastal communities are prone to feco-oral infections transmitted by the consumption of contaminated food and drink. The micro-organisms that cause these infections are found in the excreta of infected people or animals, and surface water becomes contaminated with them from sources such as blocked sewers and overflowing septic tanks, and often from defecation in the open by livestock and by people who have no toilet.[30] This contaminated surface water can infect people through the contamination of their hands, their utensils, or their drinking water supply. Children are particularly exposed to infection when playing or bathing in the water.

In the slums of north Jakarta, where drainage and standing water are major problems, occurrence of diseases and infections is high. Diarrhea is 342 episodes per 1000 population. The peak incidence occurs during the rainy season, affecting the infants from 6-12 months. Intestinal worms are widespread, as a result of environmental circumstances. Approximately 43% of children below five years of age are infected with ascaris and trichuris or both.[31] In Gameranga, Bangladesh, the village has seasonal outbreaks of certain communicable diseases

[30] Sandy Cairncross and E.A.R. Ouano, "Surface Water Drainage in Urban Areas," in Poor Die Young: Housing and Health in Third World Cities, eds., Sandy Cairncross, Jorge Hardoy, and David Satterthwaite, (London: Earthscan Publications, 1990), p.159.

[31] C. Jurjadi, "Preliminary Analysis of the Immunization Survey at Subdistrict of West Pademangan and Subdistrict of Penjaringan" (Atma Jaya University,1990) in Trudy Harpham, Paul Garner and Charles Surjadi, "Planning for Child Health in a Poor Urban Environment - The Case of Jakarta, Indonesia," Environment and Urbanization (October, 1990) 2(2), p. 80.

like cholera, scabies, malaria and boils. Also, intestinal infections, worms and influenza are problems throughout the year.[32]

In small ecologically sensitive islands, sanitation and safe waste disposal are inextricably linked with the question of water supply. As populations increase, so do problems of water supply and sewage disposal, if the limited freshwater supply, especially below coral islands, is not to be contaminated. This type of contamination was the cause of cholera outbreak in urban Kiribati, a small island in the South Pacific, in 1977, and prompted the construction of toilets discharging into the open ocean. [33]

In the same way, the resulting problems are obvious when domestic wastes are dumped into the surrounding area. Piles of garbage are scattered by scavengers or animals and serve as food or breeding grounds for disease vectors, primarily flies and rats. Dangers to health also arise in the refuse itself and from the disease vectors which breed or feed there. Where rivers or lakes are polluted with garbage and excreta, this means further extensive site contamination.[34] In Jakarta, where latrines are built above the canals and where garbage is dumped, bathing and laundry in the canal are still being done.[35] In Guayaquil, the marshlands are characterized by polluted mud and stagnant water. Such exposed water of any type is likely to serve as a breeding site for a range of insects and some, even though not blood-suckers, may become an abundant nuisance, especially moth-flies and midges whose cast pupal skins may provoke allergies.[36] *Dengue haemorrhagic* fever occurs in epidemics in Jakarta slum areas. This condition is caused by the aedes mosquito, and may cause a severe illness in children resulting in death. Malaria may also occur as an epidemic, and this disease is common in areas

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[32] Pirani, 1989, p.33

[33] Marjoram, 1983, p.16

[34] Stenio de Coura Cuentro and Dji Malla Gadji, " The Collection and Management of Household Garbage", in Poor Die Young: Housing and Health in Third World Cities, eds., Sandy Cairncross, Jorge Hardoy, and David Satterthwaite,(London: Earthscan Publications, 1990), p169.

[35] Marcussen, 1990, p.93.

[36] C. J. Schofield, et.al., "The Role of House Design in Limiting Vector -Borne Diseases," in Poor Die Young: Housing and Health in Third World Cities, eds., Sandy Cairncross, Jorge Hardoy, and David Satterthwaite,(London: Earthscan Publications, 1990), p.198.

where drainage and standing water is a problem.[37] In West Africa, some river settlements have been disrupted by vector-borne diseases such as river blindness, *Onchocerciasis*.[38]

In *klong* settlements in Bangkok, wastewater from sullage cesspools and surface run-off are directed into the pond or stagnant water beneath the house. This stagnant water has been the playground of children especially during the heavy rains: they swim and play, thereby increasing the risk of contracting diseases. There is no existing sewerage system or wastewater treatment. The pond is likely to become a breeding place for insects.[39] Wastewater from bathing and personal hygiene, washing of clothes, household cleaning, food preparation and dishwashing are all disposed of into the ground beneath the houses. Since there is no sewerage in the area, this adds to the pool of water that has remained in the surroundings. The soil is hardly permeable in nature, resulting in non-absorption of the water.[40]

The discussion of the sanitation and environmental problems of coastal communities raises the question of tolerating the growth of communities in this environment. From an environmental point of view, the process of residential development in coastal areas involves a complex of potential ecological disturbances to coastal waters, due to construction activity and human occupancy. The degree of disturbance is heightened by the increased density of development, closer proximity to the water, extensive alteration of the shorescape, and the ecologic sensitivity of the ecosystem.[41]

In this context, it can be argued that the most fundamental source of problems in coastal and waterfront communities and those in low-lying areas is the occupation of sites that

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[37] Harpman, et. al, 1990,p.80

[38] C.J. Schofield et.al., 1990, p. 198.

[39] Ilde Balanay Deloria, "Low-Cost Sanitation System Alternatives in Slum Areas: A Case Study of Khlong Kum, Bangkok, Thailand, "(Master of Engineering, Asian Institute of Technology, Bangkok, Thailand, 1991) p.26.

[40] Ibid, 1991, p.31.

[41] Clark, John, Coastal Ecosystem:Ecological Consideration for Management of the Coastal Zone, (Washington: The conservation Foundation,1974), p. 161.

are considered environmentally critical areas and are not appropriate for settlement planning. Such sites are used as easements for maintaining shorelines and waterfronts and low-lying areas prone to flooding. The presence of growing communities in these areas pose negative impact on the environment such as degradation and exploitation of resources and water pollution.

In cases where the environment becomes the priority, eviction and resettlement of the community from the site seems the most logical approach. Considering those informal settlements found in the urban areas, as in the cases of Jakarta, Bangkok and Guayaquil, where there are no available sites to relocate the community, accommodation and regularization of such communities became the other options. To accommodate or regulate the coastal slums, the local government is faced with several issues in improving sanitation and environmental conditions. In more traditional communities, reliance on their environment for livelihood and food are too difficult to outweigh. Hence, what interventions were made in these communities to improve sanitation? Were these interventions successful? What sanitation systems were implemented in these communities? Were they sustained by the community? What are the problems associated with the application of these systems in these coastal and waterfront communities? What are their causes? The next chapter attempts to answer these questions by discussing the sanitation systems used in some of the communities discussed earlier.

Chapter 3
SANITATION SYSTEMS USED IN COASTAL AND WATERFRONT COMMUNITIES-- A LITERATURE REVIEW

The literature review of the sanitation conditions in coastal and waterfront communities indicated that the unsanitary means of disposing of human waste has negative impact to the health of the community and to the condition of the environment. In some of the communities reviewed, interventions have been done to improve sanitation conditions. Such interventions were either provision of sanitation facilities to the community by the local government or a simple system which the people themselves have adopted and used. This chapter provides a brief introduction to available low-cost sanitation systems and identifies which systems have been applied in coastal and waterfront communities and those built on low-lying areas.

3.1 AVAILABLE LOW-COST SANITATION TECHNOLOGIES

Recent studies in sanitation identified several low-cost sanitation technologies. These excreta-disposal systems offer different degrees of user convenience, protection against the spread of diseases and water demand for their operation. They can be classified in several ways. A basic classification is based on whether the waste is disposed of within the site or is transported somewhere else. Under this classification, the technology is either on-site or off-site systems. On-site sanitation systems include those in which safe disposal of excreta

takesplace on or near the plot or site of the toilet.[1] Systems included in this classification are; overhung latrines, trench latrines, pit latrines, Reed Odorless Earth Closet (ROEC), ventilated improved pit latrines (VIP), composting latrines, pour-flush latrines, and septic tanks. Off-site sanitation systems include those in which excreta are collected from the individual toilets and carried away from the plot to be disposed of.[2] Vault and cartage and bucket latrine are included in this category. Some of these systems involve the use of water and are therefore classified as wet systems. Others disallow the use of water, even for hygienic purposes, and are therefore classified as dry systems. Figure 3.1 shows the generic classification of sanitation systems.

Another way of classifying sanitation systems is through their application as either individual household sanitation technologies or community sanitation technologies.[3] Systems that are classified as household sanitation systems include the pit latrine, pour-flush toilets, composting toilets, aquaprivies and septic tanks, which are built in individual houses. Systems such as bucket latrines, vault toilets with vacuum-cart collection, communal toilets and sewerage systems are classified as community sanitation facilities.

Studies of appropriate technology for water supply and sanitation under the World Bank International Drinking Water Supply and Sanitation Decade (1980-1990) defined several comparative criteria to introduce the putative performance of these technologies. Among these criteria are the following: water supply service levels; soil condition requirements; cost; housing density; complementary investments; reuse potentials; environmental factors; self-help potential; and institutional constraints.[4] A descriptive comparison of sanitation technologies based on some of these criteria is shown in Table 3.1.

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[1] Andre Cotton and Richard Franceys, Services for Shelter, (Great Britain: Liverpool University Press, 1991), p.75.

[2] Ibid., 1991, p.75.

[3] John M. Kalbermatten, De Anne Julius and Charles Gunnerson, Appropriate Technology for Water Supply and Sanitation; A Summary of Technical and Economic Options, (Washington D.C.: World Bank, 1980), p. 3.

[4] John M. Kalbermatten, De Anne Julius and Charles Gunnerson, Appropriate Technology for Water Supply and Sanitation; A Planner's Guide,(Washington D.C.: World Bank, 1980), pp. 43-49.

Recent studies on sanitation in developing countries identify some special requirements needed above the general criteria identified above. Nimpuno (1984) emphasizes operation, costs, construction, water requirements and urban adaptability as special considerations in the selection of sanitation technologies in developing countries.[5] For existing low-income settlements without adequate sanitation facilities it is of great importance that small-scale, even individual, household installations can be chosen, that in time the individual provisions can be linked up to form a network, and that the systems can be upgraded gradually.

In actual sanitation projects, one of the causes of their failure is the overemphasis on technological installations at the expense of behavioral considerations such as latrine usage and upkeep and general hygiene practice of the users.[6] In most of these projects, the stated priorities or goals often promote installation of facilities or numerical targets. Project planners pay little attention to the types of technologies acceptable to a given community, or to hygiene education needed to support the chosen option. Under these circumstances, it is more than simply a technical or economical analysis to the approach of providing adequate sanitation facilities. There is an element of deep-rooted cultural values which needs to be responded to in the process.[7]

[5] For the system to be acceptable in low-income communities in developing countries the following considerations must be met: (1) the daily operation should require minimal educational and technical instructions which can be taught to all ages. A simple, safe toilet routine should suffice for the daily operation of the system; (2) the construction costs should not exceed 10% of the total house investment; (3) the maintenance requirements be low that the construction require mainly local materials and be executed by semi-skilled labor; (4) the use of water to dilute and transport the excreta should be avoided since water is scarce and water treatment entails high cost; and (5) since a great majority of the urban dwellers in developing countries do not have access to satisfactory excreta disposal systems, it is important to require that disposal systems are identified for existing housing areas. Application should also be possible in existing high density areas. Krisno, Nimpuno, "Viable Low Cost Sanitation Options", In Water and Sanitation: Economic and Sociological Perspectives, ed. Peter G. Bourne, Florida: Academic Press Inc. 1984, p.266-267.

[6] Yaccob, 1992, p.v.

[7] Pirani, 1989, p.

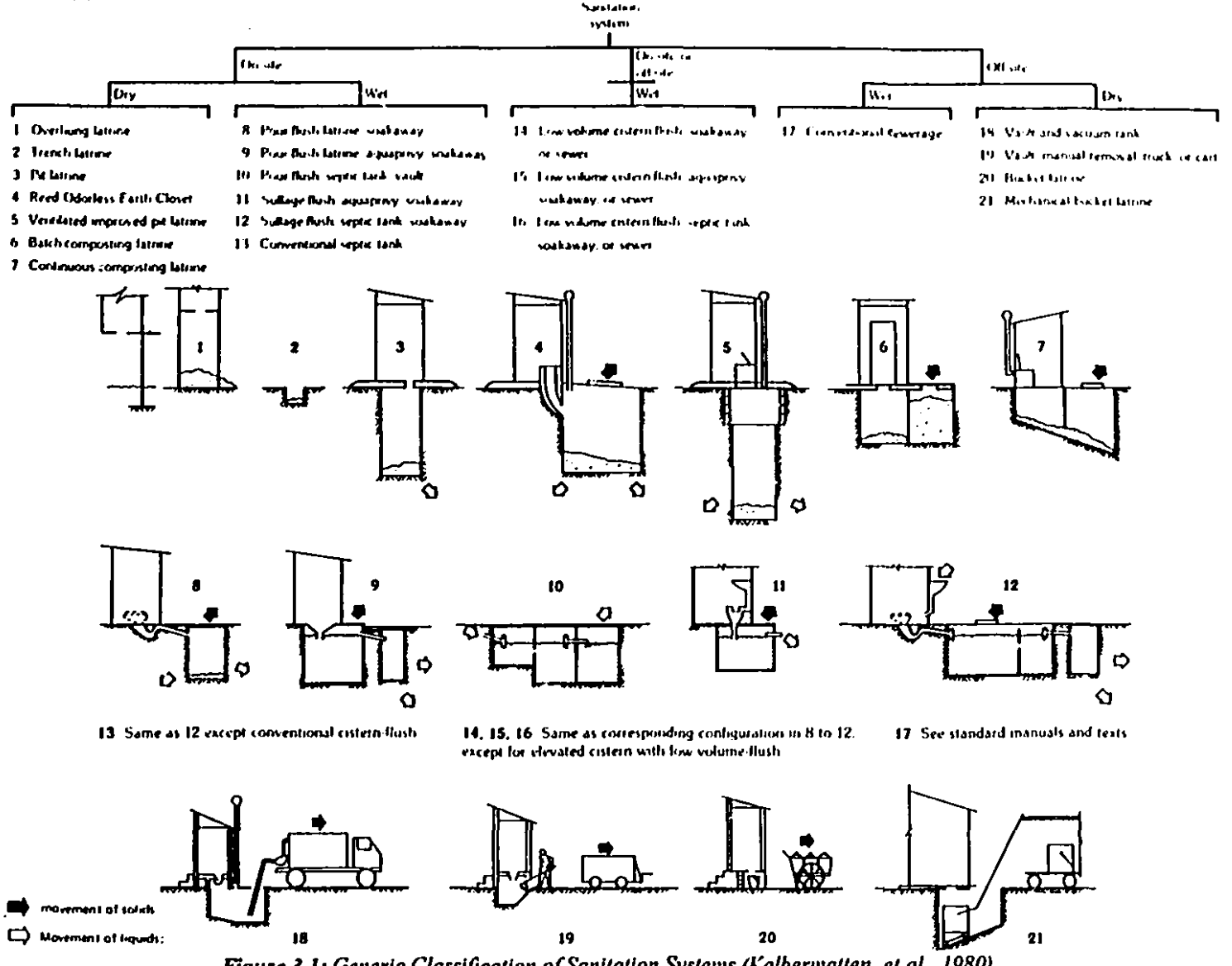

Figure 3.1: Generic Classification of Sanitation Systems (Kalbermatten, et.al., 1980).

Sanitation technology	*Rural application*	*Urban application*	*Construction cost*	*Operating cost*	*Ease of construction*	*Self-help potential*	*Water requirement*	*Required soil conditions*	*Complementary off-site investment*[a]	*Reuse potential*	*Health benefits*	*Institutional requirements*
Ventilated improved pit (VIP) latrines and Reed Odorless Earth Closets (ROEC's)	Suitable	Suitable in L/M-density areas	L	L	Very easy except in wet or rocky ground	H	None	Stable permeable soil; groundwater at least 1 meter below surface[b]	None	L	Good	L
Pour-flush (PF) toilets	Suitable	Suitable in L/M-density areas	I	L	Easy	H	Water near toilet	Stable permeable soil; groundwater at least 1 meter below surface[b]	None	L	Very good	L
Double vault composting (DVC) toilets	Suitable	Suitable in L/M density areas	M	L	Very easy except in wet or rocky ground	H	None	None (can be built above ground)	None	H	Good	L
Self flopping aquaprivy	Suitable	Suitable in L/M-density areas	M	L	Requires some skilled labor	H	Water near toilet	Permeable soil; groundwater at least 1 meter below surface[b]	Treatment facilities for sludge	M	Very good	L
Septic tank	Suitable for rural institutions	Suitable in L/M-density areas	H	H	Requires some skilled labor	L	Water piped to house and toilet	Permeable soil, groundwater at least 1 meter below surface[b]	Off-site treatment facilities for sludge	M	Very good	L
Three stage septic tanks	Suitable	Suitable in L/M density areas	M	L	Requires some skilled labor	H	Water near toilet	Permeable soil, groundwater at least 1 meter below surface[b]	Treatment facilities for sludge	M	Very good	L
Vault toilets and collage	Not suitable	Suitable	M	H	Requires some skilled labor	H (for vault construction)	Water near toilet	None (can be built above ground)	Treatment facilities for night soil	H	Very good	VH
Sewered pit toilets, septic tanks, aquaprivies	Not suitable	Suitable	H	M	Requires skilled engineer/ builder	L	Water piped to house and toilet	None	Sewers and treatment facilities	H	Very good	H
Sewerage	Not suitable	Suitable	VH	H	Requires skilled engineer/ builder	L	Water piped to house and toilet	None	Sewers and treatment facilities	H	Very good	H

Note: L, low; M, medium; H, high; VH, very high.

a. On- or off-site sullage disposal facilities are required for nonsewered technologies with water service levels in excess of 50 to 100 lcd, depending on population density.

b. If groundwater is less than 1 meter below the surface, a plinth can be built.

Table 3.1: Descriptive Comparison of Sanitation Systems (Kalbermatten, et.al., 1980).

3.2 SANITATION SYSTEMS USED IN COASTAL AND WATERFRONT COMMUNITIES

Among the various options of low-cost sanitation systems mentioned above, a few have been used in some coastal and waterfront communities. These systems include both individual and community systems. Descriptions of how they were used and the factors affecting the success or failure of their usage are identified in the following discussion. It is important to note, however, that the analysis of the systems discussed are within the context of the community where they were used. Since this review is based on limited and scattered documentation, the degree of comprehensiveness of the discussion for each system vary.

a. Communal Toilets

The most common approach used to solve sanitation problems in coastal communities is the provision of communal toilets. This option has been considered as the only feasible and realistic sanitation improvement in high density low-income urban areas built on tidal mudflats.[8] Communal toilets or public toilets consist of a number of cubicles built on more stable grounds shared by community members. In Port Moresby, Papua New Guinea, six communal toilets were built initially on the mainland for the Koki settlement, which is a squatter community built entirely on the sea.[9] In the case of Jakarta, public toilets were also built under the Kampung Improvement Program for the *kampung* settlements located at swamp and marshy lands.[10] In Klong Khum in Bangkok, Thailand, public toilets were provided by the National Housing Authority of Bangkok.[11]

In the provision of communal toilets, problems caused by technical requirements and socio-cultural inacceptability of the facility were met. In Jakarta, the public toilets built were

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[8] Kalbermatten, et. al., 1980.p.53

[9] Swan, P.J., 1980. p.111,113

[10] Marcussen, 1990:p.132

[11] Deloria, 1991, p.26

not used much and did not function properly because the collection tanks of the facility were flooded whenever it rained. Since users had to pay to use the facility, many children defecated over open drains instead.[12] In several cases, poor maintenance resulted in the facilities being abandoned. In the Koki settlement, the communal latrine did not function well, so people continued to use the sea for sanitation. Another problem is the poor proximity of the facility to the users. The residents of Klong Khum preferred to have latrines inside their houses, rather than use communal facilities which were distant from their homes.

b. Collection of Nightsoil

In communities where communal toilets were not acceptable, individual facilities were preferred. The problem with the provision of individual toilets is the limited options for safe disposal of human waste, especially for those houses that are built on areas with high groundwater level and those submerged in water. With these conditions, the most ideal means is to collect the human waste and transport it to another site for treatment or disposal.

In China, human excreta has for centuries, been looked upon as a valuable source of fertilizer. Hence, excreta in buckets are collected for reuse. Collection of nightsoil has been the traditional practice in the Zhou-zhuang fishing village. In this village, due to the absence of running water and a sewer system, the traditional *matong*, wooden portable chamber pots, continue to be used to collect human waste. An integral part of the early morning scenes of Zhou-zhuang are the *matong* set by the doorstep of each household for collection.[13]

This practice of collecting human waste demands the acceptability of wastehandling among the community members. In communities where the sight and handling of excreta is rejected, the waste has to be disposed of quickly. In some communities reviewed, especially those located on marshlands, other options for sanitary excreta disposal have been tried, but due to the high groundwater level, problems occurred with the use of such systems. Sanitation technologies used in these communities involve on-site treatment such as the septic tanks.

[12] Marcussen, 1990, p.132

[13] Wang, 1992, p.145.

c. Septic Tanks

Septic tanks are comprised of a sealed tank having both an inlet and an outlet into which excreta are flushed from a conventional cistern flush toilet or a pour-flush toilet. The tank acts as a settlement unit in which solids settle out by gravity. The solids undergo a process of anaerobic decomposition which results in the production of water, gases, sludge and a layer of floating scum. In communities built on low-lying areas, septic tanks do not function properly since the subsoil structure is too impermeable for the leaching of the septic tank effluent. Being unable to permeate the soil, the effluent, still laden with pathogens, flows across the ground, thereby hastening the spread of diseases and not allaying it.[14]

In Jakarta, septic tanks do not operate properly because of flooding and the high ground water table, which means that much of the sewage from the septic tanks goes unfermented into canals and swamps. Low-permeability is a problem for the subsurface effluent disposal system. Eventually, the surrounding soil will cease to absorb the effluent thereby causing a failure in treating the effluent.[15]

Another problem with the use of this system is the requirement for an in-house connection of water supply for the system to operate. In communities where the water supply is not accessible, this system is not feasible. As in the case of the communities in the small islands of the South Pacific, pour-flush toilets linked with septic tanks were used. But due to the limited water supply, saltwater from the sea was used instead. The use of salt water to flush latrines retards decomposition and soakaway of sewage, hence making the system operate ineffectively.[16]

With high groundwater level seen as problem with the use of on-site systems, some sanitation technologies were designed for this condition. However, non-technical problems, such as implementation and usage problems were identified with the use of such systems, as in the case of the cesspools commonly used in Thailand.

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[14] McGarry, 1977, p. 251.

[15] Marcussen, 1990, p. 132

[16] Marjoram, 1983, p.16.

d. Cesspools

In *klong* or canal settlements in Bangkok, Thailand, the most common type of sanitation technology used is the cesspool. The cesspool consists of concrete rings which are about 0.75 meter in diameter with small holes through the rings. The rings are stacked below the latrine floor and fixed above it is a ceramic toilet bowl with or without a water trap. The floor of the latrine is generally raised above the floor level to avoid overflow during the rains.[17] The cesspool is widely accepted by the residents because of its ease of construction and low cost. The construction materials are available in prefabricated form and construction at the site takes only a few hours, and no special skills are required. Most of the households construct their own latrines.[18]

The cesspool was designed for areas with a high ground water level. It was launched as a low-cost solution for urban areas in Thailand in the early seventies.[19] The original design of the cesspool, consists of two interconnected tanks; the first tank for settling solids, the second tank, the soakage, where purified effluent flows. The first tank has a ventpipe, since most of the biogas is produced here, and an inlet for the waste is a squatting plate with a water seal. Both tanks are made of concrete rings; the first one has a tight bottom, the second one has no floor. This design requires a regular removal of sludge, but the system still percolates a considerable quantity of unstabilized organic matter and pathogens into the ground water.[20]

This system operates well in sites with a high ground water level. The high ground water level keeps the second tank filled with fluids, allowing secondary treatment of effluent before it soaks away. If there is a low ground water level, the overflowing fluids from the first tank will soakaway into the ground before any secondary treatment takes place, resulting in considerable pollution.[21]

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[17] Monsoor, 1990, p. 27.

[18] Deloria, 1991, p.54-55.

[19] Nimpuno, 1984, p.273.

[20] Ibid., 1984, pp.273-274

[21] Ibid., 1984, p. 274.

Despite the wide application and acceptance of the technology by the residents of the *klong* settlements, sanitation and environmental problems occur in the actual installations of the cesspool. This is because the system was not constructed properly based on the original design of the cesspool. In the study of sanitation conditions of two *klong* settlements in Bangkok, namely, Klong Khum and Klong Toey, conducted by Monsoor (1990) and Deloria (1991), respectively, the common observation is the installation of only one tank instead of two. Since there is no secondary treatment of effluents, fresh fecal matter percolate and fluids leach directly into the surrounding water. The leaching effect constitutes long term health hazards and causes severe pollution.[22] In the Klong Toey settlements, Monsoor observed that fecal solids from poorly constructed cesspools seeped into the water and were exposed.[23] Figure 3.2 illustrates the cesspool as used in the *klong* settlements.

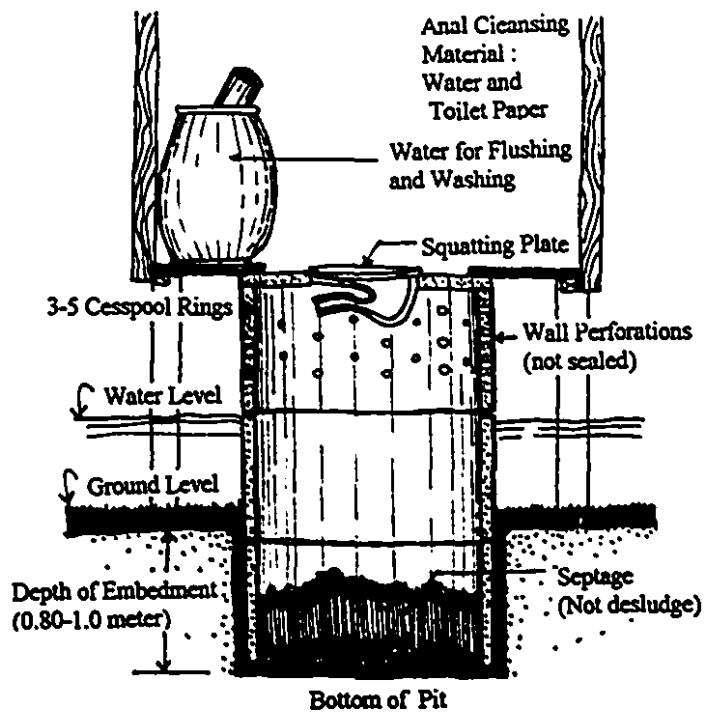


Figure 3.2: Cesspool is widely used in the klong settlements of Bangkok, Thailand (adapted from Deloria, 1991).

[22] Ibid, 1984, pp.274-275

[23] Monsoor, 1990, p.24.

Other problems associated with simplified cesspools are improper construction of the tanks and absence of the vent pipe. Surveys in the two *klong* settlements showed that the tanks were not embedded into the ground, and cylinders were stacked up until they reached the floor level of the house. Deloria observed that in Klong Khum, ventpipes were not installed in the cesspool. The vent pipe supposedly helps prevent the methane gas from accumulating in the vault which might otherwise cause harm or unprecedented explosion. Furthermore, dislodging of the built cesspool is a problem since most of the latrines do not have an off-set vault and no manhole is provided. Latrine owners would abandon it once it is full or would break the vault and replace it with a new one.[24]

e. Composting Toilets

In swampy and flood-prone areas of Vietnam, the Vietnamese composting toilets are used and are considered to function well in such ground conditions. As shown in Figure 3.3, this system is a family unit consisting of two above-ground tanks for dry and anaerobic composting.[25] The two watertight tanks serve by turns as receptacles for defecation and composting. Unlike other composting toilets, the composting process takes place without aeration or turning over of the material. Ashes are added to the fresh excreta to achieve suitable carbon-nitrogen ratio, to eliminate odor and prevent the presence of flies. The system also involves the separation of urine treatment to reduce acidity and humidity, and to lower the nitrogen content of the waste pile. The urine is placed in another container with either water or soil and ashes, which after a few days, can be used a garden fertilizer.

The main advantages of this system are the non-disposal of waste into the ground and the possibility of building the vault above the ground, despite the adverse ground conditions. However, the success of this system relies on a high degree of user care and attention, as in the case of Vietnam, where careful use and maintenance of the composting toilet is not difficult.

[24] Deloria, 1991, p. 23.

[25] Nimpuno, 1984, p.275.

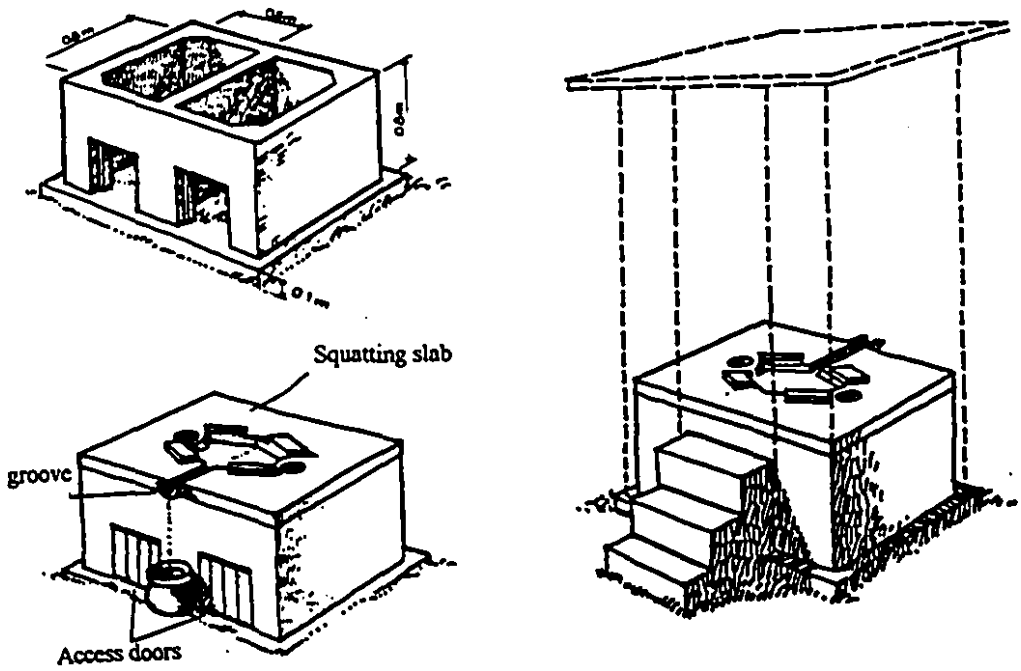


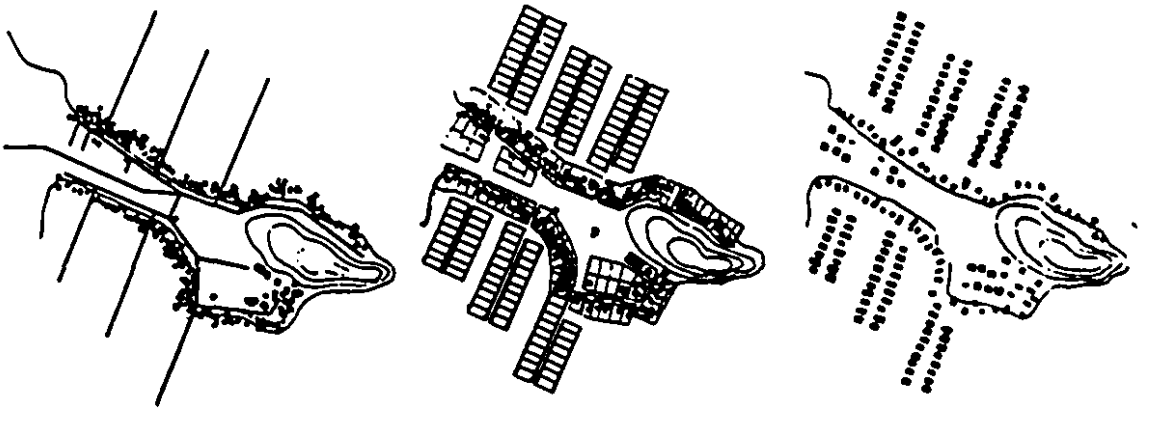
Figure 3.3 : The Vietnamese Composting Toilet (Winblad, 1980).

The problem with the low-cost options described earlier is that they are demanding from the user's point of view. In most cases, the users have to be involved in the maintenance and operation of the systems. In the earlier attempt to provide sanitation facilities for coastal and waterfront communities, the sewerage system was considered technically appropriate. Also, since it provides the "flush and forget comfort" to the user,[26] this approach supposedly simplifies the solution. However, the actual application of the sewerage system is found to be not at all feasible as in the case of the Koki settlements, Port Morsby.

[26] Ibid, 1984, p.272.

f. Sewerage System

The sewerage system is considered technically feasible in coastal and waterfront communities, but due to high capital requirements, and a large amount of water supply to operate the system, such option will remain inappropriate. In the Koki settlements in Port Moresby, Papua New Guinea, a sewerage system was initially provided as part of the master plan of the community. As shown in Figure 3.4, the official upgrading process involved the expansion of the community towards the sea by building long walkways. This approach was implemented because it was traditional for the people to live above the water and they were able to moor their boats near their houses.[27] Thus, the sewerage system was integrated with the proposed upgrading scheme.



SANITATION

Water borne sewerage required.
Pit-latrines not possible due to development over water.
Individual latrines in form of concrete slabs with built-in water seal for each allotment.
Pipe work and slab installation carried out by engineering contractors.
Latrine and shower unit shelters constructed by each family (self help).

SUBDIVISION

Average of 200 square metres for each allotment. Subdivision designed around existing dwellings.
One permanent dwelling only allowed per allotment. Surplus must relocate along walkways. Land allotments without water frontage provided for temporary relocation of houses affected by walkway construction, possible long term use as communal food gardens.
Security of tenure initially through Housing Commission tenancy agreement.

RELOCATION AND CONSTRUCTION

Where two or more existing dwellings occur on one allotment, the families decide amongst themselves who will stay and who will relocate along the walkways.
New dwellings constructed on walkways (self help). Each dwelling allocated a 10 metre walkway frontage with own shower and latrine unit. Existing dwellings improved (self help). Loans and grants in form of building materials. Technical assistance provided.

Figure 3.4 : Upgrading of the Koki Settlement integrated the sewerage system (Swan, 1980).

[27] Swan, 1980, p. 116

In upgrading the community, walkways were built over the sea with houses located at both sides. Water supply pipes ran along these walkways and the point of tapping was located at the front of each house. The sewage plastic pipes were suspended underneath the walkway. Sewage was then collected into a central tank and from there pumped into the municipal sewerage system. In 1977, the upgrading was completed except that the sewerage system has not been made to work. People still defecated in the open sea. Children played with the plastic pipes under the walkways and damaged them. It was difficult to ensure both privacy and cleanliness in the toilet blocks provided. In fact, the pump for the sewerage system was never used. It is exceedingly doubtful whether the sewerage scheme will ever be made to work successfully.[28]

In summary, the sanitation system applied in the communities reviewed in this chapter, include communal toilets, on-site technologies such as septic tanks and cesspools, and off-site technologies such as the bucket latrine and sewerage systems. Problems associated with the use of communal toilets include poor proximity and access to the user, poor maintenance of the toilets and poor functioning of the treatment systems used, which resulted in non-usage of the facility. Septic tanks used in flood-prone areas or areas with high ground water levels do not function well due to poor soil conditions. In the case of the cesspool, though designed for areas with high groundwater level, pollution problems still occur due to poor implementation and usage of the system. Malfunctioning of these on-site systems result in health and environmental problems in the community rather than improving it. Other options used are off-site treatment technologies such as the bucket latrine and the sewerage system. The bucket latrine is an acceptable means to collect waste in the watertowns in China. However, social and cultural acceptance of waste handling is the main limiting factor for other cultures. Sewerage was attempted, as in the case of the Koki settlement. But due to the high cost accompanied by the high water service level required, such technology remains not feasible in coastal communities.

[28] Ibid., 1980, p.120.

From this discussion, it can be concluded that the location and environmental conditions of the coastal and waterfront communities limit sanitation options to those which involve the off-site treatment of waste. Poor soil conditions characterized by high ground water level and poor permeability makes on-site options technically inappropriate. This makes provision of individual sanitation systems difficult especially in communities built above inundated land or those built above the surface water. Options requiring collection of human waste, such as the bucket latrine, may be technically feasible, even in communities built above the water. However, this system is only feasible in cultures where the handling of excreta is acceptable. Economically and technically, the provision of communal toilets built on more stable land appears to be the most feasible option. However, it is important to consider the social and cultural limitations of this option as well as the maintenance and operation requirements.

The discussion of the usage of sanitation systems presented in this chapter provides only bits and pieces of information since the data gathered for each system are limited and are of varying degrees of scope. To be able to analyze comprehensively the problems associated with the provision of sanitation systems in coastal and waterfront communities, a prototypical coastal community is studied. The succeeding chapters present the case study.

Chapter 4
THE CASE STUDY

The case study focuses on the coastal communities of Puerto Princesa in Palawan Province, Philippines. This selection is based on the following parameters: first, the community is primarily a low-income[1] informal settlement occupying the coasts of Puerto Princesa Bay, with a large percentage built farther onto the bay; 2) it has a large population with the present number of households close to 3,000; 3) the attempt of the local government to relocate the community was unsuccessful, hence incremental upgrading was implemented. Interventions included the provision of services such as access to water supply and electricity, the provision of communal toilets and the collection of garbage. Despite the availability of these services, sanitation and environmental problems are still prevalent in the community.

This chapter provides a background on the coastal communities of Puerto Princesa. It discusses the communities' context within the city, why they are located on the coasts of Puerto Princesa Bay, the predominant livelihood of the community members, the size of the communities and the general interventions done by the local government to upgrade living conditions. This discussion is followed by a definition of the methodology used for the case study, specifically the tasks involved in the field survey conducted.

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[1] A survey of the monthly income of the coastal communities shows that approximately 68.19% of the households earn not more than $181.82 (Canada.) per month, with the majority earning only between $91 to $136 (Canada), which is below the national poverty level of Philippines. City of Puerto Princesa Survey, May 1992. See Appendix A, Table 2: Household Monthly Income.

4.1 COMMUNITY BACKGROUND

a. The City of Puerto Princesa

Puerto Princesa City is the capital of Palawan Province. As shown in Figure 4.1, it lies at the midsection of the province which is a long strip of island located at the south west tip of the whole Philippine archipelago. Its land area is 235,264 hectares which is 17% of the total land area of the province.[2]

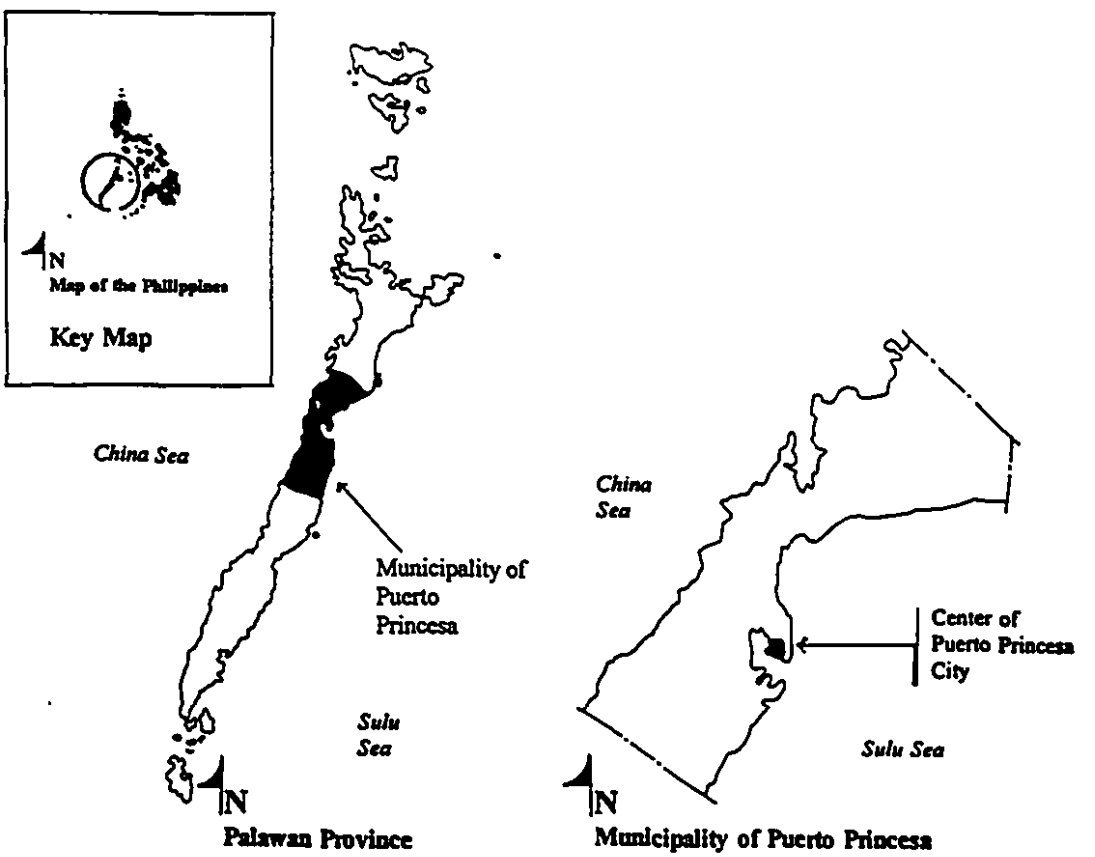

Figure 4.1: Location Map of Puerto Princesa City.

[2] City Profile of Puerto Princesa, Palawan, Philippines, Government Document, 1989.

The city, being relatively the most urbanized area in the whole province, has attracted migrants from other municipalities, as well as from nearby provinces. Studies on population growth show that the population of the city increases by 14 people per day since 1980 due to migration. With Palawan Province having a population of 558,000 persons, approximately 40% of this is concentrated in the city.[3]

The center of Puerto Princesa City, which is only about 200 square kilometers in area, is bounded by the Puerto Princesa Bay from the northwest to the south perimeter. As illustrated in Figure 4.2, this natural barrier allows the growth of the city to extend only towards the north and east corridors. Thus, the vast coast of the bay adjacent to the city became the ideal site for squatting of the migrating population. The rapid growth of the community resulted in the encroachment of settlements towards the Puerto Princesa Bay as shown in Figure 4.3.

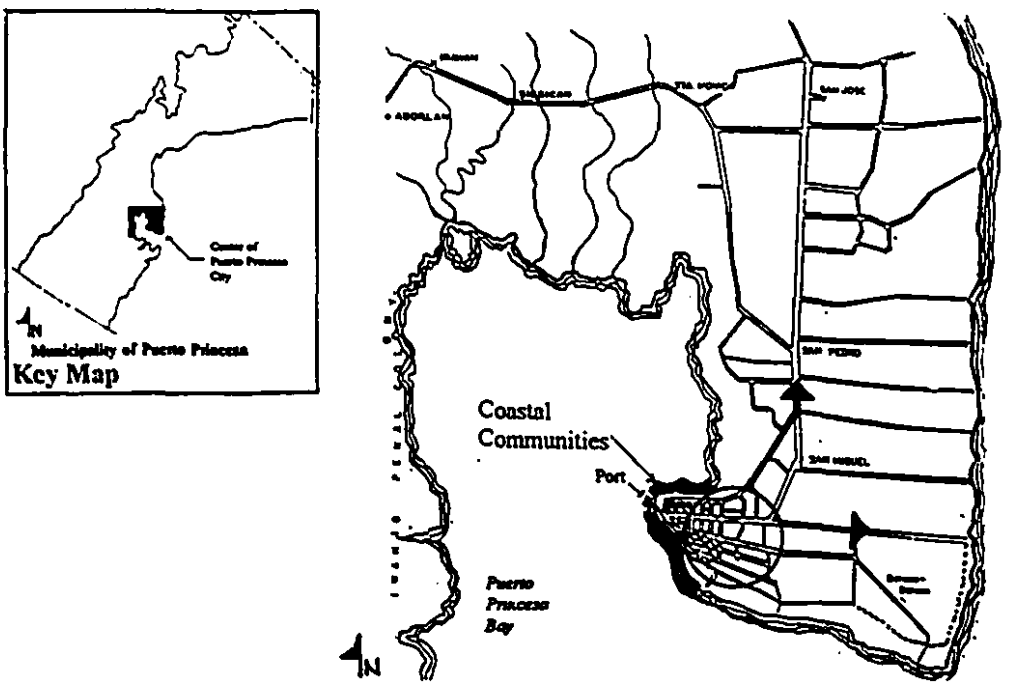

Figure 4.2: Map of Puerto Princesa City Proper

[3] City Profile, 1989.

Figure 4.3: The coastal communities have encrooched on the Puerto Princesa Bay.

b. Reasons for Occupying the Coasts of Puerto Princesa Bay

A survey conducted by the city government of Puerto Princesa in May 1993 showed that approximately 47% of the total number of households of the coastal communities has been living in the area for more than ten years.[4] An interview with one of the residents who has been living in the area since 1940, indicated that initially the community started as a single layer of houses built along the coastal area. Every year, a new layer develops with the community expanding towards the waters. The rapid growth of the community occurred only in the last thirty years.

The occupation of the coasts of the Puerto Princesa Bay by the community can be attributed to economic reasons as well as to the physical properties of the site. The site, being a coastal reserve zone, was idle. With the site being accessible to both the bay and the city proper, it has been an attractive settlement area for migrants seeking livelihood opportunities from the city as well as from the fishing resources of the bay. The growth of the community was encouraged by the natural properties of the site.

[4] See Appendix A, Table 1: Household Mobility Indicators of the coastal communities, Puerto Princesa City Survey, May 1992.

The residents of the coastal communities seek access to the center of the city for employment opportunities, community services and utilities. Within the center of the city, the public market and the nearby slaughterhouse are the major livelihood generating facilities, which attract the people to settle along the coasts. The Puerto Princesa port, which is the main seaport of the whole province is located at the northwestern tip of the city and is adjacent to the city proper. In relation to the coastal communities, the port lies at the middle of the whole stretch of the coastal strip occupied by the community and provides livelihood opportunities to the people.

The municipality of Puerto Princesa is endowed with rich natural resources which boosts the economy of the province. The Puerto Princesa Bay has been identified by the Philippines Bureau of Fisheries and Aquatic Resources (BFAR) as a major fishing ground.[5] The fishing industry is a thriving enterprise in the coastal slums. Migrants who have no fishing experience and who have settled along the coastal communities have resorted to fishing as a means of livelihood. At present, approximately 33.6 % of the community depend on the bay for their fishing livelihood.[6]

The natural properties of the coasts have encouraged the growth of the community. The Puerto Princesa Bay is natural harbor or cove, protected from the rough waters of the Sulu Sea. At the same time, since the province of Palawan has a geographical advantage of not lying in the northwestern typhoon path, tropical storms do not occur in the site. This natural protection has encouraged the community to extend from the coasts towards the bay. Furthermore, the abundance of materials within the site for building houses has influenced the fast growth of the community. Locally available materials such as bamboo, palm leaves, local timber and mangrove are among the predominant construction materials used by the people to build their homes.

[5] Palawan Integrated Area Development Project (PIADP) Study, (Unpublished Report), 1989.

[6] See Appendix A, Table 3: Number of Households Dependent on Fishing Livelihood, Coastal Communities, Puerto Princesa City Survey, May 1992.

c. Community Size

The coastal communities of Puerto Princesa are composed of nine sub-communities or *barangays* and can be divided into two groups in terms of their location. Barangays Matahimik, Tagumpay, Seaside and Bagong Pag-asa are located at the northern coast of the center of the city. The northern coastal slums comprise 45% of the population of the coastal communities, while Barangays Liwanag, Mabuhay, Pagkakaisa, Bagong Silang and Mandaragat are located at the southwest perimeter of the city. These southwest communities comprise 55% of the total population of the community. Figure 4.4 shows the location of the nine *barangays* along the bay. The total population of the whole community as of May 1992 has grown to as much as 14,136 persons, corresponding to 2,973 households.[7]

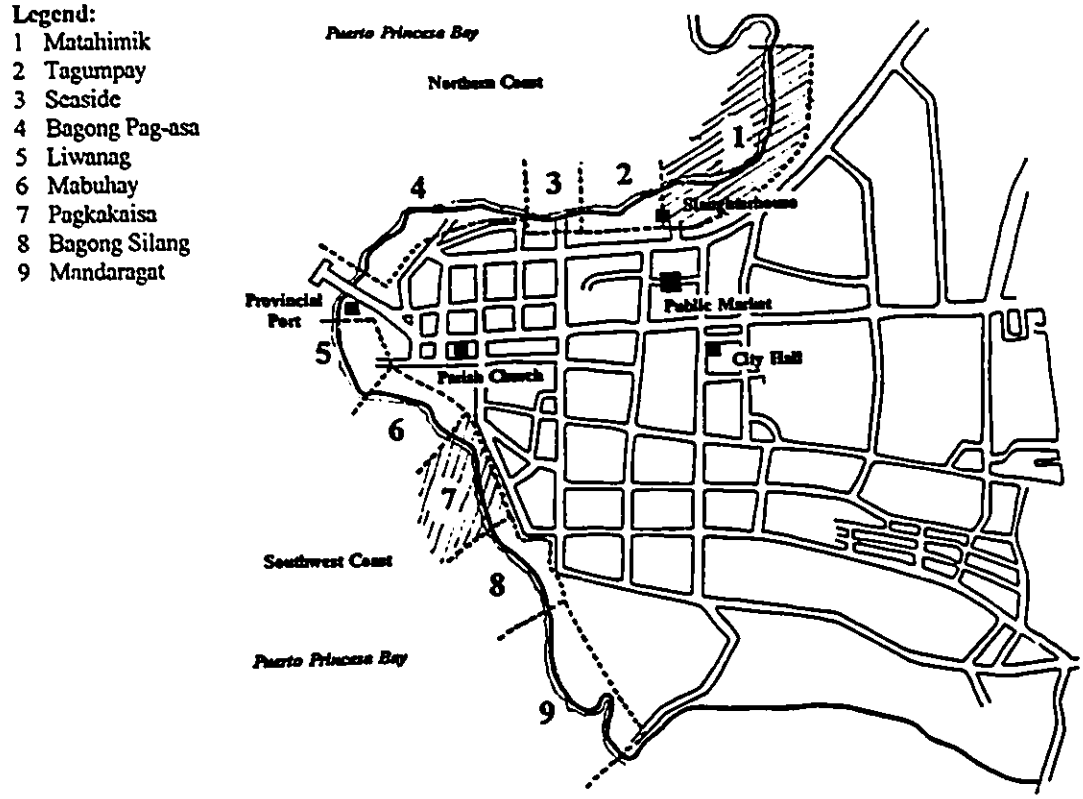

Figure 4.4: Location map of the nine coastal communities of Puerto Princesa

[7] See Appendix A, Table 4: Population per Barangay. Puerto Princesa City Survey, 1992.

d. Local Government Interventions

The occupation of the coastal sites by the community, which are considered environmentally critical areas, started to concern the local government when the rate of growth of the community increased rapidly. Environmental problems such as pollution of the coasts and the bay are the consequences of allowing the community to invade the area.

Past administrations in the province expressed concern for the problems associated with the coastal communities. Seeing the alarming growth of the community and its consequences, the city government attempted to resettle the community on other sites. Interviews with some local officials and community members indicated that the relocation site was far from the city proper and the means of livelihood to sustain the community were not considered in the planning process. Hence, the people eventually returned to the coastal areas and rebuilt their houses. The failure to relocate the community resulted in on-site incremental improvements provided by the government such as access to water, electricity, the building of communal toilet facilities and the repair and construction of walkways.

The present government is committed to relocate the community by implementing housing projects in different parts of the municipality. The relocation is initiated by the future plans of the city government to construct a coastal boulevard within the area for tourism related activities. To start the process, the city government conducted a survey of the community in May 1992. At the same time, the government established means to control the growth of the community by assigning numbers to each house and not allowing the construction of new houses after.

At present, the government is surveying sites for the various housing projects to accommodate the 2,973 households. A pilot housing project is presently being planned for the first 400 households. In an interview with the city planners, when asked about the time frame of the whole relocation process, no definite period was put forth. With a pilot project housing only 400 households planned in two years, how long will it take to house 2,973 families? With the people living in the coastal areas, facing the same problems in terms of environmental sanitation, for more than twenty years, and with indications that it would still take time for the

relocation process to be completed, what could be done to upgrade their sanitation and environmental conditions?

4.2 THE FIELD SURVEY

The author conducted a field survey in June 1993 and included a study of all the coastal communities of Puerto Princesa as a macro analysis as well as a detailed study of two selected communities, namely Barangay Matahimik and Barangay Pagkakaisa. The survey involved data collection retrieved from the local government as well as non-government organizations working in the communities. The majority of the data analyzed is based on the actual inspection of the communities as well as random interviews of household members.

a. Gathering of General Information on the Coastal Communities

In gathering general information on the coastal communities, the following tasks were done during the field survey: interviews of local government officials and planners regarding the existing conditions of the coastal slums and plans to improve their sanitation conditions; collation of data from the survey conducted by the city government in May 1992;[8] and a preliminary visual survey of the nine communities with photo-documentation. This preliminary survey helped in the selection of the two communities chosen for detailed analysis.

b. Detailed Study of Two Communities

Two of the nine communities, Barangay Matahimik and Barangay Pagkakaisa, were chosen as sub-case studies to analyze in depth the range of sanitation problems in the coastal communities. Barangay Matahimik was chosen for the following reasons: it has the largest population; it is located in the coastal area of the Puerto Princesa Bay with the highest waste concentration; and a large part of the community has been recently rebuilt and upgraded after the occurrence of a fire in March 1991. The last factor makes the community ideal for the

[8] This survey was conducted by the local government of Puerto Princesa to support future plans for relocation and low-cost housing project for the coastal communities.

analysis since, major interventions were done by the local government after the fire. Barangay Pagkakaisa, was selected for the following reasons: it is the most congested and it has the worst living conditions among the nine communities; it is located on the other side of the city, which is at the opposite side of Barangay Matahimik, where conditions are different; and finally, like Barangay Matahimik, it has also been affected by a fire, hence major upgrading was done to the community.

c. Random Household Interviews

For both communities, random household interviews were conducted. Due to time constraints, a quota of only 5% of the total number of households of the community was set. Thus, 26 households were interviewed for Barangay Matahimik, which has 493 households and 17 for Barangay Pagkakaisa which has 297 households. The reliance of the data gathered are geared more towards qualitative analysis rather than quantitative. The data gathered are used for exploratory and descriptive analysis of the existing conditions within the communities. Additional information not gathered from the interviews are based on the author's observations and insights.

The basis of household interviews are discussed as follows. The location of the house and the availability or cooperation of the household members influenced the selection of households for interviews. Household conditions can be classified according to their location within the coastal areas. This includes those houses which are built on the elevated areas which are not reached by the tide, houses built on the tidal mudflats which are dry during low tide and are inundated during the high tide, and those built on the waters. For every walkway, at least one household from each location was chosen for interview. The availability and cooperation of the household members to be interviewed also influenced the household selection. Interviews were conducted from 10:00 a.m. to 6:00 p.m. Since most of the men were at work during these hours, the interviewees were mostly housewives. This is an advantage for the study since the housewives interviewed appeared more familiar with the conditions of their homes.

The manner of interview was done through informal conversations with the household members. The concerns of the interviews that are essential to the thesis include: utilities and services available to the household; cultural and social factors affecting sanitary and hygienic practices, health conditions of the household members and conditions of the house. Utilities and services available to the household include water supply, the type of toilet and means of waste disposal, bathing, washing and laundry facilities and the garbage disposal method. Cultural and social factors affecting sanitary and hygienic practices include the anal cleaning material used, the attitude on wastehandling, acceptability of communal toilet and privacy requirements. Health conditions of the household members refers to observed prevailing sicknesses among family members. Table 4.1 enumerates these considerations.

Household Size		
Utilities and Services	Water Supply	Water Sources Consumption Monthly Fees Manner of Distribution Storage of Water
	Toilet Facilities	Toilet Types Disposal Method Private or Communal
	Bathing Facilities	Location Wastewater Disposal
	Laundry Facilities	Location Wastewater Disposal Method
	Garbage Disposal	Individual and Community Garbage Collection
Cultural Factors affecting Sanitation and Hygeinic Practices	Anal Cleaning Material Used	
	Attitude on Wastehandling	
	Acceptability of Communal Toilets	
	Privacy Requirements	
Health Conditions	Prevailing Diseases within the household	
House Conditions	Location	
	Houseplan	
	Condition	

Table 4.1: Household Interview Guide

Results of the interviews were documented and preliminary sketches of the houses were made at the end of the day. To structure the results of the interviews, a Respondent Profile Form, shown in Plate 2, Appendix B was filled out. In this form, other information not gathered from the interview was based on the results of the survey conducted by the city government. The summary of household interviews for both communities are tabulated in Plates 3 and 4, Appendix B. The results of the survey and the analysis of data gathered are presented in the succeeding chapters.

Chapter 5
RESULTS OF FIELD SURVEY -- ANALYSIS OF EXISTING SANITATION IN THE COASTAL COMMUNITIES OF PUERTO PRINCESA

The case study analyzes the existing sanitation in the coastal communities of Puerto Princesa, in order to determine essential factors for the provision of sanitation systems for the community. This chapter discusses the range of problems encountered by the community due to absence of sanitary means of disposing human wastes. Other sanitation and environmental issues are considered accordingly to give a clearer picture of the problems. The study is based on the results of the field survey and research conducted by the author in June 1993.

5.1 BASIS OF ANALYSIS

In analyzing the sanitation conditions in the coastal communities, an understanding of the community layout and housing conditions is necessary. These factors have a direct bearing on the sanitation conditions in the community and the problems related to them. The following discussions illustrate the typical community layout and the varying conditions among the households depending on the location of their houses within the coastal site.

a. Community Layout

A typical layout of the coastal communities is a comb-like structure, wherein an access road or pathway, acting as the base of the comb, runs along the coast. From this pathway or

road, main wooden walkways supported by stilts branch off, extending towards the bay. These major wooden walkways give access to the different houses.

The two communities studied in detail illustrate this layout. In the case of Barangay Matahimik, the community is divided into five zones. Zones are identified through the major walkways that branch off the mainland, extending to the waters. The main access to the community is through the small street, called Calle Bajo, found at the west end. A long concrete pathway running along the southeast perimeter of the community is accessible from this street. From this pathway, wooden walkways on stilts branch-off, giving access to as many as 12 houses at one side which are at least 120 meters long. In the case of Barangay Pagkakaisa, the main access is through a coastal road, called Reynoso Street, which is the northeast perimeter of the community. From this road, six main footpaths branch off, providing access to the houses built above the tidal mudflat and the water. The layouts of the two communities are illustrated in Figures 5.1 and 5.2.

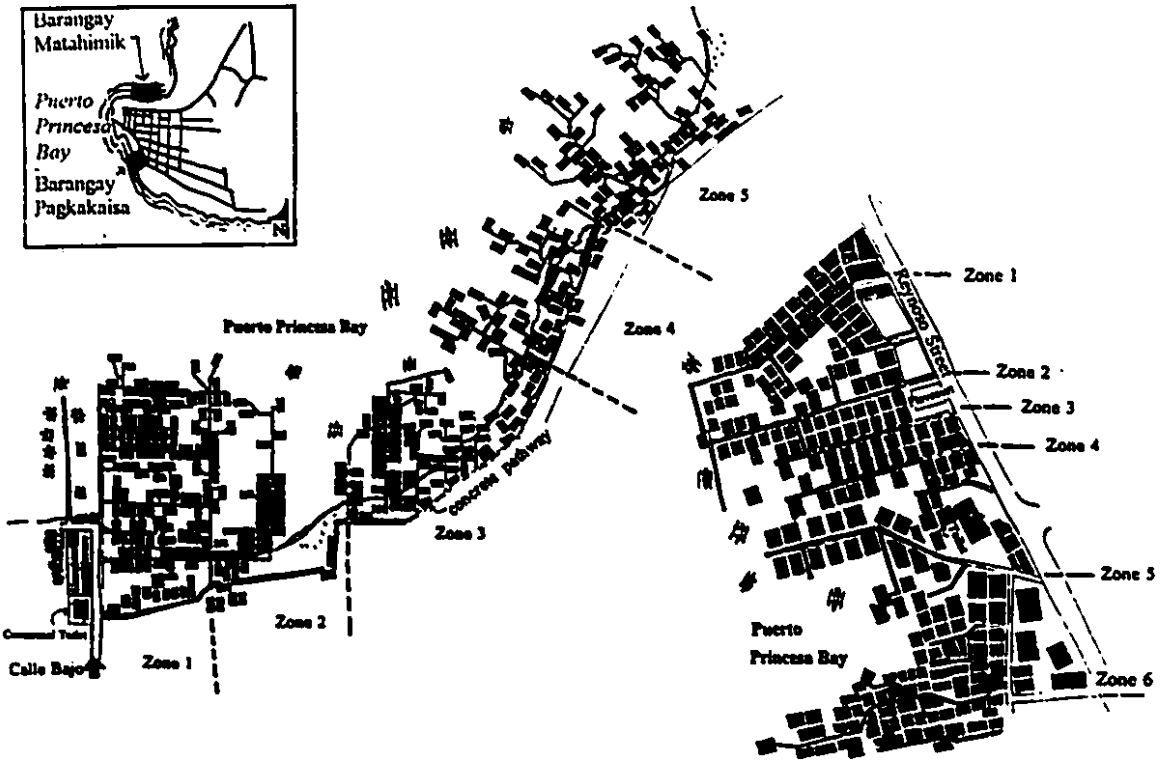

Figure 5.1: Community Layout of Barangay Matahimik

Figure 5.2: Community Layout Barangay Pagkakaisa

b. Housing Conditions

An actual count of houses in the community conducted by the city government of Puerto Princesa last May 1992, shows that there are 2,367 houses built in the community. Conditions vary among the households depending on the location of their houses within the coastal site. To illustrate these varying conditions, three zones, consisting of the dry, transition and water zones are defined.

The dry zone includes houses occupying the innermost strip of the coast that is relatively elevated and is not reached by the water even at high tide. Though this area is characterized by high ground water level, the level varies depending on the exact location of the house. The transition zone is between the elevated and water zones. This includes houses built above the tidal mudflat, the site of which is submerged in water at high tide and is dry at low tide. Finally, the water zone is the outermost strip of the community, with houses built above the bay itself. A house at the outermost edge of the water zone can be as far as 200 meters from the main stable land. There is no exact boundary among these zones, since it is very difficult to define precisely the high and low tide levels of the bay. These zones were defined to represent the varying conditions within the community and are used as a basis of analysis throughout the thesis. A graphical representation of the zones is shown in Figure 5.3.

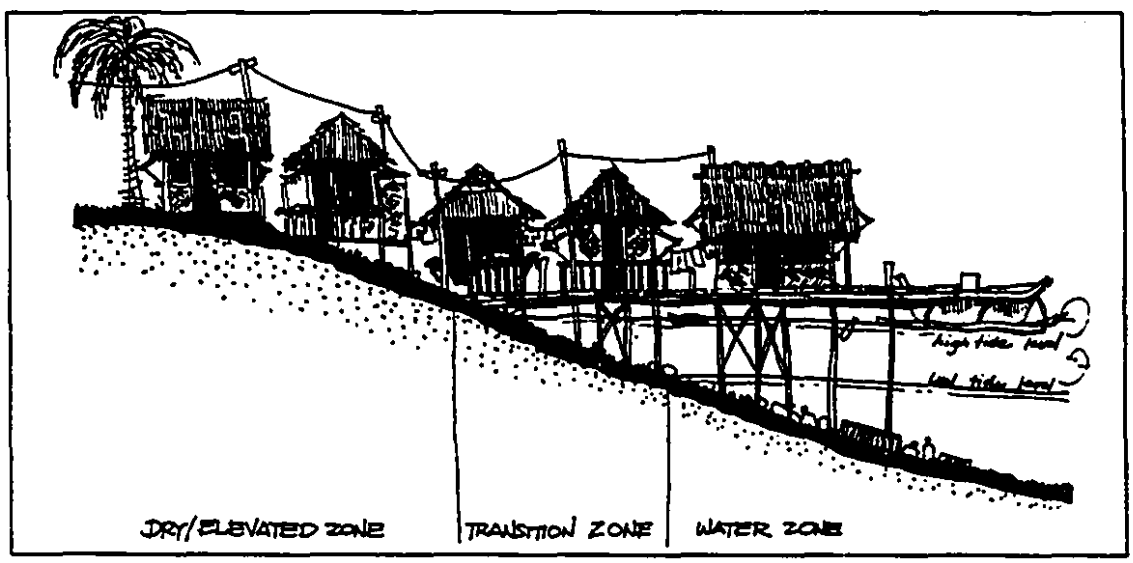

Figure 5.3: The three zones representing the varying conditions within the community.

Housing conditions vary in terms of building materials used. From the visual survey of the communities, it was observed that some of the houses located on the dry and elevated regions are built with stronger materials such as concrete hollow blocks for walls, concrete flooring and foundation. On the other hand, houses built on the transition and water regions are made of lighter materials such as bamboo, mangrove and palm leaves. As shown in Figure 5.4, the houses in these areas are supported by stilts. Their floor level is at least a meter from the highest level of water.

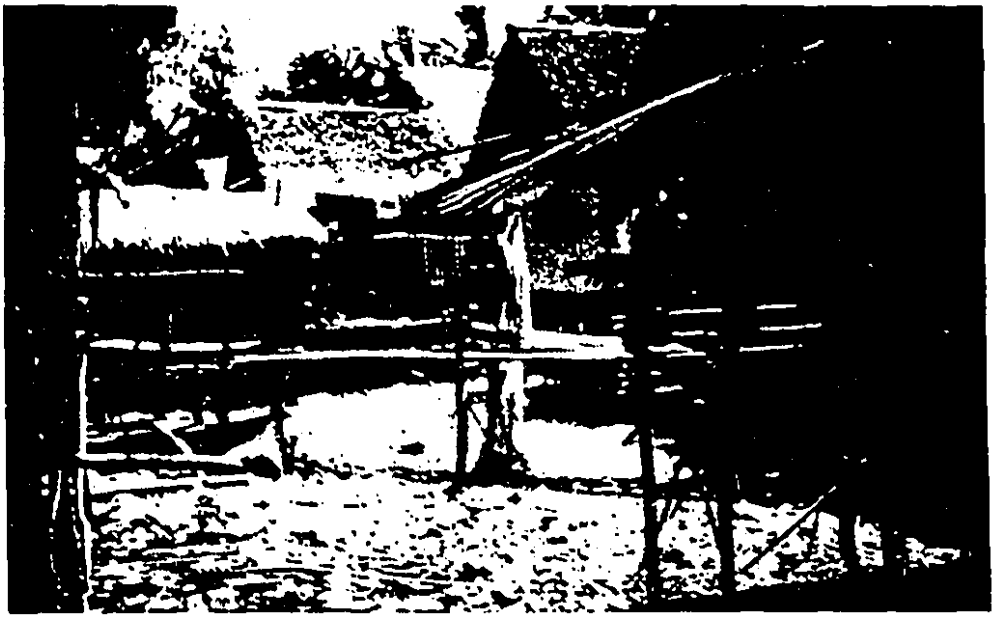

Figure 5.4: Houses located on transition and water zones are supported on stilts with the floor level of the houses at least a meter from the high tide water level.

5.2 EXISTING ENVIRONMENTAL SANITATION

The analysis of the environmental sanitation in the coastal communities includes human waste disposal, the available water supply service levels, wastewater and solid waste disposal. Some existing services such communal toilets, water supply and garbage collection were provided by the local government to upgrade the sanitation conditions within the communities. Other aspects such as health related problems as well as the impact on the environment are discussed accordingly.

a. Human Waste Disposal

Existing sanitation facilities in the community are categorized as either communal toilet facilities provided by the local government and private toilets built by the people themselves. Though, these facilities are available, they do not guarantee the safe disposal of the excreta. Problems associated with the existing sanitation facilities are discussed below.

The communal toilets provided by the local government in the coastal communities were located on the elevated areas to simplify the provision of waste treatment facilites. In the case of Barangay Pagkakaisa, as shown in Figure 5.5, the communal toilet is located between zones 4 and 5. The facility has six stalls with a communal septic tank for waste treatment. At present, it is being used and maintained by six households who live close to the facility. It is not made accessible to the other community members at all.

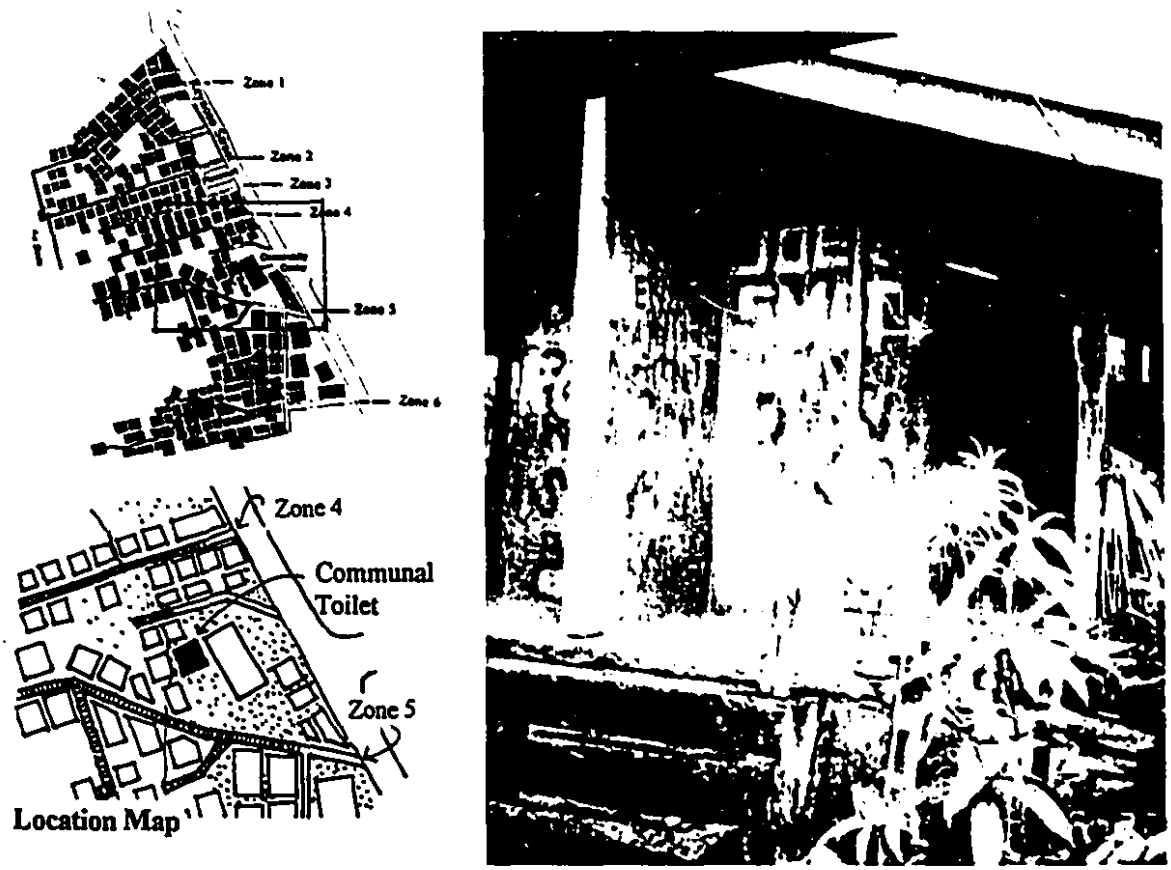

Figure 5.5: In Barangay Pagkakaisa, the communal toilet facility provided by the local government is used and maintained by six households living close to the facility.

An interview with the community head of Barangay Pagkakaisa indicated that in the past, usage of the facility was a failure because the people did not know how to maintain it and it earned a reputation as an unsafe place, especially for children and women. Because of this, it was closed for some time. The residents living near the toilet, expressing their need for the facility, started to informally maintain it until it became their personal facility. At present, the six families who have access to the facility hold the key to their respective cubicle.

In the case, of Barangay Matahimik, the communal tolet is located along Calle Bajo at the southwest side of the community. The house at the opposite end is approximately 400 meters from the facility. The built toilet has six cubicles with a septic tank for waste treatment. As in the case of Barangay Pagkakaisa, improper use and poor maintenance were the problems. Most often stones were found inside the toilet seats. At present, the facility is locked and is not available to the community.

The unsuccessful attempt to provide communal toilets resulted in people providing their facilities. In Barangay Matahimik, 22 out of 26 respondents have private toilets, while the rest use their neighbor's toilet. In Barangay Pagkakaisa, all households interviewed have individual toilets. While toilets may be available in most households, no sanitary means of disposing human waste exists. In Barangay Matahimik, only one of the respondents with private toilets has a septic tank for waste treatment. In Barangay Pagkakaisa, only two respondent have septic tanks. The individual toilets of the rest are simply makeshift overhung toilets with human waste directly disposed into the bay. A detailed description of these toilets is discussed below.

Private toilets are built inside the houses, or outside, as extensions or as separate structures. The type of toilet built and used by the people varies depending on the location of the house. For some households built on dry and elevated areas, pour flush toilets were installed with septic tanks for on-site treatment.[1] Household no. 233 of Barangay Pagkakaisa, located within the elevated site, was able to build a pour-flush toilet with a septic tank underneath. Figure 5.6 illustrates this case.

[1] See for example the case of household no. 256 of Barangay Matahimik, Plate no.10, Appendix B.

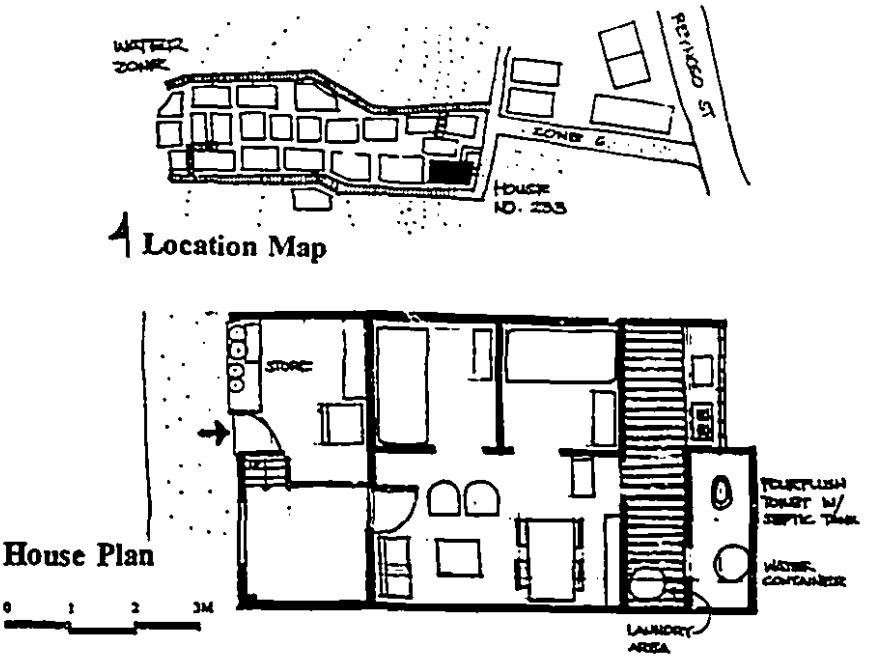

Figure 5.6 : Household located on elevated and dry area was able to build pour-flush toilet with septic tank for waste treatment.

Although households located on drier and elevated areas can have septic tanks for waste treatment, this does not guarantee sanitary means of disposing waste. Problems of effluent disposal from septic tanks may occur, considering that the ground water level in most of these areas is high and that the population density is also great.[2] From the survey and interviews conducted, it is noteworthy that there are some households that have pour-flush toilets without waste treatment means. In this case, human waste is disposed directly into the ground underneath the toilet. An example to illustrate this case is household no. 89 of Barangay Matahimik. At present, the house owner is still saving money to upgrade the toilet facility. Residents are hesitant to invest their money in toilet facilities when they do not own the land they are occupying.[3]

[2] See for example the case of household no. 170 of Barangay Matahimik, Plate no. 7, Appendix B.

[3] See Plate no.5, Appendix B.

For houses located on the transition and water regions, the only option left is to build makeshift overhung toilets, with the human waste directly disposed into the water or mudflat. An example of this case is house no. 236-A of Barangay Matahimik. The house is located at the end of the walkway and is approximately 200 meters from the concrete footpath on land. As shown in Figure 5.7, the overhung toilet is a separate structure made of bamboo and grass supported by stilts. The floor is made of bamboo slats with a hole at the center. Human waste is directly disposed of into the water.[4]

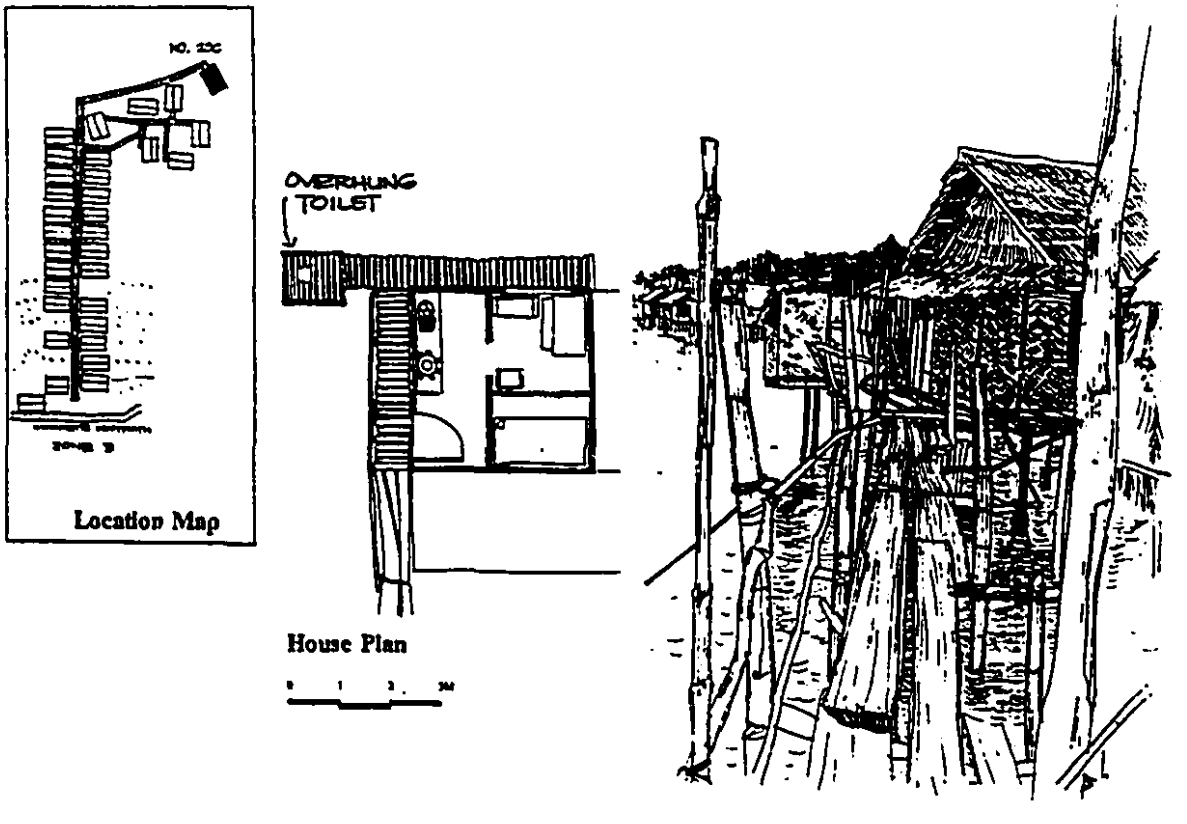

Figure 5.7 : Household located above the water uses an overhung toilet where human waste is directly disposed of into the bay.

[4] See for example: Household no. 111 of Barangay Pagkakaisa, Plate no.13, Appendix B; Household no. 114 of Barangay Pagkakaisa, Plate no. 14 Appendix B; Household no. 191 of Barangay Matahimik , Plate no. 8 Appendix B.

b. Water Supply

Water supply both for drinking and domestic use is available in the coastal communities. In the case of Barangay Matahimik and Barangay Pagkakaisa, three means are used to supply water for drinking and domestic use: tapping water from the city water lines; fetching water from the communal handpumps installed by the local government for the community; and buying water from neighbors who either have water connections from the city lines or who have handpumps.

Considering the household survey conducted in Barangay Matahimik, 15 out of the 26 household respondents, have water connection from the city waterlines. Of these 15 households, 10 have connection lines while the remaining retrieve a part of their fee for water services either by selling water to neighbors or by sharing the waterline with another household. In Barangay Pagkakaisa, 4 out of 17 households interviewed have connections to the city waterlines. The remaining households depend on fetching water from the communal handpumps or buying water from neighbors.

The city government provided access to the community to tap from the city waterlines. The water supply system of the Puerto Princesa city is managed by the Local Waterworks and Utilities Administration (LWUA). Pipe connections from the city lines are provided to the community. A household member can apply for the connection and has to pay a minimum fee of $1.80 to $2.40 per month.[5] Pipes are then suspended underneath the walkways bringing water to the houses. However, this service is limited to houses that are located on dry and transition areas.[6] To increase access to this source, and at the same time reduce the monthly expenses for this service, households with connections share the line with a neighbor or relative.

As shown in Figure 5.8, household no. 191 of Barangay Matahimik, while it is located at the end of the walkway, has access to the waterline through line sharing. In this example, the

[5] All prices mentioned in the text are in Canadian Dollars. As of 1993, the exchange rate of $ 1.00 is approximately between P24.00 to P25.00 Philippine Pesos.

[6] See for example the case of Household no.345 of Barangay Matahimik, Plate no. 12 Appendix B.

household connected a rubber hose from the water pipe of the line owner and suspended the hose underneath the houses and walkways to bring water to his house. In this set-up, the household shares the monthly fee by paying at least half of the amount.

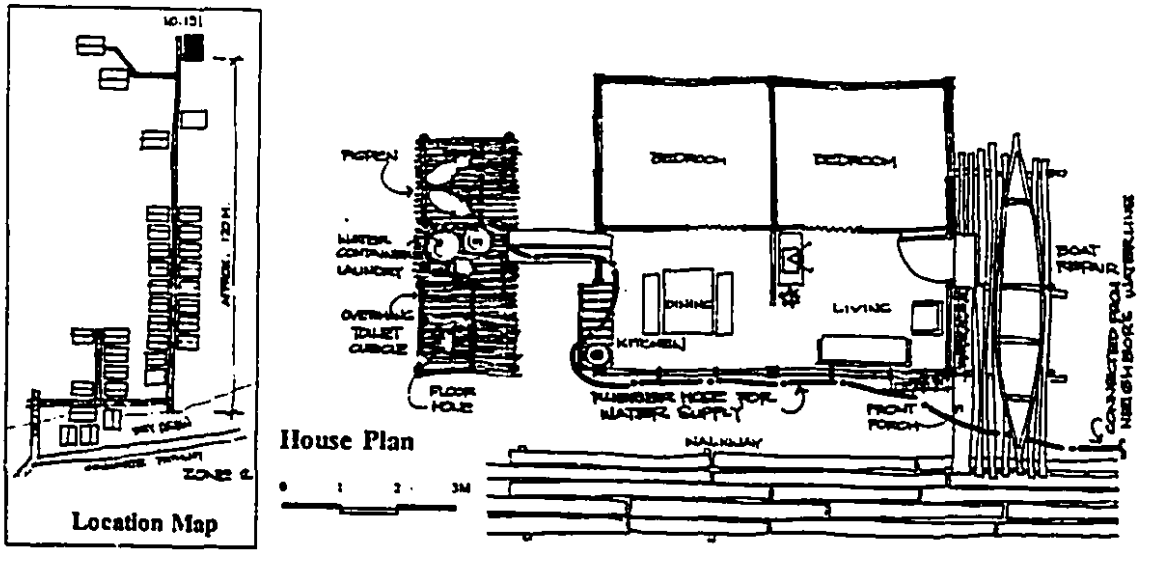

Figure 5.8: Households no. 191, though located at the end of the walkway, still has access to the city waterline by sharing with a relative.

Water pressure from the city lines varies during the day. Pressure is relatively high in early mornings and late evenings. Most often, households with connections have to collect water during these periods in large drums or containers for their use.

Some households with access to the city lines sell water to their neighbors.[7] In selling water, a faucet or rubber hose is normally installed in front of the house. Neighbors bring their pails or containers and create a queue along the walkway. Water coming from this source is usually for drinking. As shown in Figure 5.9, a typical morning scene in the community includes waterbuying, characterized by rows of containers and pails along the walkways.[8]

[7] See for example : Household no. 111 of Barangay Pagkakaisa, Plate no. 13, Appendix B; Household no. 233 of Barangay Pagkakaisa, Plate no. 15 Appendix B; Household no. 256 of Barangay Matahimik, Plate no. 10, Appendix B.

[8] See also the cases of Household no. 114 of Barangay Pagkakaisa, Plate no. 14, Appendix B; Household no. 236 of Barangay Matahimik, Plate no. 8 Appendix B.

Figure 5.9 : Waterbuying is an important source of water in the coastal communities.

Water is sold in containers with prices ranging between $0.04 to $0.08 per 20 liters. In Barangay Matahimik, a household pays approximately $0.02 for a 10 liter pail of water and $0.04 for a 20 liter container. In Barangay Pagkakaisa, the price of water is double the price of that in Barangay Matahimik. Households pay at least $0.08 for a 20-liter container. This is due to much lower water pressure in Barangay Pagkakaisa as compared to that in Barangay Matahimik.

The third source of water in the coastal communities is the communal handpumps. In Barangay Matahimik, the local government installed eight handpumps along the elevated areas of the site. At present, only four of these are functioning. Water coming from this source is consumed for drinking as well as for domestic use such as bathing, laundry, and washing.

In most cases, fetching of water is done daily. Household members fetch enough water for the consumption of the day. Since the handpumps are located on the elevated areas of the site, the household members, especially those located on the water zone, have to walk a long distance to get water.[9] Figure 5.10 shows a typical handpump provided in the community.

[9] See for example the case of Household no. 131 of Barangay Matahimik, Plate no. 6,Appendix B.

Figure 5.10: Communal handpumps were provided by the local government.

c. Wastewater Disposal

Wastewater from the kitchen, laundry and bathing is disposed of into the bay without treatment. The kitchen sink consists of a basin with the hole or outlet, allowing the water to spill directly outside. Laundry is normally done at the rear extension of the house beside the overhang toilet,[10] on the small balcony in front of the house,[11] or on the wooden walkways itself. A typical scene in the community is of women washing clothes in front of the houses, with a parade of clothes hanging along the sides of the walkways. Bathing is done in the extension at the back of the house beside the toilet. Others, especially children, simply bathe on their front balcony or on the walkways where laundry is done. Doing laundry and bathing in these areas is convenient for the household members since they need not bring the pails or containers of water all the way inside the house.

[10] See for example the case of Household no. 191 of Barangay Matahimik, Plate no.8,Appendix B.

[11] See for example the case of Household no.256 of Barangay Matahimik, Plate no. 10, Appendix B.

d. Solid Waste Disposal

Accumulation of solid wastes, mostly broken bottles, plastics and other non-biodegradable wastes, remains a big problem in the coastal communities. This has been the consequence of the improper solid waste disposal practiced by the people over the years. Natural factors such as current and wind direction also contributed to this condition. The factors influencing this problem and interventions made to solve it are discussed as follows.

In 1989, a study of problems associated with the waste disposal in the Puerto Princesa Bay was prepared under the Palawan Integrated Area Development Project (PIADP). Based on the study, the types and composition of wastes discharged in the bay include: biodegradable wastes or those that can be decomposed by natural processes in the form of papers, excreta, food leftovers, comprise about 25%; and non-biodegradable materials in the form of broken-glasses, aluminum cans and plastics comprise 75% of the total wastes. In the coastal communities, 46% of the solid wastes are thrown into the bay, 35% are burned while 16% are disposed of in open pits. Only 3% is collected by the city garbage.[12]

The problem of accumulation of solid wastes along the Puerto Princesa Bay occupied by the coastal communities is also intensified by natural environmental factors. A study of the pollution problems of the Puerto Princesa Bay identified two areas of highest waste concentration, one of which is the site of the northern coastal slums.[13] According to the study, the accumulation of the waste in these areas is influenced by tidal fluctuations, actions of river draining into the bay, wind direction and water current direction.

Under normal estuarine conditions, the flushing of water is into the river during high tide and into the open sea during low tide. Since Puerto Princesa is a protected cove, the situation is different. The study of PIADP, as shown in Figure 5.11, illustrates that the current flows into the bay during high tide and flushes out in the reverse direction during low tide. Under ideal conditions, which means without the interference of the wind and river system, the bulk of the waste discharged into the bay will be brought out into the open sea by virtue of the

[12] Palawan Integrated Area Development Project (PIADP), Unpublished Report, 1989, p.103.

[13] Ibid., 1989.

"in-out" movement of the currents during the tidal changes. With the action of the wind and the absence of rivers however, the wastes become concentrated at some parts of the bay.[14] This include the northern part of the port, which is occupied by four communities of the coastal slums, namely Barangay Matahimik, Tagumpay, Seaside, and Bagong Pag-asa. In this area, characterized by a relatively shallow depth, the absence of a river to push out the accumulated waste, and the presence of the wind for 6 months, from November to April, blowing towards the area, the waste materials cannot be carried out by the outgoing current. Hence, solid wastes continue to accumulate.

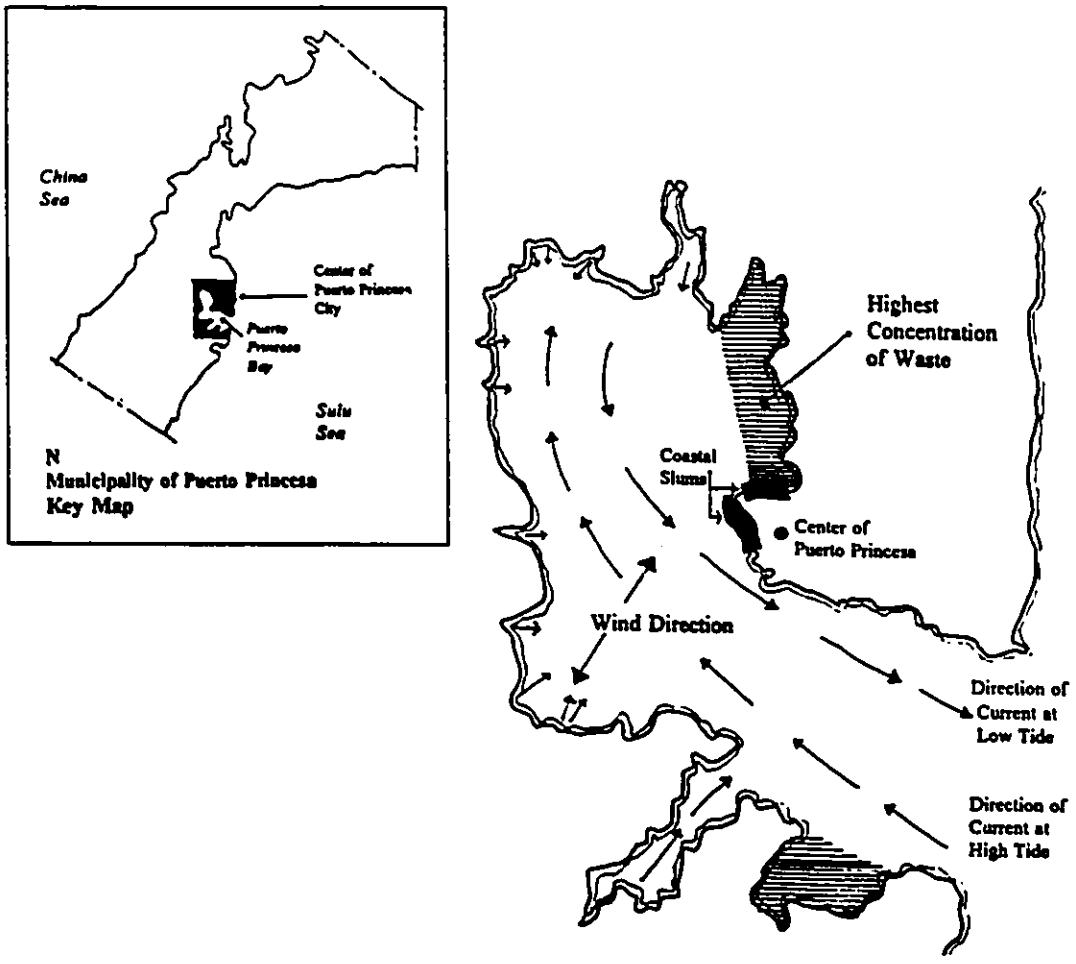

Figure 5.11: Natural factors affecting waste accumulation along the coasts of Puerto Princesa Bay

[14] Ibid., 1989, p.100-101.

In the case of Barangay Matahimik, which is located at the coastal area with the highest waste concentration, accumulated waste is about two feet high. The pollution problem due to garbage accumulation is worsened with the disposal of untreated human waste on the shoreline from the household overhang latrines.

The city government has implemented regular collection of garbage within the whole city to resolve or minimize pollution problems. In the case of Barangay Matahimik, all households were required to collect their garbage in plastic bags or sacks and bring them to the trash bins along the main roads and pathways on land. The garbage inside the bins is then collected and brought to a dumping area along the main road for the garbage truck pickup. This organized system helped minimize the pollution problems but does not, however, solve the problem of accumulation of waste on the coasts. At present, no major action is being taken regarding the removal of these wastes from the area.

Despite this organized system for garbage collection, throwing garbage into the water is still prevalent. In the random interview of households in Barangay Matahimik, 17 out of 26 respondents collect their trash and bring them to the trash bins on the mainland for collection. Five of the respondents claim to use their garbage as fuel for cooking. Other respondents, mostly those whose houses are built on the water, claim to throw their garbage into the bay.

5.3 HEALTH CONDITION AND OBSERVED HYGIENIC PRACTICES RELATED TO SANITATION AND WATER SUPPLY

a. Prevailing Diseases

There is limited information on the health status of the people of the coastal slums. The response from the random household interviews conducted did not clearly indicate diseases related to poor sanitation. This aspect of the household interview cannot be used to evaluate the present health status of the community. In an interview with the employees of the City Public Health Office, among the predominant sicknesses affecting the community members, especially children, are typhoid fever and diarrhea. The 1992 Health Status Report prepared by the Health Department of the City indicates that gastro-intestinal disorders are the most

prevalent sicknesses that are easily acquired through contaminated drinking water affecting all ages in the whole city of Puerto Princesa.

At present, the City Public Health cannot propose any solution to the prevailing pollution and unsanitary conditions in the community. The most they can provide are clinical services as well as health and sanitation education to the people of the coastal communities.

b. Hygienic Practices

Hygienic practices influencing the sanitation conditions in households interviewed include defecation position, anal cleaning material used, and the manner of bringing water into the house and storage of water. Inspection of the toilets in the community reveal that both squatting and sitting positions for defecating are practiced by the people. Some households, particularly those located on the elevated and drier regions of the community, have toilet seats. However, since the majority of the households have overhung toilets that consist of merely a hole in the floor, squatting is the common practice.

In terms of materials used for anal cleaning, water is used by those households with overhung toilets. This may be attributed to the fact that water is available to the community and that paper and other forms of material that can be used for anal cleaning are being discouraged from being thrown to the bay to prevent further pollution. For those households with toilets and treatment tanks, water and sometimes toilet papers are used.

The manner of bringing water into the house and storage of water are as follows. For those households with connections from the city waterlines, rubber hoses suspended underneath the houses and walkways were used. For those buying water from neighbors or fetching from the communal handpumps, water is hand carried in pails or plastic oil containers. As shown in Figure 5.12, drinking water is normally stored in plastic jars or pitchers and water for domestic and hygienic washing is stored in large metal drums or plastic pails.

The means of bringing water into the houses poses health hazards to the household members. For instance, rubber hose end connections were simply sealed with strips of cloth and the hoses have holes. Hence, water in these lines which are most often used for drinking

are prone to contamination. For water carried in pails, fingers accidentally dipped into the water cause contamination as well.

Figure 5.12 : Water is stored in plastic pails and containers and in large metal drums.

The case study illustrated that the sanitation and environmental problems in the coastal communities are due to the unsanitary means of disposing of human waste. This is amplified by the problems related to improper disposal of wastewater and solid waste.

In the two communities studied, although communal toilets have been provided, usage was not a success due to limited capacity, very poor access to users and poor maintenance. Hence, individual toilets were informally built by the people. For houses built on elevated

areas, some households have septic tanks for waste disposal. For the houses within the transition area, options include the use of septic tank and direct disposal into the mudflat. The use of the septic tank in this area is questionable because of the high ground water level. The practice of directly disposing waste into the mudflat is also unsanitary because the natural flushing of excreta is obstructed by the accumulated solid waste within the area. For houses built above the water, the only option left is to build overhung toilets with the waste directly disposed of into the bay.

In the case study, the direct relation of the environmental problems to the health of the people could not be assessed well due to limited information. However, accumulated data on the health status of the people reveal diarrhea and gastro-intestinal disorders as the prevailing diseases related to sanitation and water supply.

The results of the survey from the case study presented in this chapter are then analyzed to determine significant factors to consider in the provision of sanitation technologies for the community. This analysis is presented in the next chapter.

Chapter 6
ESSENTIAL FACTORS FOR THE PROVISION OF SANITATION SYSTEMS IN COASTAL COMMUNITIES

This chapter identifies the essential considerations for the provision of sanitation technologies in the context of the coastal communities of Puerto Princesa. These considerations are the basis of the preliminary evaluation of low-cost sanitation systems. This evaluation identifies possible options for the case study and discusses the potential and limitations of these systems. Included in the evaluation are the generic classification of low-cost technologies provided in the World Bank studies on appropriate technology for sanitation. Expensive systems such as the chemical, freeze, packaging and incinerating toilets and the waterborne sewerage are not included in the comparative analysis.[1]

6.1 CONSIDERATIONS IN THE PROVISION OF SANITATION SYSTEMS

In the analysis of sanitation in the coastal communities, conditions were found to vary among households, depending on the location of their houses within the coastal area, whether built on dry, transition or water zones. The following discussion identifies the key

[1] The chemical, freeze and packaging toilets are considered expensive modern variations of the bucket latrine, which involve the conservation of waste for some time without too many adverse environmental effects and allow later treatment elsewhere. Incinerating toilets requires the use of oil, gas, or electricity for operation. These toilets are expensive to purchase and to operate. Nimpuno, 1984, p.268.

considerations for the choice for sanitation systems in the three zones. These considerations, as summarized in Table 6.1, include environmental, community specific physical, social and cultural factors.

	Dry/Elevated Zone	Transition Zone	Water Zone
Environmental Conditions	Existing location of water supply Solid waste accumulation Improper disposal of wastewater	High groundwater level Impermeable and unstable soil Presence of pools of stagnant water Solid waste accumulation Improper disposal of wastewater	Water is not consumed for drinking Water is not stagnant There is enough current to disperse and dilute human waste Improper disposal of solid waste Improper disposal of wastewater
Community Conditions	High community density Poor circulation network Yard-tap and in-house connection water supply	High community density Poor circulation network Hand-carried water supply	High community density Poor circulation network Hand-carried water supply
Sanitation Facilities	Feasible location of communal toilets Individual toilets with waste treatment	Poor access to communal toilets Individual toilets without waste treatment	Poor access to communal toilets Individual toilets without waste treatment
Socio-Cultural Requirements	Wastehandling is rejected Water is used for toilet hygiene Preference for private toilets	Wastehandling is rejected Water is used for toilet hygiene Preference for private toilets	Wastehandling is rejected Water is used for toilet hygiene Preference for private toilets

Table 6.1: Key Considerations for the Provision of Sanitation Systems

a. Site Specific Environmental Factors

In this thesis, the environmental factors are the key determinants for differentiating coastal communities from other types of communities. These factors, which include the condition of surface water and soil conditions of the coastal areas, have a direct bearing on the options for sanitary means of disposing of human waste for the community.

Surface Water Condition

The condition of Puerto Princesa bay determines the acceptability of the practice of directly disposing human waste into the water without treatment. As repeatedly mentioned in this thesis, this practice is acceptable if the following conditions are satisfied: first, water is not consumed for drinking; 2) the feces are always deposited in water and not on land; and 3) there is sufficient current for dilution.[2] The objective of these conditions is to ensure that the excreta are disposed of properly and to prevent the contact of waste to the community.

In the context of the Puerto Princesa Bay, the first requirement is not a problem since the water of the bay is saline and is not consumed as drinking water. The water quality of Puerto Princesa Bay, based on the water test conducted by the National Pollution Control Commission in March 11, 1988, revealed that the overall water quality of the bay is still excellent.[3] Although this finding indicates the unpolluted condition of the whole bay, maintaining the existing ecological balance is necessary. During the survey, the observed continued practice of disposing of human waste, wastewater and garbage along the coasts of the bay indicates an alarming pollution problem. As the community grows, this traditional habit, which used to be hygienically acceptable and satisfactory, increases pollution problems.

With the second and third conditions, the practice of direct disposal of human waste in the water regions is not as critical as that in the transition zones. In houses built above the deeper waters, waste is always deposited into the water and not on the land, and there is enough current for dilution. The problems are more critical in the transition areas where solid wastes, which are non-biodegradable, have accumulated. Compounding this problem is the extensive usage of water for domestic and personal washing which is disposed of directly into the ground and surface water. The accumulated solid wastes

[2] McGarry, 1977, pp. 247-248.

[3] PIADP, 1989.

block the natural flow of the water thereby creating pools of stagnant waters and impeding natural flushing of other biodegradable wastes. Thus, in these areas, excreta is exposed in the environment

Ground Condition

For parts of the community located within the elevated and transition zones, the ground condition is an important consideration in the provision of sanitation systems. The topography of the site of the coastal slums is moderately sloping or rolling. The area is very low with +3.064m. and +0.21m as the highest and lowest portions respectively above the mean lowest low water (MLLW). Thus, even on the elevated areas, internal drainage or the ability of soil to absorb water is generally low since the water table is very shallow. The clay soil is deep, poorly to very poorly drained, fine and loamy in texture.[4]

Analysis of ground conditions has to be considered to avoid groundwater contamination and pollution of the bay, because these areas have a high water table and a direct hydraulic connection to coastal waters. The disposal of human waste into the ground presents a potential hazard to the health of the community. As discussed in the previous chapter, people consume water from the well for drinking. The location of the well is fairly close to the toilets of the nearby households. Groundwater contamination promotes disease transmission from the disposal site, through the groundwater to users of well water.[5]

Disposing human waste in the coastal areas without treatment causes pollution of the bay. The site's proximity to the shore means that polluted runoff goes quickly to the coastal water basin with little time for natural purification through vegetation and soil.[6] Environmental factors such as soil type and porosity, groundwater level and hydraulics, and distance to surface water influence the degree of contamination.

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[4] Puerto Princesa City Profile, 1989.

[5] Charles G. Gunnerson, et.al., Appropriate Sanitation Alternative: A Planning and Design Manual, (Baltimore: John Hopkins University Press, 1982), pp. 21-22.

[6] Clark, 1974.

In the choice of sanitation technologies, ground conditions, particularly groundwater level, soil permeability and stability, are important considerations.[7] Some sanitation technologies, except those which can be built above the ground, are feasible when the ground water level is below one meter from the surface. Other options require permeable soil for soakaway of effluent and others require stable ground for construction.

In this context, sanitation technologies can be classified as those without soil requirements and hence, can be contained above ground, and those with soil requirements. Systems that can be built above the ground are technically feasible in the three zones of the coastal communities. Options include the composting toilets, the vault and cartage system, the bucket latrines, the shallow sewer system and the small bore sewer system. On the other hand, systems that have soil requirements include pit latrines, aqua privy and septic tank. These systems require soil conditions characterized as stable, permeable and with low ground water level. These systems are technically not feasible in coastal communities, since they can not be built on sites with adverse ground conditions.

There are cases, however, when some on-site systems are modified to suit conditions of sites characterized by high groundwater level. In the case of the pit latrine, the pit can be raised above the ground level or double pits can be built to increase capacity when excavation is difficult. This prolongs the useful life of the facility and overcomes the difficulties with high water table and groundwater pollution. In the construction of the raised pit latrine, the raised portion should be lined and rendered to prevent the seepage of foul liquid out of the pit.

b. Community Physical Factors

Community density, circulation and access networks, and available services within the community influence the selection of sanitation technologies. The implications of these factors are discussed below.

[7] Gunnerson, et. al., 1982, p.42.

Community Density

In selecting sanitation systems, consideration of community density is critical in settlements with high density, as in the case of Puerto Princesa. On-site systems such as pit latrines, aqua privies and septic tanks require adequate space for the infiltration of waste discharged into them. These systems are not suitable for high density settlements, since high density poses danger in terms of wells for drinking water and sanitation facilities to be close together. Water seeping out of pit latrine which are bacterially and chemically contaminated will pollute the surrounding groundwater. The effluent from the septic tank, which did not permeate well through the soil, is still laden with pathogens and contaminates the nearby supply of drinking water. Hence, these systems are suitable only in low-medium density areas. Systems suitable for high density areas include the vault and cartage system, the shallow sewer system and the small bore sewer.[8]

Circulation and Access Network

As discussed in the analysis of present conditions in the coastal communities, the circulation network of the community consists of narrow footpaths on land and wooden walkways on water supported by stilts. In the selection of sanitation technologies for the community, some systems require methods for transporting waste from the place of defecation to another for waste treatment. In these technologies, waste is emptied manually or sludge is removed by a vacuum suction tanker or carts and is taken away for suitable disposal. The existing access network, consisting of narrow footpaths and walkways on stilts, poses limitations to the use of technologies requiring the use of trucks or carts for transporting waste. Access for trucks within the community is impossible.

In this context, sanitation technologies are classified according to those with waste transportation requirements and those without, with the former group at a disadvantage. Systems with waste or sludge transport requirement include bucket latrines, aqua privies, the septic tanks, the vault and cartage system and the composting toilets. On the other

[8] Kalbermatten, et. al., 1980, pp. 44-45.

hand, those without transport requirement include the pit latrines, the shallow sewer system and the small bore sewer system.

Proximity and Access to Services

Households located above the waters have the least proximity to the different services that are normally situated on the dry and elevated areas of the site. Unfortunately, households occupying these areas consist of a large percentage of the community. The proximity and accessibility of services such as water supply and communal toilets to the majority of the households affect choice of sanitation options.

- *Access to Water Supply and Levels of Service*

The types of water services in a given community can be hand-carried supplies, yard taps or in-house connections. These levels categorize the different sanitation options. Systems without water requirement or those requiring water only for toilet hygiene, include pit latrines, pourflush toilets, composting toilets, and their various adaptations. Those which require at least yard or household pump include septic tank and vault. More expensive systems such as cistern-flush toilets with conventional sewerage or septic tanks and soakaways are technically feasible when an in-house connection is available.[9]

In the context of the case study, the in-house connection is limited and water is usually bought or fetched from communal handpumps and hence, hand-carried. Though some households on both the transition and water zones have water connections from the city lines, water coming from this source is not consistently available and is normally collected and stored in large drums. For the majority of the households carrying water to their homes, the distance traveled by the household member fetching the water from the handpumps can be as far as 400 meters. Thus, options requiring individual in-house connections or a large amount of water for disposal are not feasible. Options are limited

[9] Ibid., et. al.,1980, p.37.

to systems that require at the most communal standpipes or handpumps for water service levels. Other systems that require no water or those in which water is used only for toilet hygiene are highly favorable.

- *Access to Communal Toilet*

The analysis of the provision of communal toilet to the coastal communities indicates that the households' access and proximity to communal toilets is an important factor influencing its acceptability to the community. From a technical point of view, communal facilities may be considered the most feasible low-cost alternative for providing sanitation to the coastal slums. This facility can serve many people and is more economical on a per capita basis than are individual household facilities. This system consists of a number of latrine cubicles with shower, laundry and clothesline facilities in some cases.[10]

With this option, facilities can be built on more suitable areas, and any waste disposal system, whether on-site or off-site systems, can be used as is technically appropriate. When communal sanitation facilities become an acceptable option, determining the most strategic location of the facility is essential. The physical layout of the coastal communities is characterized by dwelling units built on mudflats and extending towards the open waters. In this context, the capacity of the facility and the distance the user has to travel from his home to the toilet are among the important factors to be considered.

As discussed earlier, with environmental considerations, the nearer the location of the facility is to the surface water, the fewer become the options for waste disposal. The adverse ground conditions make other options technically unfeasible to operate, and increase the cost of those systems which are applicable. In cases wherein a large percentage of the population is located above the water, determining the best site for the facility involves the analysis of tradeoffs among accessibility and convenience of users, the target number of users and the cost of construction.

[10] Gunnerson, 1982.

The success of providing communal toilets does not merely depend on the ideal location and construction of the facilities. Experiences with the use of communal sanitation facilities also show that such options requires a high level of regular cleaning and basic maintenance. As in the case of the coastal communities, people prefer to use their individual overhung latrines or defecate on the surface waters than to use dirty communal toilets. The use of communal sanitation facilities becomes successful if there is a reliable party responsible for its maintenance or if there is a strong sense of community responsibility.

c. Social and Cultural Factors

Sanitation systems, even when they are properly designed, may not be appropriate when social and cultural factors affecting sanitation and hygienic practices of the community members are not considered. For instance, technologies involving re-use of excreta are unfeasible in communities where sight or handling of waste is culturally and socially unacceptable. In the same way, dry technologies are inappropriate for communities which prefer water for toilet hygiene. For the analysis of attitude in sharing toilet facilities, the level of privacy required by the community is essential. Cultural attitudes towards defecation vary; but generally, it is regarded as a private personal act. In communities that require a high level of privacy, the design of communal facilities should provide for these requirements.

Acceptability of Wastehandling

Some sanitation systems such as composting toilets and bucket latrines require wastehandling and re-use of excreta. Waste to be transported can either be the fresh excreta itself or decomposed excreta. The bucket latrine involves the handling of fresh excreta, making the system more prone to unsanitary wastehandling. The composting toilet, on the other hand, involves the handling of waste only when the excreta has been transformed into non-offensive, less harmful humus. Culturally, the most important distinction in the choice of the sanitation systems is dependent on whether the community

regard human excreta as a valuable resource or view it as an unpleasant and dangerous waste product.[11]

In the context of the case study, wastehandling is culturally unacceptable. For the community, it is best to dispose of the excreta right away. When asked about the potentials of waste reuse, respondents claimed to be uninformed about the possibility. This inevitably rejects options requiring wastehandling.

User Hygienic Practices

The material used for anal cleaning affects the choice of technology. In the sanitation systems surveyed, the systems can be categorized as dry or wet systems. Dry systems, such as the composting toilets, do not allow the use of water. When water is used for anal cleaning in pit latrines built in low-permeable soil, poor perculation and water logging occurs. In wet systems such as the pour-flush and cistern flush toilets, solid materials such as rocks, mud balls, corn cobs, stones and sticks cannot be used since these materials would cause blockage problems.

In the context of the coastal communities, water is the preferred material for anal cleaning. This may be attributed to the fact that water is available to the community and that paper and other solid materials are discouraged from being thrown into the bay to prevent further pollution. For those households with toilets and treatment tanks, water and sometimes toilet papers are used. This consideration favors wet systems or those which allow the use of water at least for toilet hygiene.

Privacy Requirements

Privacy requirements of community members should be considered, especially in the provision of communal toilet facilities . Such requirements include how many users are served by the facility and how the users are grouped and assigned to use and maintain a

[11] Uno Winblad; and Wen Kilama, Sanitation Without Water, Monograph (Stockholm: Swedish International Development Authority, 1980), p. 23.

particular toilet cubicle. The World Bank studies on sanitation identified three basic approaches to the design of communal sanitation blocks.[12] The first is to have a a highly public system, in which any user can enter any toilet compartment not in use at that time. Related to this is the separation of facilities for male and female users. The second is to provide a cubicle within the communal block for the exclusive use of one household. The third approach is a combination of the first two types, in which a public sanitation block is provided but reserved for the exclusive use of a large kinship group. The kinship group can be composed of several households that may belong to a patrilineal affinity or can be through camaraderie among neighbors.

In the context of the case study, experience shows that providing a highly public toilet is not at all feasible. Misuse and poor maintenance resulted since the facility is not owned by any household. Another problem associated with this approach is the non-acceptability of household members to share the facility with other households. Toilet activities are considered as very private, thus, sharing the same facilities with strangers is not at all favorable.

The second and third approaches are more feasible, as compared with the first design, since the household can guard and maintain their "private" facility. This is manifested in the case of Barangay Pagkakaisa, where the existing communal toilets are being used and maintained by the households living near the facility. However, the second approach, in which one cubicle is assigned to one household, is more expensive and unrealistic. In the coastal communities with very high density, it would be difficult to find enough space in the more elevated sites to provide all the toilet cubicles necessary. The third approach appears to be more realistic, since a lesser number of cubicles is provided. However, the type of social grouping per communal block will have to assessed well for this approach to be feasible.

[12] Kalbermatten, et.al.,1980, p.141.

Key Considerations	Sanitation Systems									
	Pit Latrines	Raised Pit Latrine	Double Pit Latrine	Septic Tank	Aqua Privy	Composting Toilets	Bucket Latrine	Vault and Cartage	Shallow Sewer System	Small Bore Sewer System
Feasible in adverse ground condition	○	⊖	⊖	○	○	●	●	●	●	●
Feasible in high density settlements	○	○	○	○	○	⊖	●	●	●	●
Minimum water requirement	●	●	●	⊖	⊖	●	●	⊖	●	●
No large equipment for waste collection	●	●	●	⊖	⊖	●	●	⊖	●	●
No wastehandling requirement	●	●	●	●	●	○	○	●	●	●
Allows use of water for toilet hygiene	○	○	○	●	●	○	○	●	●	●

Legend:
- ● Feasible
- ⊖ Feasible but conditional
- ○ Not feasible
- Possible Options

Figure 6.1: *Preliminary Comparative Analysis of Low-Cost Sanitation Systems*

Based on the discussion above, the important considerations for the provision of sanitation systems, whether individual or communal facilties, in the coastal communities of Puerto Princesa are summarized below. The preliminary comparative analysis of low-cost sanitation systems based on these criteria is shown in Figure 6.1.

- Sanitation systems should be feasible in areas with adverse ground conditions to avoid contamination of surface soil, ground water and surface water.
- System should be applicable to high density settlements.
- System should require minimum water, with communal stand pipes or handpump as the highest water service level.
- Waste or sludge collection, if required, should not involve large vehicles or large equipment.

- System should not require wastehandling, most especially handling of fresh excreta.
- Water can be used for toilet hygiene.

In the provision of communal toilets, special considerations include the following:

- In determining the location of the facility, the access and proximity of households especially those located on the water zone should be considered.
- Proper use and maintenance of the facility can be achieved if facilities are exclusively used by a group of households.
- Household groupings based on kinship or camaraderie among neighbors are favorable.

6.2 SANITATION SYSTEMS OPTIONS

Among the criteria developed, feasibility under adverse ground conditions is the most important consideration which inevitably limits the options for the community. This factor eliminates on-site options such as the pit latrines, aqua privy and septic tanks. Hence, sanitation systems which can be built above the ground or those without soil requirements are favorable for the community. Included are the composting toilets, bucket latrine, vault and cartage, shallow sewer system and the small bore sewer system. The following discussion identifies the limitations and potentials of these sanitation options in their application to the case study.

a. Composting Toilets

Composting toilets are classified as dry, on-site systems, which have no soil requirements, and can be built above the ground.[13] They can be used under the most difficult soil and ground water conditions.[14] The term composting has been defined as a biological process for converting organic solid wastes into a humus like product whose

[13] Gunnerson, et. al, 1982, pp.40-41.

[14] Winblad, 1980, p.3.

chief use is as soil conditioner.[15] The composting process is anaerobic and requires several months, preferably a year, to make the compost safe for use as a soil conditioner.

Composting toilets can be classified into two major types, namely he continuous and the double vault composting toilets. The continuous composting toilet consists of the composting chamber situated immediately below the squatting plate. The chamber has a sloping floor above which is suspended inverted U or V shaped channels. Grass, straw, ash, sawdust and easily biodegradable household refuse as well as excreta are added to the composting chamber. The composting material slowly moves down the chamber and into a humus vault, from which it must be regularly removed.[16] Figure 6.2 illustrates this type.The double vault composting toilet has two adjacent vaults, one which is used until it is about 3/4 full, when it is filled with earth and sealed, the other vault is used. Ash and organic matter are added to the vault before it is sealed to absorb odors and moisture. The tanks are paved and are constructed above the ground so as not to be submerged by rainwater.

The composting toilet, which can be built above the ground is technically feasible in the three zones of the community. Application of this system, however, is critical in the transition and water zones. Within the transitional area, careful design and construction is required to avoid water infiltration into the composting chamber. One version of the composting toilet, called the Vietnamese toilet, as discussed in Chapter 3, is considered the only toilet system that functions well in the swampy and floodprone areas. It consists of two tanks for dry and anaerobic composting, built above the ground[17] The construction of the composting vault suspended or supported above the water is theoretically feasible

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[15] C.G. Golueke, Composting, (Emmaus: Rodale Press, 1976), as quoted in, Witold Rybczynski, Chongrak Polprasert, and Michael McGarry, Low Cost Technology Options for Sanitation: A State-of-the-Art Review and Annotated Bibliography, (Ottawa: International Development Research Centre, 1978), p.16.

[16] Witold Rybczynski, Chongrak Polprasert, and Michael McGarry, Low Cost Technology Options for Sanitation: A State-of-the-Art Review and Annotated Bibliography, (Ottawa: International Development Research Centre, 1978), p.18.

[17] Nimpuno, pg.275-276.

but would require innovation and additional cost. Watertight vaults can be prefabricated locally using labor and materials available within the community. However, no field report supports this assumption and hence, it would require an on-site application to test the feasibility of this system.

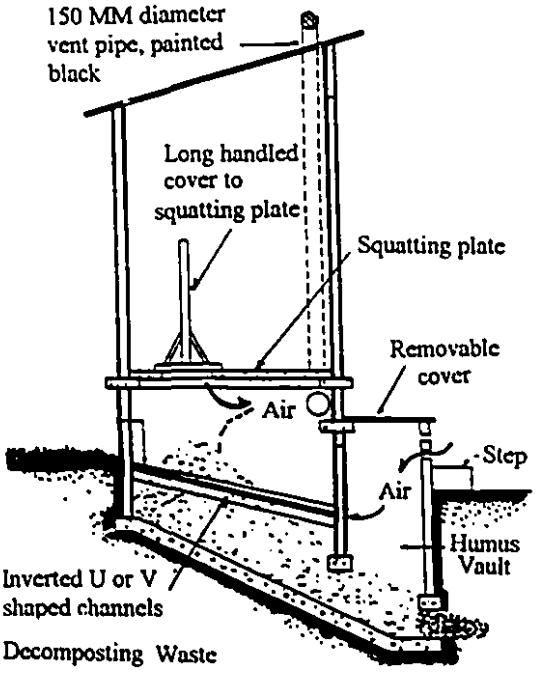

Figure 6.2: Continuous Composting Toilet (adapted from Kalbermatten, et.al., 1980)

Criteria	Zones: Dry	Transition	Water
Feasible in adverse ground conditions	●	●	⊖
Feasible in high density settlements	●	●	●
Minimum water requirement	●	●	●
No large equipment for waste collection	⊖	⊖	⊖
Allows use of water for toilet hygiene	○	○	○
No wastehandling requirement	○	○	○
Overall Assessment	○	○	○

Legend: ● feasible
⊖ feasible but conditional
○ not feasible

Table 6.2: Evaluation of Composting Toilet

The composting toilet in general does not disturb the ecological balance of the environment as there are no dicharges of excreta into water bodies, ground water or soil. When the excreta are finally returned to the soil, they have already been transformed into humus through the decomposition that took place in the receptacle. However, although environmentally feasible, the acceptability of the composting toilet is limited by social and cultural factors. The use of composting toilets in general is successful when they receive a high degree of user care and attention and where wastehandling is acceptable.

In the context of the coastal slums, wastehandling is rejected by the community, thus, making the system not acceptable. Another limiting factor is the use of water for toilet hygiene by the community members. The composting toilet, being a dry system, does not allow the use of water. These factors restrict the application of composting toilets in the case study. The evaluation of this system is summarized in Table 6.2.

Other systems, such as the bucket latrine, the vault and cartage system, the shallow sewer systems, and the small bore sewer system, are classified as off-site systems in which excreta are collected from individual houses and carried away from the plot to be treated and disposed of in another site. In theory, these options are feasible since problems of excreta being disposed directly to the surface waters and in soils with high groundwater levels are avoided. However, in these systems excreta will have to be disposed of safely somewhere else or will have to be re-used.

b. Bucket Latrine

Among the off-site sanitation systems, collection of excreta in buckets, pans and baskets is a common practice throughout the world. Whatever the mode of collection, the principle involves defecation into a container which is removed for disposal at frequent intervals into local surface water bodies or on land. This is the cheapest method for excreta collection in terms of capital investment; it is highly flexible and does not require any major capital outlay by the householder.[18] Figure 6.3 illustrates a typical bucket latrine.

In the context of the environmental and community physical factors, the bucket latrine is technically feasible in the coastal communities, even in the transition and water regions. The technology can be easily built or provided, it requires no water for operation and can be used in high density settlements. However, problems associated with social and cultural acceptance are involved. Major restricting factors in the usage of the bucket latrine in the communities are the rejection of wastehandling and the use of water for anal

[18] McGarry, 1977, p.254.

cleaning. Furthermore, the literature review indicated problems such as odor, insects, spillage and unsanitary conditions at the collection and transfer points, in the actual use of this system. Problems of transporting the excreta are amplified in the case of coastal communities where access is difficult. Though it is possible to make several improvements to the normal bucket latrine system by providing facilities for washing and disinfecting the buckets and by covering collection buckets with tightly fitting lids, it is still difficult in practice to ensure that the system is operated satisfactorily.[19] In this context, as summarized in Table 6.3, the usage of the bucket latrine in the case study is not feasible.

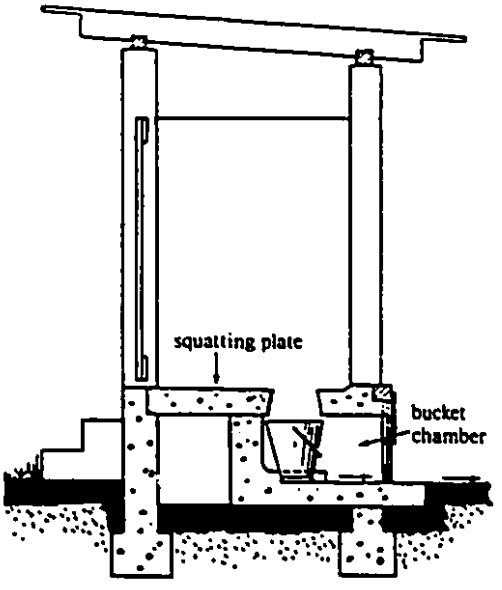

Figure 6.3 : Bucket Latrine (Broome, 1986)

Criteria	Zones: Dry	Transition	Water
Feasible in adverse ground conditions	●	●	●
Feasible in high density settlements	●	●	●
Minimum water requirement	●	●	●
No large equipment for waste collection	●	●	●
Allows use of water for toilet hygiene	○	○	○
No wastehandling requirement	○	○	○
Overall Assessment	○	○	○

Legend: ● feasible
⊖ feasible but conditional
○ not feasible

Table 6.3: Evaluation of Bucket Latrine

c. Vault and Cartage System

The vault and cartage system is composed of a low-volume water flushed toilet which discharges into a sealed tank or vault in which the waste is stored for a few weeks. It is then emptied by a vacuum suction tanker and taken away for suitable disposal. The

[19] Ibid., 1977, p. 254.

vault and cartage system overcomes the problem of the frequent emptying experienced with bucket latrines.[20] This system is illustrated in Figure 6.4.

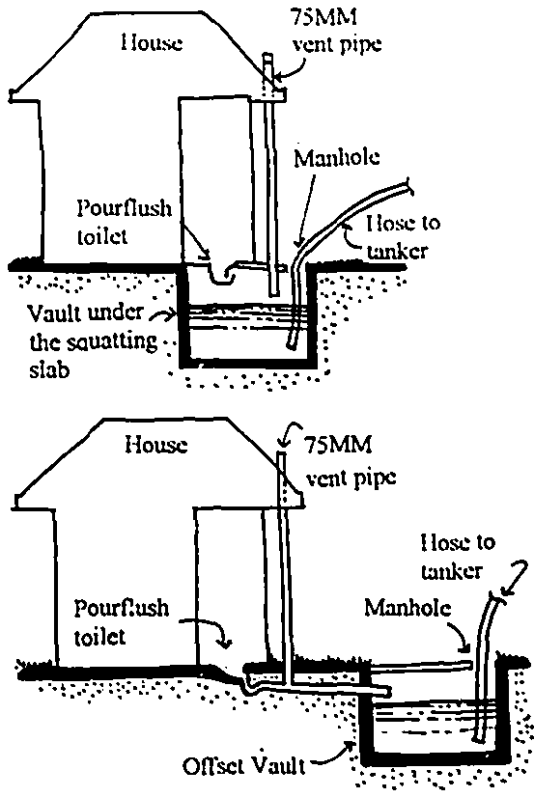

Figure 6.4: Vault and Cartage System

Criteria	Zones: Dry	Transition	Water
Feasible in adverse ground conditions	●	●	O
Feasible in high density settlements	●	●	●
Minimum water requirement	O	O	O
No large equipment for waste collection	O	O	O
Allows use of water for toilet hygiene	●	●	●
No wastehandling requirement	●	●	●
Overall Assessment	⊖	⊖	⊖

Legend: ● feasible
O feasible but conditional
O not feasible

Table 6.4: Evaluation of Vault and Cartage System

The application of this system in the coastal communities is environmentally feasible since the system can be built above ground. However, like the composting toilet, constructing the vault above the water involves innovation and this assumption has to be verified through further studies. Other factors favoring this system are its feasibility in high density settlement, no handling of waste by the users and minimum use of water.

Factors limiting the application of this system are the requirements for waste collection and for a highly efficient organization for regular collection services. Normally,

[20] Cotton,et. al., 1991, p. 85.

large collection vehicles are used to empty the tank. But in the case of coastal communities, where vehicular access is impossible, improvisation on the collection vehicle can be done. In areas, where access is difficult, smaller collection vehicles such as hand-or animal drawn carts with manually operated diaphragm pumps or small mechanically or electrically operated vehicles fitted with mechanically operated pumps can be used. Another option for this case is a pipe connection to an accessible communal vault.[21] Though the vault system requires a minimum amount of water for maintenance, it is expensive to operate and requires a highly efficient urban local authority to organize regular vault emptying. Thus, the application of the vault and cartage in the case study is feasible as long as access to waste collection is provided. The summary of the evaluation of this system is shown in Table 6.4.

d. Shallow Sewer Systems

Among the sanitation systems included in this evaluation, the shallow sewer system proves to be the most feasible. Also known as the small diameter sewerage, this system has emerged as a result of adapting the design standards of the conventional sewerage to suit the physical conditions of urban low-income settlement, such as adverse ground conditions, high settlement density and high water consumption.[22] The system is designed to accept all household wastewaters, excreta, toilet flush water and sullage in their fresh state for off-site treatment and disposal.

As applied in the urban poor in Brazil[23], the system consists of small diameter pipes, normally 100 millimeters, laid on flat gradients in shallow trenches. They are usually laid in backyards and narrow back alleys. Inspection chambers are built at intervals along the length of sewer lines to facilitate house connections and provide access for

[21] Gunnerson,et. al, 1982, p.118-119.

[22] Sinnatamby, 1990, p.146-147.

[23] For detailed description of the shallow sewer system in Brazil, see for example: Cheri Hart, "Classy 'Condo' Sewers for Brazil's Urban Poor, UNDP, March 1991, pp.16-20. For detailed information regarding the design, operation and maintenance of shallow sewer systems, with relevant case studies, see for example UNCHS, " The Design of Shallow Sewer Systems", Nairobi, Kenya, 1986

maintenance. Once the shallow sewer emerges from the block, various options exist: it can be connected to a conventional sewer, to a communal septic tank, or discharged straight into waste ponds. The choice depends on the site.[24] Figure 6.5 illustrates the typical layout of this system.

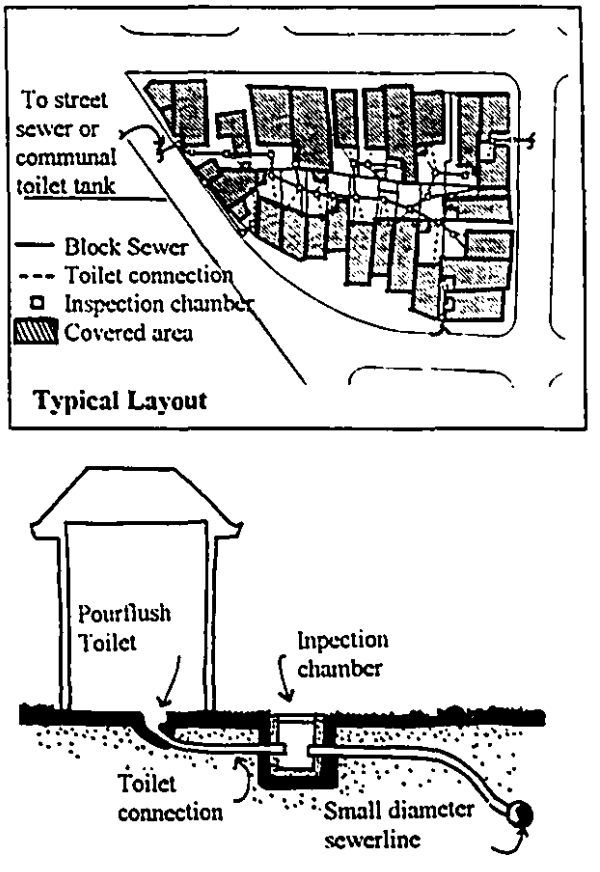

Figure 6.5: Shallow Sewer System

Criteria	Zones: Dry	Transition	Water
Feasible in adverse ground conditions	●	●	●
Feasible in high density settlements	●	●	●
Minimum water requirement	●	●	●
No large equipment for waste collection	●	●	●
Allows use of water for toilet hygiene	●	●	●
No wastehandling requirement	●	●	●
Overall Assessment	●	●	●

Legend: ● feasible
⊖ feasible but conditional
○ not feasible

Table 6.5:Evaluation of Shallow Sewer System

In the context of the coastal communities, the application of the shallow sewer system is more advantageous than the other options discussed earlier, as shown in Table 6.5. It is feasible in the three zones of the community, since the small diameter pipes can be laid even on site with adverse ground conditions and underneath the walkways built above the water. In this set-up each household, even those located above the bay, can

[24] Hart, 1991, p.18.

have pourflush toilets connected to the small diameter sewer lines. For waste treatment, the small diameter sewer lines can then be connected to the city main sewer, if possible, or to communal septic tanks which can be built on sites with favorable ground conditions.

Other factors favoring this system include its feasibility in high density settlements and a minimum water requirement. It can be used with low-volume pour-flush toilets in areas where the water supply is standpipe level of service. The system requires no manual handling of waste and allows the use of water for toilet hygiene.

A significant advantage of the shallow sewer system not found in the other options is the simultaneous collection and treatment of wastewater with human waste. The system does not rely on large quantities of flushing waters for their trouble-free operation but on the high frequency with which wastewater can pass through them.[25] With the use of the this system, the large amount of wastewater is disposed of properly.

e. Small Bore Sewer System

The small bore system, like the shallow sewer, is an improvised version of the sewerage system which has incorporated the requirements of high density, low-income communities. As shown in Figure 6.6, it involves the upgrading of systems using on-site leach pits or soakaways, such as the septic tank, by connecting them to small bore sewer systems so that their partially treated effluents are removed for treatment and disposed of off-site.[26] Such upgrading is possible when the level of water consumption increases, as a result of an increased or improved water supply in the community. With the effluent conveyed in a small bore sewer system partially treated, lower water flow velocities are required to prevent solid deposition within them. Hence, small diameter pipes are used and are laid at flatter gradients.[27]

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[25] Sinnatamby, 1990, p. 150.

[26] Ibid., 1990, p.144.

[27] Ibid., 1990, p.144.

Like the shallow sewer system, the small bore sewer can be built even in adverse ground conditions since waste is transported to another site for treatment. It can be applied in high density communities, requires no wastehandling or manual transportation of waste, allows the usage of water for toilet hygiene and incorporates the disposal of waste water. One limitation it has, however, as compared with the shallow sewer system, is its feasibility in the water zone. Since this system entails the usage of on-site systems such as the septic tank for each household, the construction of such tanks above the water is technically not feasible. An alternative for this is the incorporation of the shallow sewer system applied in the water zone with the small bore sewer applied in the transition and dry zones. The evaluation of this system is summarized in Table 6.6.

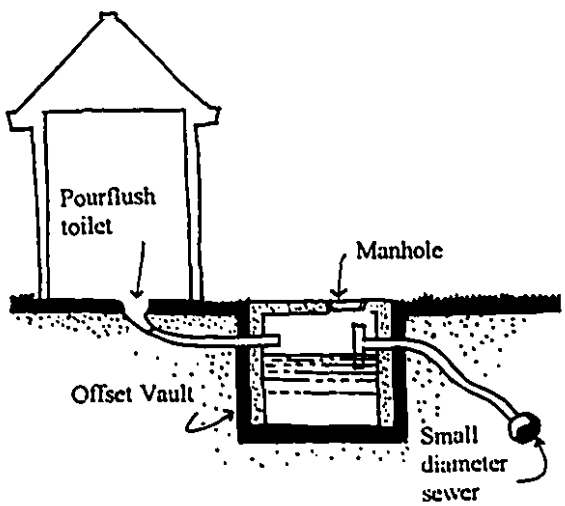

Figure 6.6: Small Bore Sewer System

Criteria	Zones: Dry	Transition	Water
Feasible in adverse ground conditions	●	●	⊖
Feasible in high density settlements	●	●	●
Minimum water requirement	●	●	●
No large equipment for waste collection	●	●	●
Allows use of water for toilet hygiene	●	●	●
No wastehandling requirement	●	●	●
Overall Assessment	●	●	⊖

Legend: ● feasible
⊖ feasible but conditional
○ not feasible

Table 6.6 : Evaluation of Small Bore Sewer System

This chapter cited the factors influencing the selection of sanitation technologies for the case study. Factors include environmental, community specific physical, social and cultural factors. Environmental factors, such as the condition of the surface water and soil are considered as the preliminary factors for the selection of sanitation technologies for the case study. Conditions of the surface water justify whether the practice of

disposing of waste into the water is still acceptable. The soil conditions of the site, characterized by high ground water level and poor permeability, favor those systems without soil requirements and those that can be built above the ground.

The other essential factors include community specific physical, social and cultural factors. Physical factors include community access networks, access to water supply and communal toilets. The poor access networks in the community limit options of those technologies not requiring the use of large trucks to collect sullage or waste. The level of water service in the community, consisting mostly of hand-carried water supply from communal standpipes or bought from neighbors, limit options not requiring in-house water connection. Social and cultural factors, on the other hand, include the user's requirements such as acceptability of waste handling, hygiene habits and required privacy level.

In the evaluation of the various sanitation systems based on the developed criteria, it can be concluded that the options for the community are narrowed down to those systems that can be built even with adverse ground conditions. These options include the composting toilets, the bucket latrine, the vault and cartage, the small bore sewer and the shallow sewer system. Social and cultural factors eliminate the bucket latrine and the composting toilets. The vault and cartage options are potentially feasible, except in the water zone, as long as the access to waste collection is provided. The application of the small bore system is only feasible within the elevated and transition zones of community. Among the systems discussed, the shallow sewer system proves to be the most appropriate based on the developed criteria.

Chapter 7
CONCLUSIONS AND RECOMMENDATIONS

This final chapter summarizes existing sanitation and environmental problems in coastal and waterfront communities and those on low-lying areas, enumerates the important considerations for the provision of sanitation systems in these communities, and identifies the feasible sanitation systems. It also provides general recommendations for future studies related to this research.

7.1 SUMMARY OF EXISTING SANITATION PROBLEMS

Findings from the literature review of several examples of coastal communities presented in Chapter 2 linked health and environmental problems to a lack of sanitation facilities. In coastal and waterfront communities, disposal of the human waste into the surface water or ground without treatment is prevalent. This traditional habit has become unhygienic since there are cases wherein the surface water is also the source of water for drinking as well as for personal and domestic cleaning. Such practice is also becoming questionable in communities with increasing densities. In other communities, the surface water is stagnant, thus the pollution problem increases. Aggravating this problem is the disposal of other domestic wastes, specifically wastewater and solid waste, both bio-degradable and nonbiodegradable, into the surroundings.

The analysis of sanitation in the coastal communities of Puerto Princesa derived similar findings. In the absence of sanitation facilities, particularly in houses built on the transition and water zones, disposal of human waste without treatment into the mudflat and bay is the common practice. It is favorable that the water of the bay is not consumed for drinking. However, disposal of excreta without treatment is not justified, especially in the transition areas where accumulated solid waste obstruct natural flushing of the waste by the current, thereby leaving the excreta exposed.

With health and environmental problems arising due to unsanitary conditions in these communities, what are the alternatives for disposing of human waste safely? In providing sanitation systems, what are the essential factors to be considered? In identifying the key considerations for the provision of low-cost sanitation systems in coastal communities, it is necessary to analyze the environment, community structure and available services such as water supply, collection of waste water and solid waste. In this analysis, the classification of the coastal environment into three zones defined in Chapter 5 is used as an important tool to be able to identify the problems clearly. These zones include the dry, transition and water zones, which are based on the location of the houses within the coastal site. Through this analysis, it was derived that existing conditions and the essential consideration for the provision of sanitation systems vary among the three zones.

7.2 KEY CONSIDERATIONS IN THE PROVISION OF SANITATION SYSTEMS

The derived key considerations include environmental factors and community-specific physical, social and cultural factors. Environmental requirements such as the condition of the surface water and ground conditions are the preliminary considerations. The condition of the surface water determines the acceptability of disposing of untreated human waste into the surface water. The prevention of such a practice becomes urgent when any of the following conditions occurs:

- community density is high in relation to the natural threshold of the surface water;

- surface water is consumed for drinking by the community;
- feces are deposited on the ground and not directly into the water; and
- surface water is stagnant or there is not enough current or tide to disperse and dilute the waste.

In determining alternative means to dispose of human waste, the basic problem with the provision of sanitation facilities in coastal communities, as illustrated in the literature review and case study, is the adverse ground conditions of the site. The site of these communities is characterized by the low permeability of the soil, and the high groundwater level to the extremes of presence of surface water. Technically, this condition inevitably limits sanitation options to those which require off-site treatment of waste or those which can be built above the ground.

Other essential factors affecting the choice of sanitation systems include the available services within the community such as water supply service levels, the means of disposing of wastewater and solid wastes, and the access networks within the community. Water supply is limited in most coastal communities. Sullage or wastewater collection does not exist, hence they are disposed of into the ground or surface water without treatment. Garbage collection is also a problem, thereby increasing the pollution of the water. Circulation networks within the community consist mainly of narrow footpaths and walkways on stilts, making access for collection of waste difficult. Whichever sanitation systems are considered feasible, based on the considerations discussed above, should however, be socially and culturally acceptable to the users.

7.3 RECOMMENDED APPROACH IN THE SELECTION OF SANITATION SYSTEMS

With the essential considerations for the provision of sanitation systems in coastal and waterfront communities identified, two general stages of selections are recommended. The first stage involves the selection between communal or individual toilets. Communal facilities involve the construction of several toilets built in one location, shared by a

number of households, while individual facilities refer to the construction of toilets for each household. The second stage is determining the appropriate means to dispose of and treat the human waste, whether through individual household or community network sanitation systems. Individual household system involves on-site treatment of waste. Community network, on the other hand, involves a collective system, in which waste is collected from several households and transported to another site for treatment. The important considerations for both stages are summarized below.

Stage 1: Communal Toilets vs. Individual Toilets

Provision of communal toilets has been considered the most common and technically feasible approach, as in the cases of the coastal communities reviewed and in the case study. For the local government and project planners, provision of these facilities simplifies the problem since the toilet blocks can be built on more stable areas, particularly on sites with favorable ground conditions where there are more feasible options for the treatment of waste. This approach however, proved a failure in most of the coastal communities reviewed due to poor access and the proximity of the facility to users and poor maintenance. When this option is preferred, the considerations discussed below must be assessed well.

A critical aspect in the planning stage of providing communal toilets in coastal communities is determining the most strategic location of the facility, considering accessibility and proximity to the users. In most cases, a large percentage of households in the communities has encroached on the water, so that their proximity to the ideal sites for the facility is decreased.[1] As analyzed in the case study, toilet blocks are located at elevated areas where it is easier to provide excreta disposal system. Thus, determining the most strategic location for the facility involves the analysis of trade-offs between user accessibility and convenience and the cost of the facility.

[1] In worse conditions, as manifested in the case of Barangay Matahimik, the local government provided only one toilet block, consisting of six stalls. Households located within the water zone travel more than 400 meters to reach the facility.

Compounding the difficulties with the provision of communal toilets are usage and maintenance problems. Public toilets seem to belong to no one and thus there is very little commitment by the individual users to keep it clean and operating properly.[2] Provision of communal toilets requires a high level of maintenance for proper operation. A well-organized community group can be an important tool for this requirement. This can be achieved by assigning the facility to a group of households who will use and maintain it exclusively. Grouping the households based on extended families and/or camaraderie among neighbors is effective.

Provision of individual toilets, on the other hand, involves a more complex set of requirements, since it is difficult to provide excreta and effluent treatment means for toilet facilities built above the water and mudflats or other low-lying areas with high groundwater level. In a prototypical coastal community, as in the case study, conditions vary in each zone, hence technical modifications and adaptations should be made depending on the specific location of the proposed toilet. The selection of waste treatment and disposal systems are discussed below.

Stage 2: Selection of Sanitation Systems

Considering the environmental and community physical factors common in coastal communities, requirements for sanitation systems can be summarized as follows: feasible in areas with adverse ground conditions, specifically impermeable and unstable soils with high ground water; feasible in high density areas; requires minimum water; and does not require large equipment for waste collection and transportation.

The adverse ground conditions inevitably restrict the use of on-site or individual sanitation systems that require favorable ground conditions. As manifested in the use of the septic tanks in *kampung* settlements in Jakarta and in the coastal communities of Puerto Princesa, the problems associated with the use of this technology include the

[2] Kalbermatten, et. al., p. 140.

following: poor permeability and high groundwater level, resulting in non-functioning of the system; contamination of groundwater, especially sources of drinking water, which eventually result in the transmission of diseases.

In dealing with high groundwater level, some on-site systems are technically feasible, namely: the double pit and raised pit latrines; the cesspool as used in the *klong* settlements of Bangkok, Thailand; and the Vietnamese composting toilets. Important considerations in the construction of improved versions of the pit latrine are the prevention of contamination of nearby water supplies and their application only in low-density settlements. With cesspools, although originally designed for areas with high groundwater level, the access of toilets for regular collection of sludge is required. For composting toilets, which can be contained above the ground, water infiltration into the vault must be prevented; wastehandling and a high degree of user care and attention are required.

Because on-site technologies are individual household systems, it is difficult to provide toilet in houses built above the waters. The improved versions of the pit latrine and the cesspool, which rely on soil infiltration are definitely not feasible in the waterzone. No field report supports the actual construction of composting toilet tanks above the water, and therefore this requires further research to check its feasibility.

Off-site systems such as the bucket latrines, the vault and cartage, the shallow sewer and the small bore sewer are feasible. The bucket latrine is used in coastal communities as in the case of the watertowns in China. This option, however, requires that waste re-use be a great demand in the community and that excreta-handling be socially and culturally acceptable. The vault and cartage system is theoretically feasible but no documentation supports its actual application in coastal communities. Like the composting toilets, the prevention of water infiltration into the tank is critical in the construction of the vault on ground with high groundwater level. The application of the vault and cartage system in the waterzone requires innovation and further study.

The two modified versions of the conventional water-borne sewerage, namely the shallow sewer and the small bore sewer systems, are two feasible options in coastal

communities. These systems can be built on sites with adverse ground conditions, they require minimum water, they can be applied in high density areas and they do not require access for large trucks or equipment for the collection of waste. The shallow sewer system is applicable in the three zones, since the small diameter sewer lines can be laid down on shallow trenches and can extend underneath the walkways above the water. With this option, pour-flush toilets can be built above the water with the small diameter sewer collecting the waste. The sewer lines can then be connected to the main sewer, if available, or to a communal septic tank built on more favorable ground for waste treatment. The small bore system, on the other hand, can upgrade the existing septic tanks and make them function properly, by connecting the tanks with small diameter sewer lines. However, this system cannot be applied on the water zone, since construction of tanks above the water is not feasible. One approach is to apply the shallow sewer in the water zone and connect it to the small bore sewer system in the dry and transition zones.

The sanitation systems, identified as options based on the preliminary considerations developed in this thesis, cannot be considered completely feasible in any coastal or waterfront site. Since a sanitation program is on a project-to-project basis, special considerations and modifications of options may be necessary, depending on the requirements of a specific community. From this preliminary selection phase, community specific economic, social, cultural and institutional requirements should be considered before the final selection is made and before the selected option is implemented.

7.4 FINAL REMARKS

In the overall analysis of the existing sanitation and environmental conditions of a prototypical coastal community, it has been observed that the closer a household is to the waterzone, the more adverse the ground conditions become, and the more limited community services are in terms of access and circulation networks, water supply, wastewater and solid waste collection. Under these conditions, the sanitation options are decreased.

The approach to improve sanitation conditions in coastal and waterfront communities and those in low-lying areas may involve more than one option or a combination of two or more systems, depending on the location of the proposed facility within the coastal site. In some cases, it may be necessary to use less perfect solutions that can be incrementally improved as other existing services are improved and those lacking are provided. Household connections for the water supply, for instance, can be made available in some areas of the community if it is necessary to make one sanitation system feasible. Walkways and circulation networks can be upgraded to allow small carts to pass through to provide access for waste or sludge collection and transportation. In cases where access improvement is not possible, improvisation of collection vehicles can be done, such as small hand-drawn or animal driven carts that can pass though the existing walkways. The trade-off among these options will have to be studied properly.

In any sanitation program, technologies may be identified as appropriate, but if the application does not involve information, training of community members and mobilization, the project will be a failure. Many sanitation programs are planned and executed by government bodies, and few are successful due to the failure to convince and educate the people of the importance of sanitation and the need for an active cooperation.[3] Education factors play a very important role because it is only through the basic understanding of the need for sanitation can the people be mobilized for its implementation.[4] Critical to the coastal communities is the need to inform the community members about the health and environmental hazards caused by their traditional practice of defecating on the surface waters. It is only when they understand the consequences of the unsanitary conditions they have that they will be willing to change their habits.

When new sanitation technologies are introduced, planners must find ways to bring the project into balance with community knowledge, attitudes and behaviors relating to health and sanitation.[5] The proposed system should not be too complicated for the user to

[3] Nimpuno, 1984, p.282.

[4] Ibid., 1984, p.279.

operate and maintain. It should not require radical behavioral changes that the community will eventually reject it. And most importantly, community training provided will ensure that the skills required to construct and operate the improved facilities are within the local capability. These requirements emphasize that usage and sustainability are critical to the success of sanitation projects. Unless facilities are suitable for the people using them and unless the technologies are affordable and efficient, the facilities will remain unaccepted and underused.[6]

[5] Yacoob, et.al., 1992, p.5.

[6] Ibid., et.al., 1992, p.4.

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APPENDIX A
BACKGROUND ON PUERTO PRINCESA, PALAWAN PROVINCE, PHILIPPINES

Contents

Table 1.a : Household Mobility Indicators

Coastal Communities, Puerto Princesa, Philippines

Duration	No. of Households	Cummulative No.	Percentage per backet	Cummulative Percentage
10 years & up	1412	1412	47.49%	47.49%
9 years - 10 years	191	1603	6.42%	53.92%
7 years - 8 years	268	1871	9.01%	62.93%
5 years -6 years	254	2125	8.54%	71.48%
2 years - 4 years	354	2479	11.91%	83.38%
7 months-2 years	322	2801	10.83%	94.21%
1month-6months	163	2964	5.48%	99.70%
not stated	9	9	0.30%	0.30%
Total	2973		100.00%	

Reference: Puerto Princesa City Survey, May 1992

Table 1.b: Household Mobility Indicators per Community

Coastal Communities, Puerto Princesa, Philippines

	Matahimik		Tagumpay		Seaside		BagongPag-asa		Liwanag		Mabuhay		Pagkakaisa		Bagong-Silang		Mandaragat	
Duration	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
10 yrs. & up	209	41.80%	66	36.07%	190	76.31%	219	56.30%	94	27.89%	147	72.06%	146	49.49%	173	38.02%	123	38.92%
9 yrs. - 10 yrs.	39	7.80%	9	4.92%	15	6.02%	11	2.83%	19	5.64%	10	4.90%	23	7.80%	35	7.69%	30	9.49%
7 yrs. - 8 yrs.	50	10.00%	10	5.46%	9	3.61%	31	7.97%	49	14.54%	11	5.39%	23	7.80%	65	14.29%	20	6.33%
5 yrs. -6 yrs.	39	7.80%	18	9.84%	10	4.02%	44	11.31%	51	15.13%	8	3.92%	33	11.19%	35	7.69%	16	5.06%
2 yrs. - 4 yrs.	58	11.60%	15	8.20%	13	5.22%	35	9.00%	48	14.24%	12	5.88%	18	6.10%	30	6.59%	125	39.56%
7 months-2 yrs.	86	17.20%	27	14.75%	11	4.42%	44	11.31%	42	12.46%	8	3.92%	34	11.53%	69	15.16%	1	0.32%
1 - 6months	19	3.80%	29	15.85%	1	0.40%	5	1.29%	34	10.09%	8	3.92%	18	6.10%	48	10.55%	1	0.32%
not stated	0	0.00%	9	4.92%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Total	500	100.00%	183	100.00%	249	100.00%	389	100.00%	337	100.00%	204	1	295	100.00%	455	100.00%	316	100.00%

Community Case Studies

Reference: Puerto Princesa City Survey, May 1992.

Table 2 : Household Monthly Income

Coastal Slums, Puerto Princesa, Palawan, Philippines

Income Range Philippine Peso		Canadian Dollars		No. of Households	Percentage
1	1,000	$0.05	$45.45	344	10.00%
1,001	2,000	$45.50	$90.91	768	22.33%
2,001	3,000	$90.95	$136.36	832	24.19%
3,001	4,000	$136.41	$181.82	401	11.66%
4,001	5,000	$181.86	$227.27	519	15.09%
5,001	6,000	$227.32	$272.73	178	5.18%
6,001	7,000	$272.77	$318.18	111	3.23%
7,001	8,000	$318.23	$363.64	84	2.44%
8,001	9,000	$363.68	$409.09	51	1.48%
9,001	10,000	$409.14	$454.55	67	1.95%
10,001	up	454.5909 up		72	2.09%
undeclared				12	0.35%
TOTAL				3439	100.00%

68.19% Below poverty Line

Reference : Puerto Princesa City Survey, May 1992.

Table 3: Households Dependent on Fishing Livelihood

Coastal Communities, Puerto Princesa, Palawan, Philippines

Community	No. of Fishermen	Total No. of Households	Percentage
Matahimik	77	493	15.62%
Tagumpay	40	185	21.62%
Seaside	121	248	48.79%
Bagong Pag-asa	66	398	16.58%
Liwanang	38	365	10.41%
Mabuhay	81	204	39.71%
Pagkakaisa	156	297	52.53%
Bagong Silang	248	457	54.27%
Mandaragat	171	326	52.45%
Total:	998	2973	33.57%

Community Case Studies

Reference: Puerto Princesa City Survey, May 1992.

Table 4: Population per Community

Coastal Slums, Puerto Princesa, Palawan, Philippines

ommunity	No. of Persons	No. of Households
Matahimik	2325	493
Tagumpay	875	185
Seaside	1343	248
Bagong Pag-asa	1867	398
Liwanag	1529	365
Mabuhay	971	204
Pagkakaisa	1523	297
Bagong Silang	2254	457
Mandaragat	1449	326
Total	14136	2973

Community Case Studies

Reference : Puerto Princesa City Survey, May 1992

APPENDIX B
SUPPLEMENTARY DATA ON FIELD SURVEY RESULTS

Contents

N

Location Map of Interviewed Households
Barangay Matahimik
Puerto Princesa, Palawan, Philippines

N

Location Map of Interviewed Households
Barangay Pagkakaisa
Puerto Princesa, Palawan, Philippines

Plate 1

Location Maps of Interviewed Households
Coastal Communities of Puerto Princesa,
Palawan Province, Philippines

RANDOM HOUSEHOLD INTEVIEW

BARANGAY _____ PERSON INTERVIEWED _____

ZONE NO. _____ DATE OF INTEVIEW _____

HOUSE NO. _____ SLIDE NOS. _____

1.00 HOUSEHOLD BACKGROUND

NAME	AGE	OCCUPATION	MONTHLY INCOME	EDUCATIONAL STATUS	SKILLS

2.00 MOBILITY

NO. OF YEARS RESIDING IN THE AREA _____ REASON FOR STAYING IN THE AREA _____

PREVIOUS RESIDENCE _____ INTENTION TO LIVE PERMANENTLY _____

ATTITUDE ON RELOCATION _____

3.00 HOUSING INDICATOR

DO YOU OWN THIS HOUSE? _____ LOT? _____ IF NO, AGREEMENT BET. YOU & OWNER? _____

DO YOU HAVE A LOT ANYWHERE IN THE CITY? _____ LOCATION _____ SIZE _____

HOUSE CONDITION _____ MATERIAL USED _____

4.00 UTILITIES AND SERVICES

WATER SUPPLY

CITY WATERLINES _____ DEEPWELL _____ WATERBUYING _____

MONTHLY PAYMENT _____ LOCATION _____ PRICE _____

CONSUMPTION _____ CONSUMPTION _____

TOILET

TOILET TYPE _____ DISPOSAL METHOD _____ CLEANSING MAT. _____

ATTITUDE ON WASTE HANDLING _____

ACCEPTABILITY OF COMMUNAL TOILET _____

BATH

LOCATION OF BATH AREA _____ DISPOSAL METHOD _____

LAUNDRY AND WASHING

LOCATION OF WASHING AREA _____ DISPOSAL METHOD _____

GARBAGE

DISPOSAL SYSTEM _____

ELECTRICITY

SOURCE _____ MONTHLY PAYMENT _____

5.00 HEALTH AND SAFETY

SAFETY OF CHILDREN _____

PREVALENT DISEASES _____

6.00 FIRE INCIDENT

SOURCE OF FIRE _____ DATE _____

WHAT WERE LOST _____ WHO REBUILT THE HOUSE _____

HOW LONG IT TOOK TO REBUILD HOUSE _____

HOW WERE THE HOUSES RESTRUCTURED _____

7.00 EXISTING HOUSE PLAN

Plate 2

Household Respondent Profile Form

Household No.	1 26	2 72	3 89	4 100	5 102	6 131	7 170	8 176	9 190	10 191	11 212	12 216	13 219	14 228	15 236	16 245	17 256	18 282	19 300	20 313	21 322	22 327	23 363	24 345	25 369	26 371	Total	%
Zone Classification																											
Dry																				●					●		2	7.69%
Transition		●	●	●	●		●										●	●						●		●	9	34.62%
Water	●					●		●	●	●	●	●	●	●	●	●			●		●	●	●				15	57.69%
Available Services																											
Water Supply																											
City Water Line																											
Own Line	●		●	●	●		●		●		●		●				●							●			10	38.46%
Line Sharing		●								●													●		●	●	5	19.23%
Handpump			●			●	●	●	●	●	●	●	●					●	●	●	●	●					14	53.85%
Water Buying						●						●		●	●	●											5	19.23%
Toilet Facilities																											
Individual																											
Overhung	●	●			●	●			●	●	●	●	●	●	●	●		●	●		●	●	●			●	18	69.23%
Pourflush			●	●			●										●										4	15.38%
Communal								●												●				●	●		4	15.38%
Disposal																											
Direct to bay	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	24	92.31%
Septic tank							●										●										2	7.69%
Wastewater																											
Disposal																											0	0.00%
Direct to Bay	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	26	100.00%
Solid Waste																											
Collected	●	●	●	●	●		●			●	●	●		●		●	●	●	●	●	●				●		17	65.38%
Direct to bay						●			●				●								●	●	●	●			7	26.92%
Burned						●			●					●								●				●	5	19.23%
Not Declared								●							●												2	7.69%

Plate 3: Barangay Matahimik
Summary of Household Survey Results

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
Household No.	34	30	17	18	49	86	69	111	123	114	115	116	233	228	200	210	221	Total	%
Zone Classification																			
Dry					●								●					2	11.76%
Transition			●	●		●		●	●	●				●	●			8	47.06%
Water	●	●					●				●	●				●	●	7	41.18%
Available Utilities and Services																			
Source of Water																			
City Line																			
Own Line								●					●	●				3	17.65%
Line Sharing	●																	1	5.88%
Handpump	●	●							●									3	17.65%
Water Buying		●	●	●	●	●	●		●	●	●	●			●	●	●	13	76.47%
Toilet Facilities																			
Individual																			
Overhung	●	●	●	●		●	●	●	●	●	●	●		●	●	●	●	15	88.24%
Pourflush					●													1	5.88%
Communal													●					1	
Disposal																			
Direct to bay	●	●	●	●		●	●	●	●	●	●	●		●	●	●	●	15	88.24%
Septic tank					●								●					2	11.76%
Wastewater																			
Disposal																		0	0.00%
Direct to Bay	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	17	100.00%
Garbage																			
Collected	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	16	94.12%
Direct to bay								●	●									2	11.76%
Burned																		0	0.00%

Plate 4: Barangay Pagkakaisa

Summary of Household Survey Results

Remarks:

- **Location of House:**

The house is located along the first walkway which is parallel to the coastline in zone 1. Though the site is not reached by the water even during high tide, the soil condition is characterized by high groundwater level.

- **Occupancy Status:**

The household, composed of five members, owns the house. They have been living in the area since 1984. The husband and wife are meat dealers in the public market. Access to the city proper made them settle in the area.

- **Water Supply:**

The household has water connection from the city waterlines. When pressure is low from the waterlines, they fetch water from the communal handpump. Water for bathing is stored in a large water container inside the toilet. Water for drinking is stored in plastic pitchers and jars.

- **Toilet Facility:**

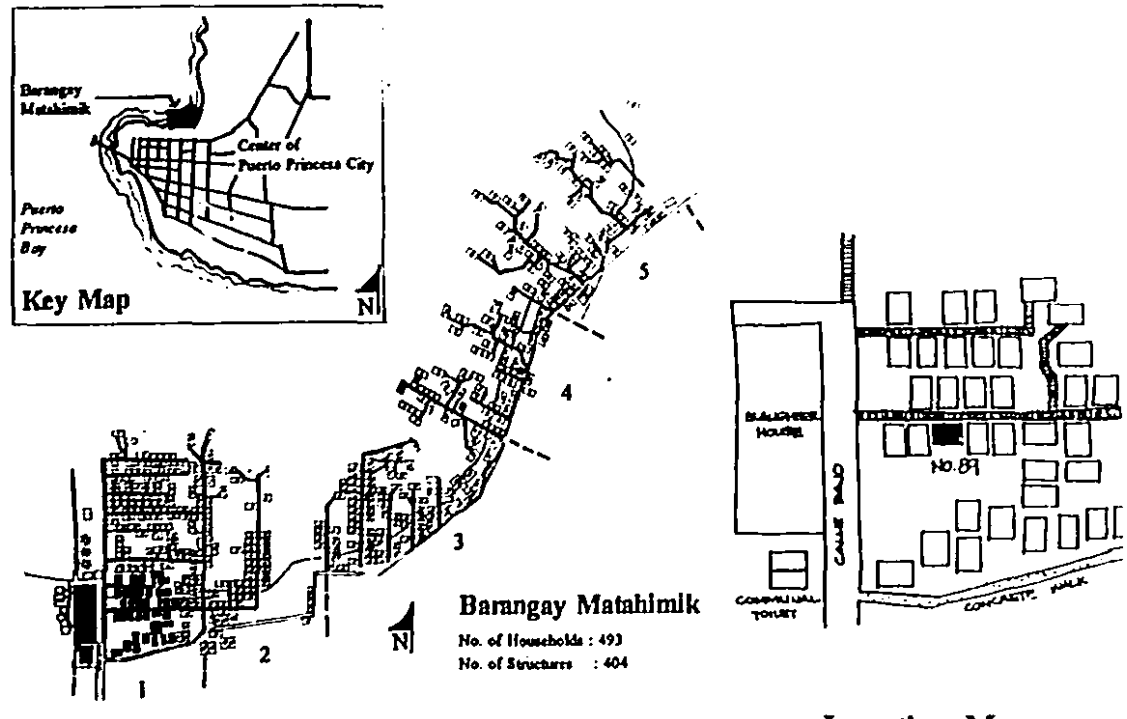
The household has a pourflush toilet supported by concrete floor. The facility is located at the rear right hand corner of the house. At present, though the household has a toilet seat, there is no treatment facility. The human waste is directly disposed into the ground underneath the house. The household is hesitant in investing their money for the construction of the septic tank because of their temporary tenure in the coastal area.

- **Wastewater Disposal:**

Wastewater from bathing and domestic washing is disposed of into the ground without treatment.

- **Solid Waste Collection:**

Garbage is collected by the household in plastic bags and is thrown into the trashcans along the concrete footpath for collection.



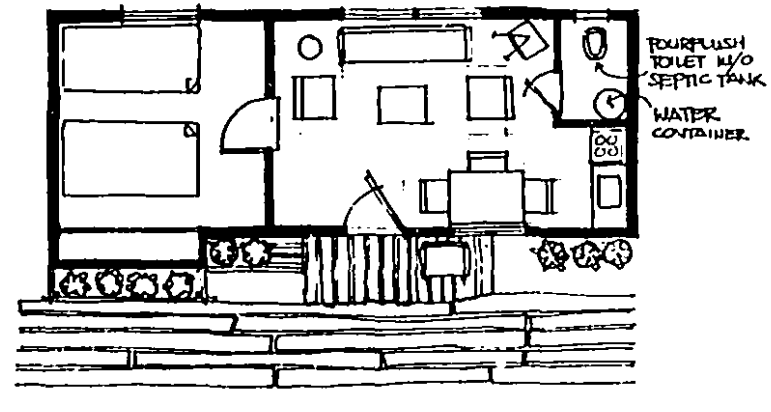


Plate 5

Household No. 89 **Barangay Matahimik**

Elevated/Dry Zone **Zone No.1**

Remarks:

- **Location of House:**

The house is located at the end of the second walkway of zone 1 and is approximately 150 meters from the concrete footpath on land. It is built above the water and is supported by bamboo and mangrove stilts.

- **Occupancy Status:**

A family of seven members owns the house. They have been living in the area for four years. The husband is a fisherman and the wife is a market vendor. Access to source of livelihood made them stay in the community.

- **Water Supply:**

The household buys water from their neighbor with water connection from the city lines. They pay $0.02 (Canadian) for a ten-liter container of water and consumes approximately four to five containers per day. They also fetch water from the communal handpumps which is free of charge. The children travel almost 360 meters to fetch water from this source and bring it to their house.

- **Toilet Facility:**

The household toilet consists of an overhung toilet built as an extension at the rear of the house. It is made of bamboo and grass supported by bamboo and mangrove stilts. The flooring is of bamboo slats with a hole at the center. Human waste is directly disposed of into the water.

- **Wastewater Disposal:**

Wastewater from laundry, bathing and domestic washing is disposed into the water without treatment. Laundry is done on the walkway in front of the house.

- **Solid Waste Disposal:**

Household members throw their garbage, both bio-degradable and non-biodegradable into the water. Sometimes, the housewife uses garbage such as paper, cardboard and wood as cooking fuel.

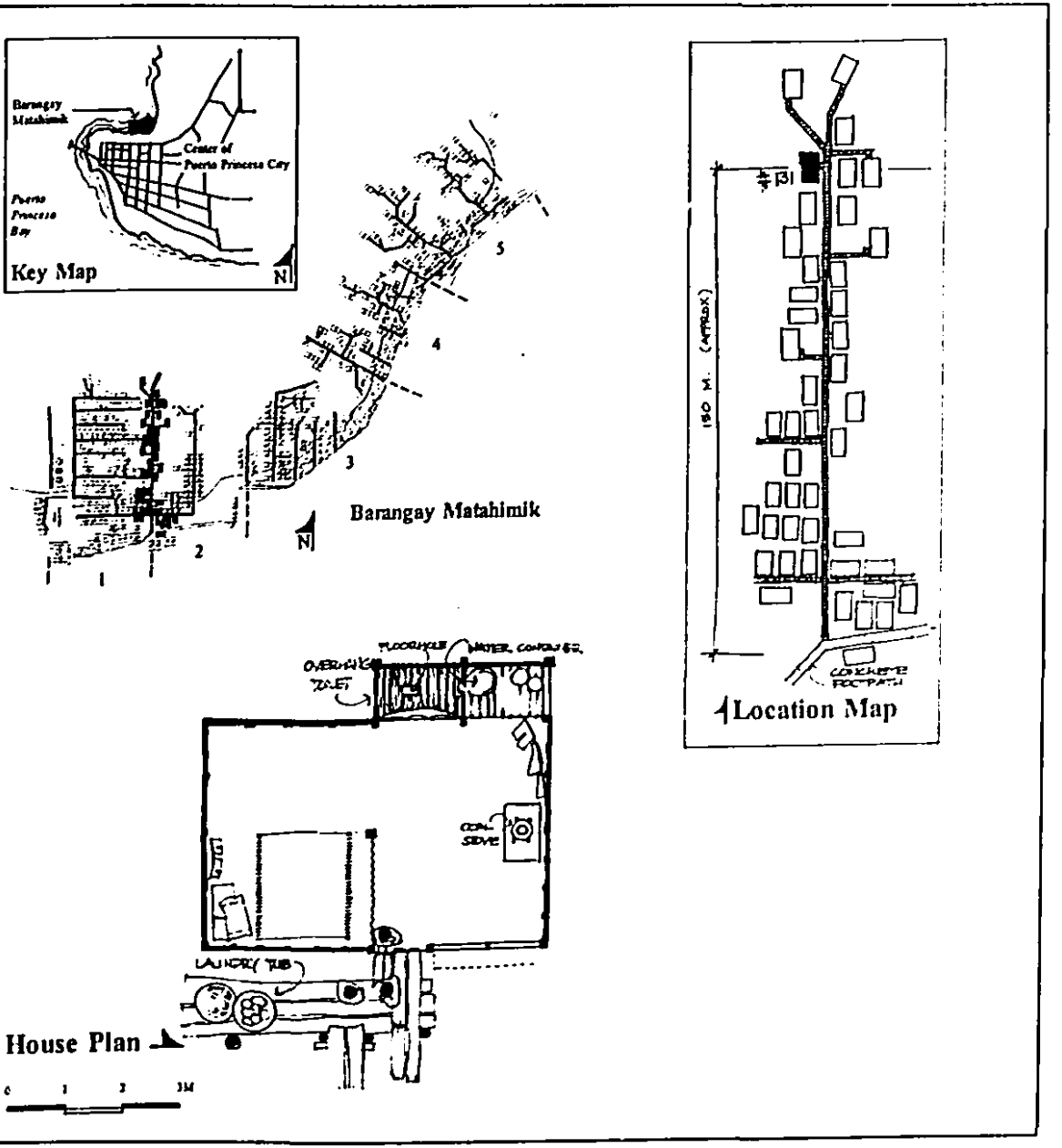


Plate 6

Household No. 131 Barangay Matahimik

Water Zone Zone No.1

Remarks:

- **Location of House:**

The house is located along the first walkway of zone 2. It is built on wet mudflat with the site submerged in water only during high tide. The house is about 12 meters from the concrete footpath on land.

- **Occupancy Status:**

The household, composed of 5 members, owns the house. They have been living in the area since 1966. The husband is a tricycle operator (three-wheeled motorcycle for public transportation) and the wife manages their small convenience store. Access to the city proper for their livelihood made them settle in the area.

- **Water Supply:**

The household has waterline connection from the city lines. Rubber hose is used to collect water into water drums and pails. The household also fetches water from the nearby communal handpump.

- **Toilet Facility:**

The household's toilet facility consists of a pouflush toilet with a septic tank underneath for treatment. The facility has been built since March 1991. However, the site of the facility is characterized by very high groundwater level, thus, making the leaching of the septic tank effluent difficult.

Manner of defecating is done in sitting position. Water is used for anal cleansing. When asked about communal toilet facilities, the household prefers a private facility.

- **Wastewater:**

Wastewater from laundry, bathing and domestic washing is disposed of into the ground without treatment. Laundry area is on the right front corner of the house.

- **Solid Waste Collection:**

Household member collects garbage in plastic bags and brings them to the trashcans along the concrete walkway for collection.

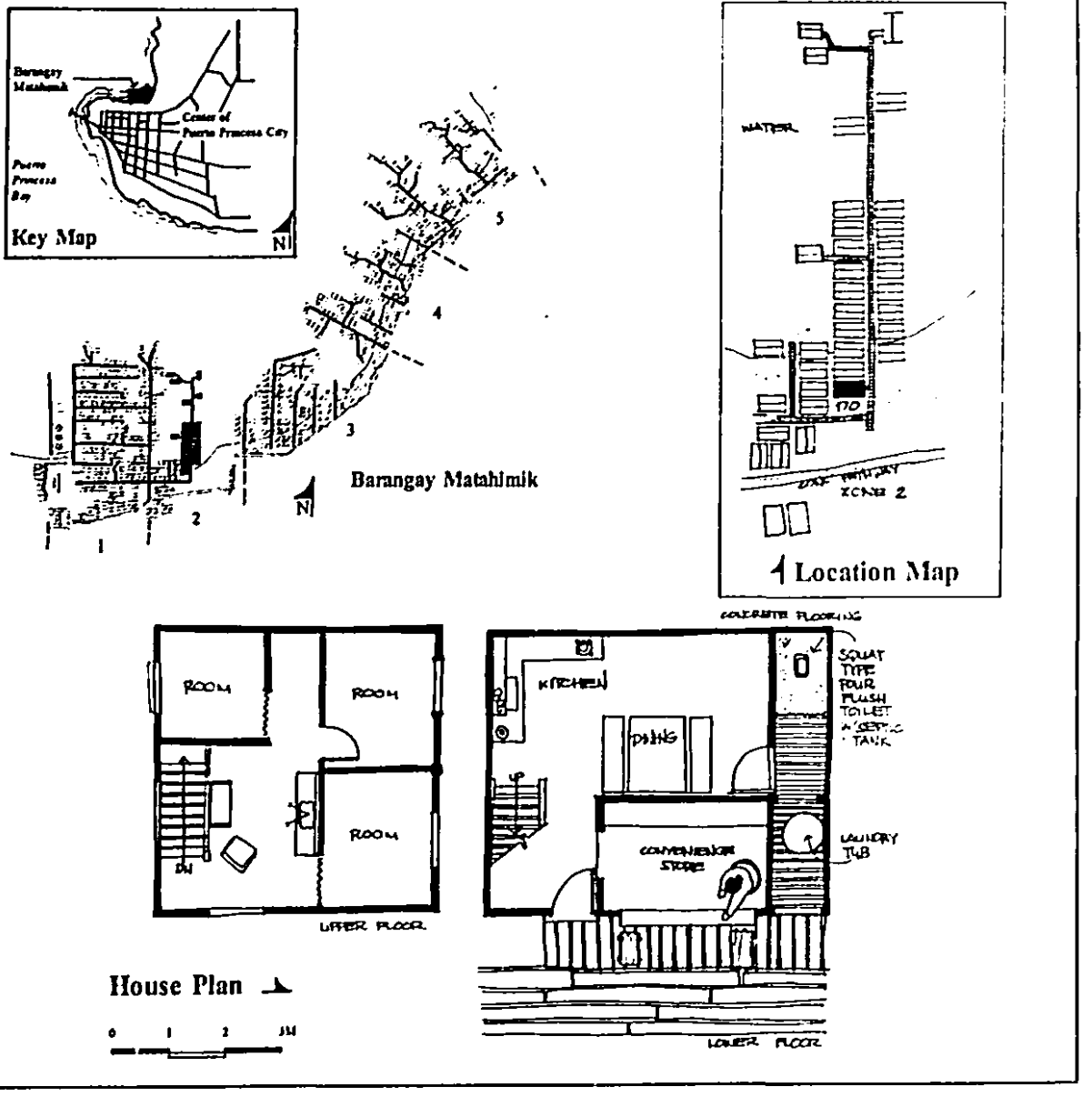


Plate 7

Household No. 170 **Barangay Matahimik**

Transition Zone **Zone No.2**

Remarks:

- **Location of House:**

The house is located at the end of the first walkway of zone 2 which is about 120 meters from the concrete footpath on land. The distance between the water level and the floor level of the house is about 1.5 meters and decreases to 0.50 meter during high tide.

- **Occupancy Status:**

The household, composed of four members, owns the house. They have been living in the community for six years.

- **Water Supply:**

The household shares waterline with their neighbor. They pay half of the monthly fee that is approximately $2.82 (Canadian). Manner of connecting waterline to their house is through a rubber hose installed from the main faucet of the neighbor. The hose is suspended underneath the house and the walkways leading to the kitchen. When pressure is low from the city waterlines, the household fetches water from the communal handpump. The household member travels at least 240 meters to fetch water from the nearest handpump.

- **Toilet Facility:**

The toilet is simply a makeshift overhung toilet, made of grass and bamboo, supported by stilts. Floor is made with bamboo slats with a hole at the center. No treatment is done to the excreta and is disposed of directly into the bay. The toilet is located at a separate structure at the back of the house.

Defecation is done on a squatting position. Water is used for anal cleansing.

- **Wastewater and Animal Waste:**

Wastewater from laundry, bathing and domestic washing is directly disposed of into the bay. Laundry and bathing are done at the rear extension beside the toilet.

- **Solid Waste and Animal Waste:**

Garbage from the house is collected in plastic bags and is brought by a household member to the trashcans in the mainland for collection. Animal waste is directly disposed of into the bay.

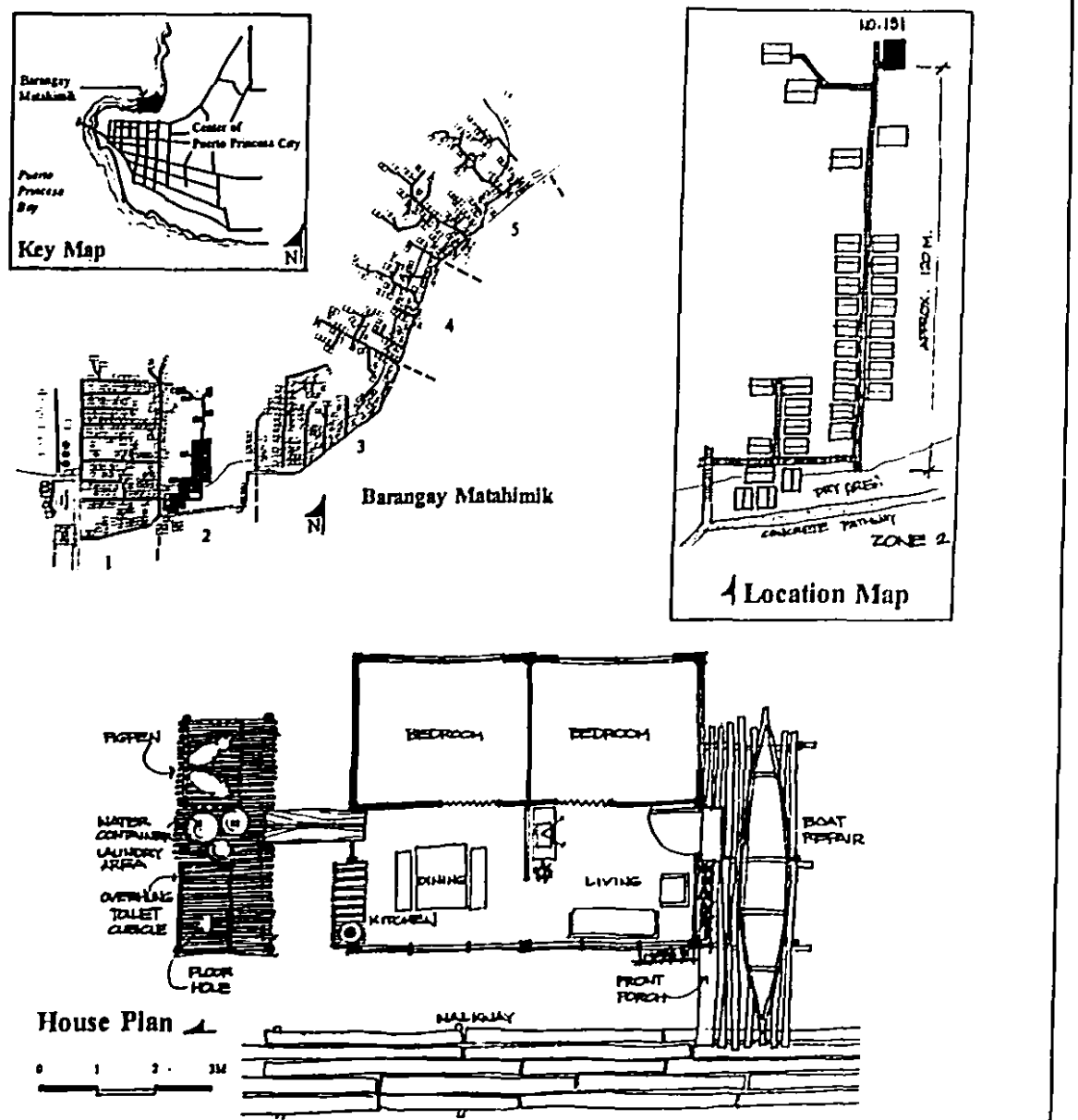


Plate 8

Household No.191 Barangay Matahimik
Water Zone Zone No.2

Remarks

- **Location of House:**

The house is located at the end of the first walkway of Zone 3. It is built above the water and is approximately 200 meters from the concrete footpath on land.

- **Status of Occupancy:**

The household is composed of a couple with a one-year old son. They leases a 3-room unit at the left rear corner of the house that is only 16.00 square meters in area. They have been staying in the area for only three months.

Another family leases the unit at the right rear corner. The owner of the house occupies the front part of the house.

- **Water Supply:**

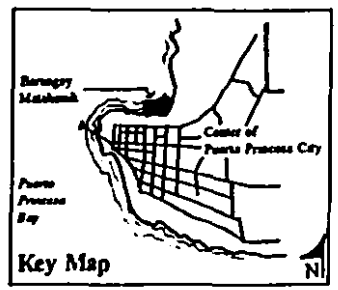
The family buys water from their tenant and pays $0.01 (Canadian) for an 8-liter pail. The household consumes about 6-8 pails per day for both drinking and domestic use. They do not fetch water from the handpump since their house is too far from the facility.

- **Toilet Facility:**

The household shares a communal toilet with the owner and the family leasing the other unit. The toilet is a separate structure at the left rear corner of the house. It is simply an overhung toilet made of bamboo and grass, supported on stilts. The floor is made of bamboo slats with a hole at the center. Waste is directly disposed of into the water.

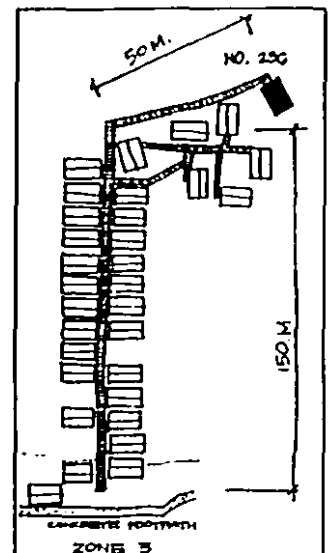
- **Wastewater Disposal:**

Wastewater from laundry, bathing and washing is directly disposed of into the bay.

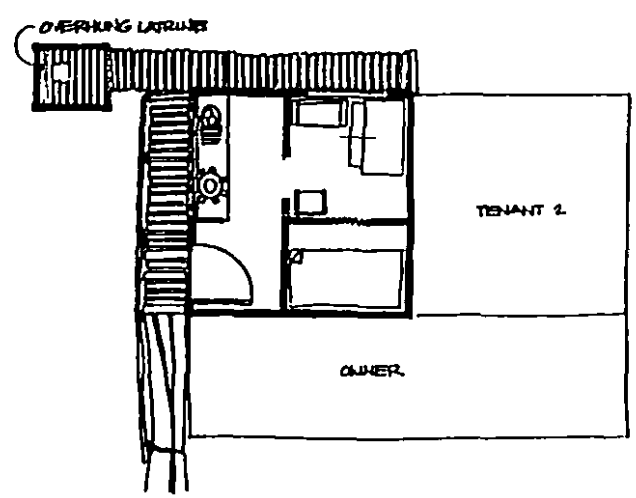


Key Map

Barangay Matahimik



Location Map



House Plan

Plate 9

Household No. 236-A Barangay Matahimik

Water Zone **Zone No.3**

Remarks:

- **Location of House:**

The house is located along the third walkway of zone 3. It is approximately 24 meters from the concrete footpath. It is built above the mudflat, which is submerged in water only during high tide.

- **Occupancy Status:**

Two households occupy the house. The owner occupies the upper floor while a related family leases the lower floor. The owners have been living in the area since 1947. Access to the city proper made them stay in the community.

- **Water Supply:**

The household has waterline connection from the city lines and pays an average fee of $13.00 (Canadian) per month. To retrieve the part of the expenses allotted to water supply, the family sells water to their neighbors.

- **Toilet:**

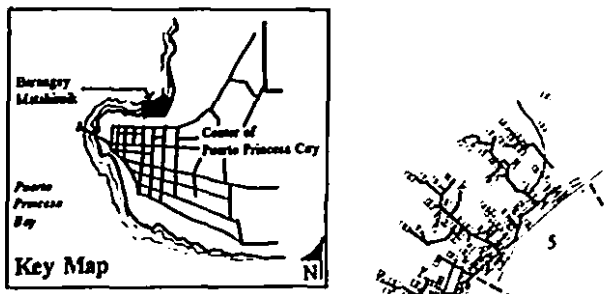
The toilet is a pourflush toilet with septic tank underneath. The facility is located at the right rear corner of the house at the lower floor. It is being shared by the two families.

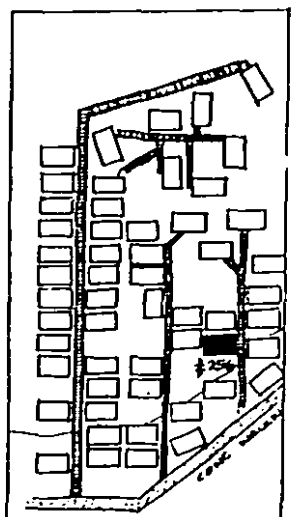
- **Wastewater Disposal:**

Laundry area is located at the right side of the house. Wastewater from laundry, bathing and domestic washing is not treated and is disposed of directly to the ground.

- **Solid Waste Disposal:**

The household collects garbage in plastic bags and brings them to the trashcans along the concrete footpath for collection.





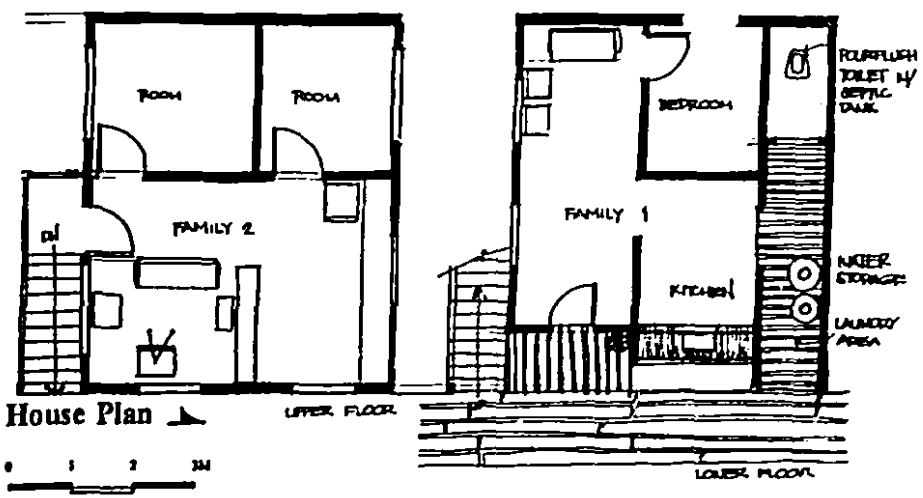


Plate 10

Household No. 256 Barangay Matahimik
Transition Zone Zone No. 3

Remarks:

- **Location of House:**

The house is located at the end of fifth walkway of Zone 3. It is the last house along the walkway and is approximately 100 meters from the concrete footpath on land.

- **Occupancy Status:**

The household, composed of 6 members, owns the house. They have been living in the area for four years. The husband is a security guard in a bank while the wife is a midwife. Access to their jobs in city proper and to the public schools of their children made them settle in the community.

- **Water Supply:**

The household relies mainly on water fetching from the communal handpumps. The husband fetches water everyday and travels at least 400 meters to fetch water and bring it to the house. The household consumes 10 eight-liter pails of water per day. When two pails of water is fetched in one time, it means that the husband travels 2 kilometers per day to supply water. Water from the deepwell is consumed for domestic washing as well as for drinking.

- **Toilet Facility:**

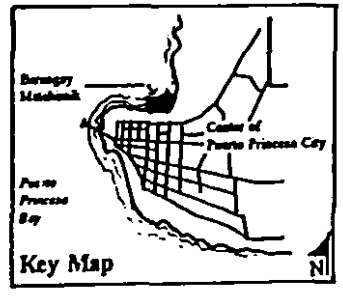
The household has an overhung toilet at the rear extension of the house. The toilet is simply a small cubicle with bamboo and grass walls supported by stilts. The flooring of the toilet is made of bamboo slats and has a hole at the middle.

- **Wastewater Disposal:**

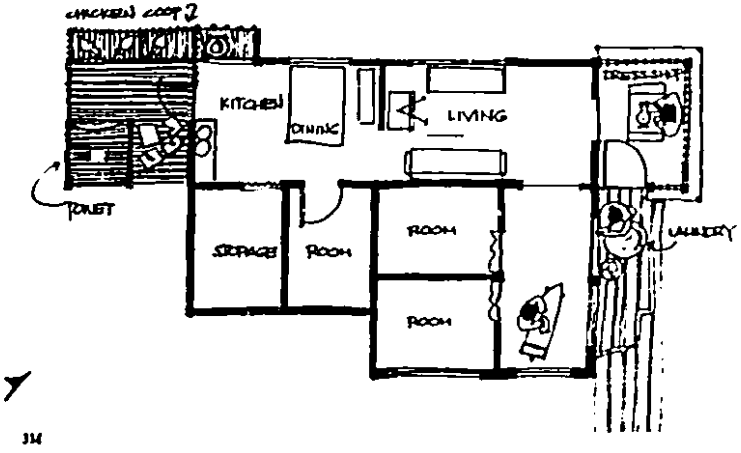
Laundry is normally done by the daughter in front of the house. This location is found to be convenient since there is no need to bring water inside the house. Wastewater from laundry washing, kitchen and bathing is disposed of into the bay.

- **Solid Waste Collection:**

Household collects garbage in plastic bags and brings them to the trash cans along concrete footpath for collection.



Location Map



House Plan

0 1 2 3M

Plate 11

Household No. 300 Barangay Matahimik

Water Zone Zone No.3

Remarks

- **House Location:**

The house is located along the first walkway of zone 5. Th site is within the transition zone and is approximately ten meters away from the concrete footpath.

- **Occupancy Status:**

The household, composed of five members, owns the house. They have been living in the community since 1981. The wife is a market vendor and the husband works for a construction company as a contractual building painter. Access to the city proper made them settle in the area.

- **Water supply:**

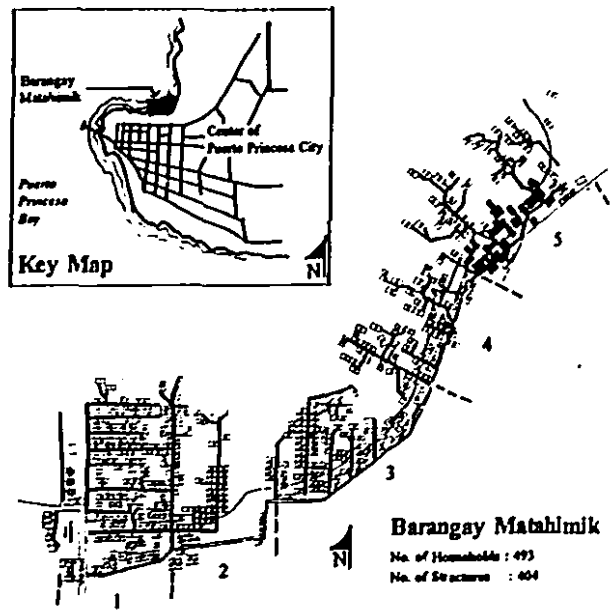
The household has their connection from the city waterlines and pays monthly dues. A rubber hose is connected from the main faucet of the house to bring water to the kitchen area and laundry area.

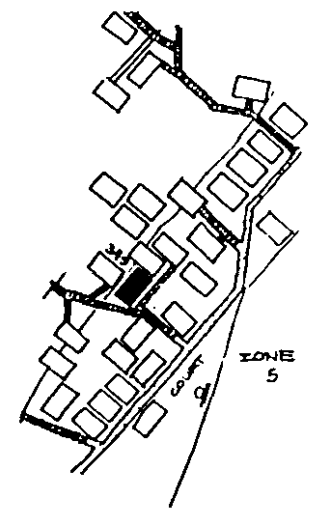
- **Toilet Facility:**

The household has no toilet. The family members use the toilet of neighbor. Sharing toilet with the neighbor is acceptable to the household members as long as the facility is not very far.

- **Wastewater Disposal:**

Laundry is normally done on the front porch of the house. Water used is from the city waterlines. Wastewater from laundry is disposed of to the soil and bay without treatment





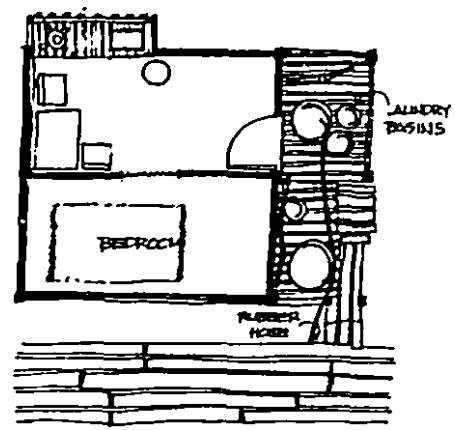


Plate 12

House No. 345 **Barangay Matahimik**

Transition Zone **Zone No.5**

Remarks:

- **Location of House:**

The house is the third house at the right side of the walkway of Zone 4. The site is submerged into the water during high tide and is dry during low tide. It is approximately 40 meters from the main access road of the community.

- **Occupancy Status:**

Two related households, currently occupies the house. With both families relying on fishing as a source of income, they prefer settling along the coast of the bay. They have been living in the area since 1973.

- **Source of Water:**

The households have waterline connection from the city lines and pays an average of $21.70 (Canadian) per month. They sell water to their neighbors. At present, more than 5 families buy water from them regularly. Water is sold in containers brought by the buyers. A 10-liter container is worth $0.02 (Canadian). Rubber hose is connected from the main faucet of the house and is brought in front, along the walkway, where the buyers fetch the water. Every morning, a queue of water containers and pails is seen in front of the house.

- **Toilet Facility:**

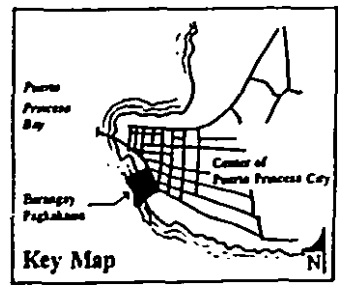
The households have two overhung toilets built as extensions at the rear of the house. The toilet is simply a small cubicle made of bamboo and palm leaves, supported by stilts. The floor is made of bamboo slats with a hole at the middle.

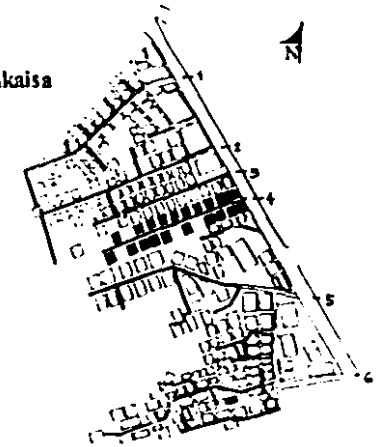
- **Wastewater Disposal:**

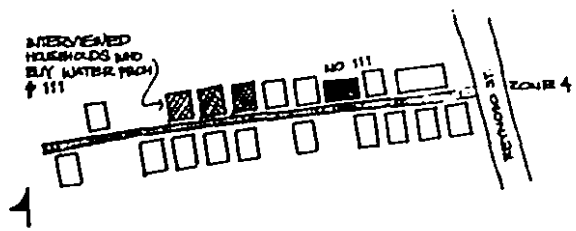
Laundry is normally done along the walkway in front of the house. Wastewater from laundry as well as other domestic washing is disposed of into the ground without treatment.

- **Solid Waste Disposal:**

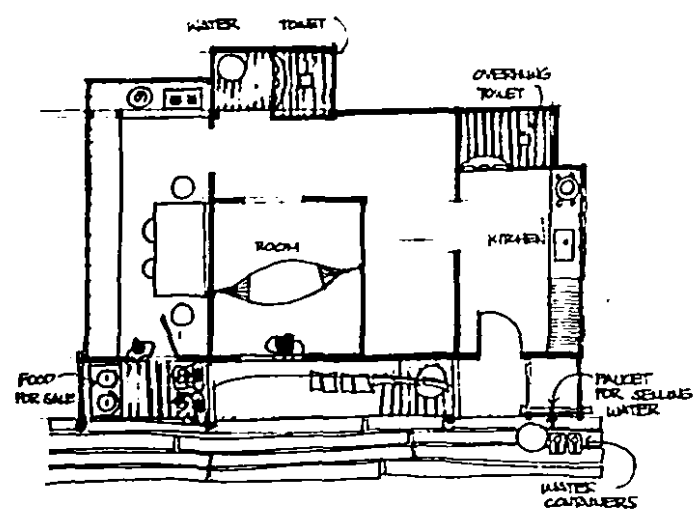
Initially, the household collects the garbage in plastic bags and brings them to the trash receptacle along the street. However, according to the respondent, the collection of garbage along the street is not done regularly. Hence, they find it more convenient to throw the trash into the mudflat beneath their house.







Location Map



House Plan

0 1 2 3M

Plate 13

Household No. 111 Barangay Pagakakaisa

Transition Zone Zone No. 4

Remarks:

- **Location of House:**

The house is the 6th house at the right side of the walkway in Zone 4. It is approximately 60 meters from the east perimeter road of the community. The site is submerged in water during high tide.

- **Occupancy Status:**

The household, composed of six members owns the house. They have been living in the area since 1985. The husband is a fisherman while the wife works as a streetsweeper. Access to the bay and to the city proper made them settle in the community.

- **Water Supply:**

The household buys water from their neighbor, Household no.111, which is three houses away. They pay $0.02 (Canadian) per container.

- **Toilet Facility:**

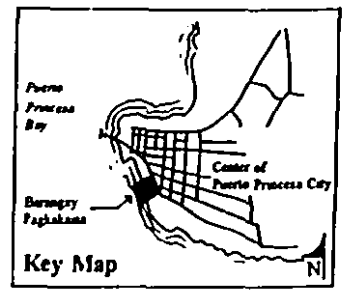
The household, located above the water, has an overhung toilet. The facility is simply a small cubicle built as an extension at the back of the house. The cubicle is made of wood and palm leaves, with bamboo slats as flooring. At the middle of the cubicle is a small hole. Human waste is directly disposed of into mudflat underneath the toilet.

- **Wastewater Disposal:**

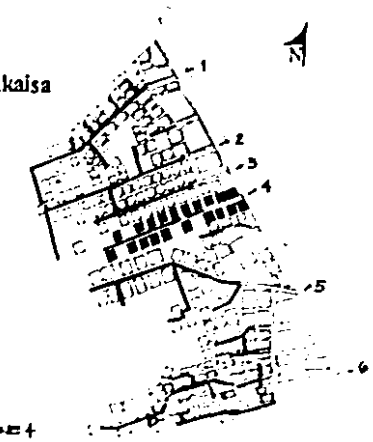
Wastewater from laundry, bathing and domestic washing is directly disposed of into the ground.

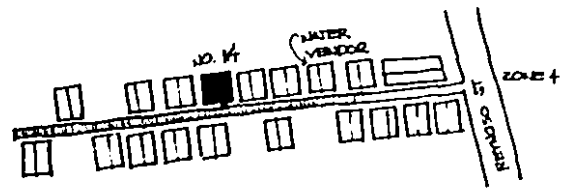
- **Solid Waste Collection:**

The household collects their garbage in a plastic bag and brings them to the trashcan along the road for truck collection.

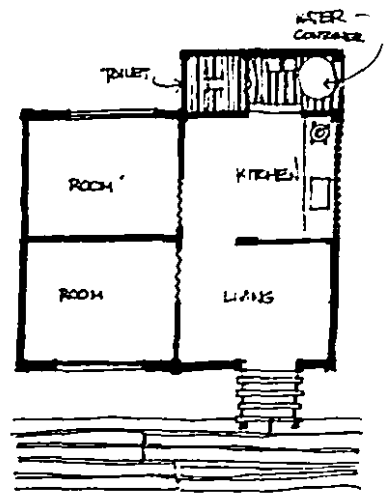


Key Map





Location Map



House Plan

0 1 2 3M

Plate 14

Household No.114 **Barangay Pagkakaisa**
Transition Zone **Zone No.4**

Remarks:

- **Location of House:**

The house is located along the southernmost walkway in zone 6. The site is still within the dry area and is approximately 30 meters from the main access road of the community. Hence, the house is built on concrete foundation

- **Occupancy Status:**

The household, composed of five members, owns the house. They have been living in the area since 1969. The husband is a carpenter and the wife is a market vendor. Access to the city proper for their livelihood is favorable to them.

- **Water Supply:**

The household has its connection from the city waterlines. They pay $5.6 (Canadian) per month. Having their own line, the household sells water to their neighbors. Ten liters of water costs $0.03 (Canadian).

- **Toilet Facility:**

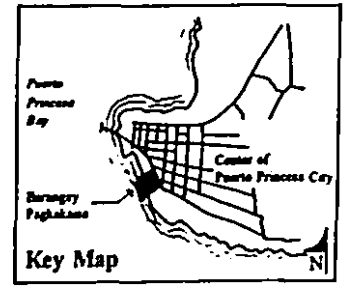
The household has a pour-flush toilet seat supported on concrete flooring with septic tank for treatment built underneath. Water is used for anal cleansing.

- **Wastewater Disposal:**

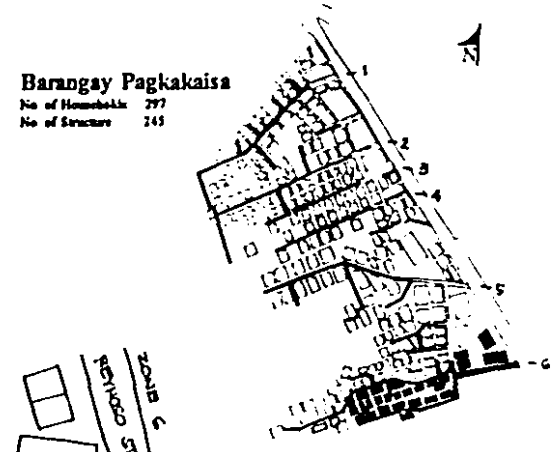
Wastewater from laundry, bathing and domestic washing is disposed of into the ground without treatment.

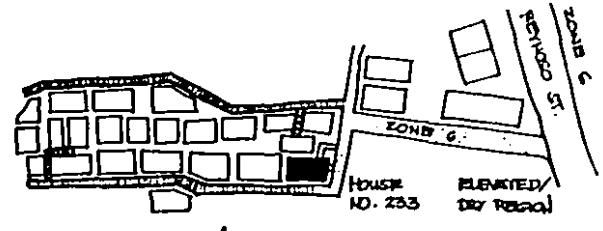
- **Solid Waste Collection:**

The household brings their garbage along the perimeter road for truck collection.

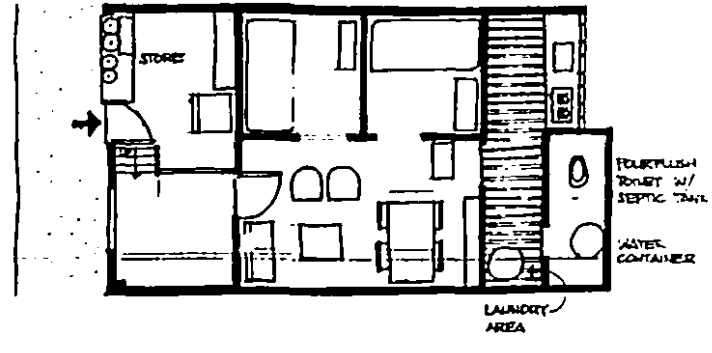


Key Map





Location Map



House Plan

Plate 15

Household No. 233 Barangay Matahimik
Dry Zone Zone No. 6