Papua New Guinea

GEOGRAPHY, CLIMATE AND POPULATION

Geography

Papua New Guinea lies to the north of Australia just south of the equator. Apart from the mainland, it consists of a collection of islands, atolls and coral reefs scattered around the coastline. The total area of the country is 462 840 km^2 (Table 1). For administrative purposes, the country is divided into fourteen provinces on the mainland: Central, Chimbu, Eastern Highlands, East Sepik, Enga, Gulf, Madang, Milne Bay, Morobe, Northern, West Sepik (also called Sandaun), Southern Highlands, Western, and Western Highlands; four provinces in the Bismarck Archipelago: East New Britain, Manus, New Ireland, and West New Britain; one autonomous region: North Solomons (also called Bougainville); and one district: National Capital (Port Moresby).

The principal topographical features of the mainland, the Bismarck Archipelago and the North Solomon Islands are the highly dissected mountain ranges, which reach 4 509 m on the mainland. In the western half of the mainland are the extensive lowland plains and swamps of the Sepik-Ramu and Fly rivers, lying respectively north and south of the main mountain ranges.

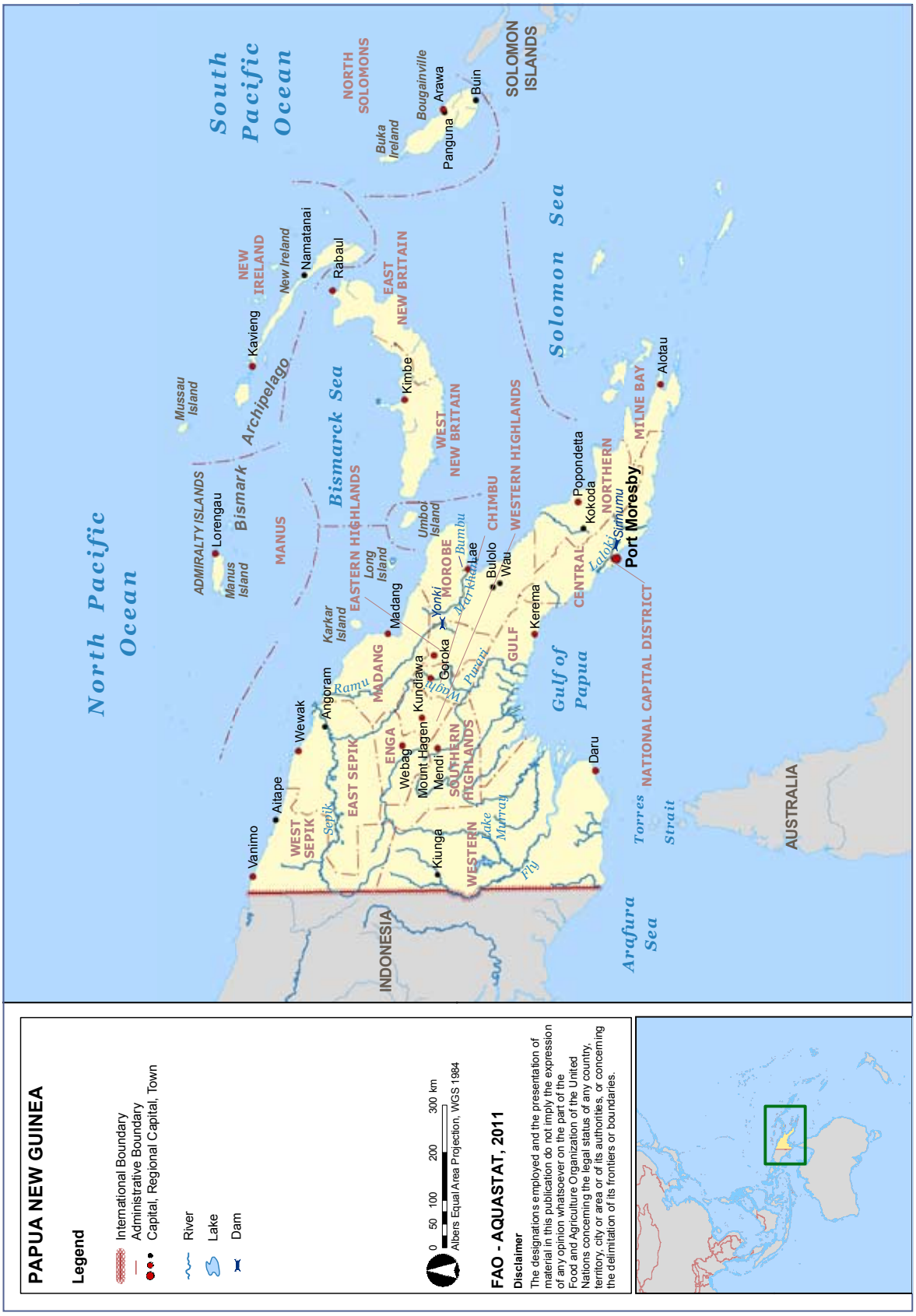
In 1997, the cultivable area was about 12 500 000 ha, or about 27 percent of the total area. In 2009, the total cultivated area was an estimated 960 000 ha of which 260 000 ha or 27 percent for annual crops and 700 000 ha or 73 percent of permanent crops. In 1997 some 787 000 ha were reported to be cultivated, mainly with starch food crops such as taro, sweet potato, yam, cassava, banana and sago. Export crops planted in extensive plantations and by subsistence farmers include coffee, cocoa, oil palm, coconut and minor export crops such as tea, cardamon, vanilla and rubber.

Climate

The climate is humid and rainy. Temperatures are not extreme for tropical climates and most areas, apart from the high altitudes, have a daily mean temperature of 27 ºC with little variation. Humidity in the lowland areas varies around 80 percent. Varied topography and location determine localized climates. There are two principal wind directions, which strongly influence the rainfall patterns: southeast from May to October and northwest from December to March.

April and November are transition months. However, high mountain barriers across the path of these winds induce heavy orographic convective rainfall on the northern and southern slopes in the highlands themselves. Thermal convective rainfall is characteristic of the Fly and Sepik lowlands.

Average rainfall varies from one location to another. On the mainland, the mean annual rainfall ranges from less than 2 000 mm along the coast to more than 8 000 mm in some mountain areas. The island groups to the north and northeast receive an average annual rainfall between 3 000 and 7 000 mm. Areas lying southwest of the Fly River, west of Lae in the Markham valley, receive less than 2 000 mm/year. The Port Moresby coastal area receives least rain with less than 1 000 mm/year.


PAPUA NEW GUINEA
Legend
International Boundary
Administrative Boundary
Capital, Regional Capital, Town
River
Lake
Dam
0 50 100 200 300 km
Albers Equal Area Projection, WGS 1984
FAO - AQUASTAT, 2011
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North Pacific Ocean
South Pacific Ocean
Solomon Sea
Bismarck Sea
Gulf of Papua
Arafura Sea
Torres Strait
INDONESIA
AUSTRALIA
SOLOMON ISLANDS
NORTH SOLOMONS
ADMIRALTY ISLANDS
Bismark Archipelago
NEW IRELAND
EAST NEW BRITAIN
WEST NEW BRITAIN
WESTERN HIGHLANDS
EASTERN HIGHLANDS
CHIMBU
MOROBE
GULF
CENTRAL
NORTHERN
MILNE BAY
NATIONAL CAPITAL DISTRICT
MANUS
MADANG
ENGA
SOUTHERN HIGHLANDS
EAST SEPIK
WEST SEPIK
WESTERN
Vanimo
Aitape
Wewak
Angoram
Madang
Kundiawa
Goroka
Mount Hagen
Mendi
Kiunga
Daru
Kerema
Bulolo
Wau
Lae
Kokoda
Popondetta
Port Moresby
Alotau
Kimbe
Rabaul
Namatanai
Kavieng
Lorengau
Buin
Arawa
Panguna
Sepik
Ramu
Purari
Fly
Lake Murray
Yonki
Markham
Bumbu
Laloki
Karkar Island
Long Island
Umboi Island
Manus Island
Mussau Island
New Ireland
Buka
Ireland
Bougainville

TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2009	46 284 000	ha
Cultivated area (arable land and area under permanent crops)	2009	960 000	ha
• as % of the total area of the country	2009	2	%
• arable land (annual crops + temp fallow + temp meadows)	2009	260 000	ha
• area under permanent crops	2009	700 000	ha
Population			
Total population	2009	6 703 000	inhabitants
• of which rural	2009	88	%
Population density	2009	14	inhabitants/km^2
Economically active population	2009	2 949 000	inhabitants
• as % of total population	2009	44	%
• female	2009	49	%
• male	2009	51	%
Population economically active in agriculture	2009	2 065 000	inhabitants
• as % of total economically active population	2009	70	%
• female	2009	55	%
• male	2009	45	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2009	7 893	million US$/yr
• value added in agriculture (% of GDP)	2009	36	%
• GDP per capita	2009	1 177	US$/yr
Human Development Index (highest = 1)	2010	0.431	
Access to improved drinking water sources			
Total population	2008	40	%
Urban population	2008	87	%
Rural population	2008	33	%

Population

In 2009, the total population was 6.7 million, of which around 88 percent live in rural areas (Table 1). Population density is 14 inhabitants/km^2. Population densities are higher in pockets such as Chimbu, Western Highlands and Eastern Highlands province. The annual population growth rate was 2.5 during the period 1999-2009.

In 2008, access to improved drinking water sources reached 40 percent (87 and 33 percent for the urban and rural population respectively). Sanitation coverage was 45 percent (71 and 41 percent for the urban and rural population respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2009, the total population economically active in agriculture was around 2 065 000 inhabitants, amounting to 70 percent of the economically active population. Of the total population economically active in agriculture, 55 percent are women. In 2009, the gross domestic product (GDP) was US$7 893 million of which agriculture accounted for 36 percent (Table 1).

WATER RESOURCES AND USE

Water resources

Geologically, Papua New Guinea is a young country. The presence of high mountain ranges and abundant rainfall leads to high runoff over most of the country.

There are nine hydrological drainage divisions (basins). The largest river basins are the Sepik, Fly, Purari and Markham. Even though the Sepik has the lowest annual discharge, it has the largest catchment area, 78 000 km^2, followed by the Fly River with 61 000 km^2, Purari with 33 670 km^2, and Markham with 12 000 km^2. The other catchments are less than 5 000 km^2 in area and very steep.

The internal renewable water resources are an estimated 801 km^3/year (Table 2). As the country has an abundance of surface water resources and as there are few large-scale consumers, groundwater resources have not been developed. However, there is evidence that groundwater is being used increasingly as a source of reliable high-quality water. In 1974, a surveyed 34 percent of the villages relied on groundwater from boreholes, dug-wells or springs. In the 1970s and 1980s, groundwater was developed for urban water supply schemes in seven major towns. Groundwater resources have not been assessed but it is assumed that most groundwater returns to the river systems and is therefore included in the surface water resources.

There are 5 383 mostly small natural freshwater lakes, only 22 have a surface area exceeding 1 000 ha. Lake Murray is the largest with a surface area of 64 700 ha.

In 1986, there were three dams over 15 m high. The gross theoretical hydropower potential for Papua New Guinea is 175 000 GWh/year. In 1990, the total installed capacity was 163 MW and the annual generation was 438 GWh. In 2008, of the country's total power generating capacity of 580 MW, hydropower comprises 220 MW (ADB, 2008). The Sirinumu dam,

TABLE 2
Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	3 142	mm/yr
	-	1 454 000	million m^3/yr
Internal renewable water resources (long-term average)	-	801 000	million m^3/yr
Total actual renewable water resources	-	801 000	million m^3/yr
Dependency ratio	-	0	%
Total actual renewable water resources per inhabitant	2009	119 499	m^3/yr
Total dam capacity	2009	665	million m^3
Water withdrawal			
Total water withdrawal	2005	392.1	million m^3/yr
- irrigation + livestock	2005	1	million m^3/yr
- municipalities	2005	223.5	million m^3/yr
- industry	2005	167.6	million m^3/yr
• per inhabitant	2005	64.3	m^3/yr
Surface water and groundwater withdrawal	2005	392.1	million m^3/yr
• as % of total actual renewable water resources	2005	0.05	%
Non-conventional sources of water			
Produced wastewater		-	million m^3/yr
Treated wastewater		-	million m^3/yr
Reused treated wastewater		-	million m^3/yr
Desalinated water produced		-	million m^3/yr
Reused agricultural drainage water		-	million m^3/yr

which was officially opened in 1963, provides water for consumption and electricity for Port Moresby (NLA, 1963). The Yonki dam, a 60 m high dam of zoned earth-fill construction, is a hydroelectricity dam located on the Ramu river in Eastern Highlands Province. In 2009, total dam capacity has been estimated at 665 million m^3.

International water issues

In 1973, an agreement was enacted between Australia (acting on its own behalf and on behalf of Papua New Guinea) and Indonesia concerning administrative arrangements with regard to the border between Papua New Guinea and Indonesia, which involved the Sepik basin (of which 97 percent of the area lies in Papua New Guinea and 3 percent in Indonesia) and the Fly basin (of which 93 percent of the area lies in Papua New Guinea and 7 percent in Indonesia) (UNEP and FAO, 2002).

Water use

In 2005, the total water withdrawal was estimated at about 392 million m^3, of which about 1.0 million m^3 (0.3 percent) for agriculture, 223.5 million m^3 (57.0 percent) for municipalities and 167.6 million m^3 (42.7 percent) for industries (Table 2 and Figure 1).

IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

Subsistence agriculture is the largest single economic activity. Most of the crops are rainfed and there is very little irrigation. There is evidence that simple flood irrigation techniques began in the highlands at least 450 years ago. The traditional methods of water application include:

- Simple flooding, where water is led to the upper edge of the garden and then circulates down, usually with wood or stone barriers to slow the flow. This acts to control erosion and trap sediments. In some cases, rough terraces are constructed directly in small stream beds. This is a highland practice found in Enga, Madang, Western Highlands, Eastern Highlands and Morobe provinces. Irrigated garden areas are generally small.
- The pondfield system, where the planted area is an artificial pond through which water is kept constantly flowing. The system is reported on the Mussau islands.
- Corrugated or furrow irrigation, where water is applied to the ground in small, shallow furrows so that it soaks laterally through the soil, wetting the area between the corrugations. This system is used in west New Britain and Bougainville.

A FAO study in 1986 identified a land area of 36 000 ha as agronomically suitable for irrigated rice production (Table 3). A commercial company in the Markham-Ramu valley introduced limited supplementary irrigation early in its development to establish seed cane nurseries and initial wetting of plant cane to promote germination. However, the project was later abandoned for economic reasons.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

The major government institutions involved in the water resources and irrigation sector are:

- Department of Environment and Conservation (DEC), which is responsible for the management and protection of the country's water resources, pollution control, water-related laws and regulations, and their enforcement. Its Water Resources Management

Branch is responsible for the management, conservation and control of the natural water resources. The Branch's policy states that the role of the Bureau is: "To monitor, manage and control the country's water resources in an effective and efficient manner for the benefit of the community, as stipulated in the Water Resources Act 1982". The Hydrological Services Branch maintains a network of hydrological stations around the country as well as a national hydrological data bank and carries out hydrological data collection analysis and archiving for the government and clients (IPA, 2006).

- Geological Survey of the Department of Mineral Resources (GSPNG), which is responsible for providing advice on groundwater exploration, assessment, management and protection of resources.
- Water Board, which is a statutory organization responsible for water supply and sewerage in 11 towns throughout the country, though not the capital city. The development and management of rural water supply and sanitation has been delegated to the Department of Health since 1987.

Water management

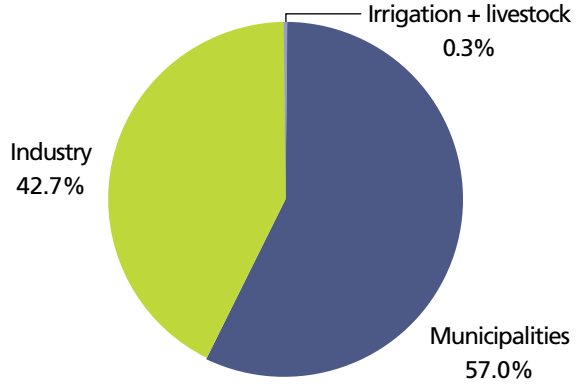
Papua New Guinea is rich in natural resources including water. However, owing to a lack of both human resources and political interest, and to underlying financial constraints, it has not been able to achieve sustainable development in the water sector. The water sector is fragmented and poorly coordinated.

The fourth directive principle of the country's national constitution is to conserve its natural resources (including water), use them for the collective benefit and ensure that they are replenished for the benefit of future generations.

Papua New Guinea is a rural country, where up to 90 percent of the population is reported to depend on subsistence or semi-subsistence agriculture. There is hardly any significant irrigation development programme or proper irrigation policy. This experience has led the Government to seriously consider irrigation development as announced by the Minister for Agriculture and Livestock in a 1997 World Food Day message. According to this message:

- there is a need to develop small-scale village water supply, irrigation and water management;
- the Government and policy-makers need to examine irrigation development as a component of the strategy for increased food production; and
- it is important to establish an irrigation development unit within the Department of Agriculture and Livestock and to develop a national irrigation policy.

FIGURE 1
Water withdrawal by sector
Total: 392 million m³ in 2005



Irrigation was introduced for the first time in a pilot area, under FAO's Special Programme for Food Security, where subsistence farming is the norm.

The Government is aware that the natural water resources are coming under increasing pressure from the large number of resource development projects that are being implemented throughout the country in accordance with the government's overall development policies. There is an increasingly urgent need to ensure that the protection

and conservation of this resource is managed in an effective, efficient and sustainable manner (IPA, 2006).

TABLE 3
Irrigation and drainage

Irrigation potential			36 000	ha
Irrigation				
1. Full control irrigation: equipped area			-	ha
- surface irrigation			-	ha
- sprinkler irrigation			-	ha
- localized irrigation			-	ha
• % of area irrigated from surface water			-	%
• % of area irrigated from groundwater			-	%
• % of area irrigated from mixed surface water and groundwater			-	%
• % of area irrigated from mixed non-conventional sources of water			-	%
• area equipped for full control irrigation actually irrigated			-	ha
- as % of full control area equipped			-	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)			-	ha
3. Spate irrigation			-	ha
Total area equipped for irrigation (1+2+3)			**-**	**ha**
• as % of cultivated area			-	%
• % of total area equipped for irrigation actually irrigated			-	%
• average increase per year over the last 13 years			-	%
• power irrigated area as % of total area equipped			-	%
4. Non-equipped cultivated wetlands and inland valley bottoms			-	ha
5. Non-equipped flood recession cropping area			-	ha
Total water-managed area (1+2+3+4+5)			**-**	**ha**
• as % of cultivated area			-	%
Full control irrigation schemes	**Criteria**			
Small-scale schemes	< ha		-	ha
Medium-scale schemes			-	ha
Large-scale schemes	> ha		-	ha
Total number of households in irrigation			-	
Irrigated crops in full control irrigation schemes				
Total irrigated grain production			-	metric tons
• as % of total grain production			-	%
Harvested crops				
Total harvested irrigated cropped area			-	ha
• Annual crops: total			-	ha
• Permanent crops: total			-	ha
Irrigated cropping intensity (on full control equipped actually irrigated area)			-	%
Drainage - Environment				
Total drained area		1997	0	ha
- part of the area equipped for irrigation drained		1997	0	ha
- other drained area (non-irrigated)			-	ha
• drained area as % of cultivated area		1997	0	%
Flood-protected areas			-	ha
Area salinized by irrigation			-	ha
Population affected by water-related diseases			-	inhabitants

The Water Resources Act (1982) is applied through the issuance of Water Use and Water Investigation Permits and through the declaration of Water Control Districts. Compliance conditions attached to the permits are designed to ensure that environmental quality is adequately protected in order to sustain the value of the resource. The establishment of Water Control Districts is a planning instrument, which is used to provide wider protection of environmental values in key or critical areas.

The Act is implemented by a Water Resources Board, which is composed of representatives from the Division and other Government departments and agencies including Health, Agriculture, Fisheries, Forests, Mining and Petroleum and the various Water Boards that are responsible for water supply and sewerage reticulation. The Water Resources Management Branch is required to provide the Water Resources Board with sound and accurate resource management advice on all water-related matters, and to implement and enforce the decisions and recommendations of the Board under the Act. A key component in the formulation of sound resource management is the availability of accurate information upon which to base reliable assessments. The integrity and efficacy of the Bureau's planning strategies and management programmes, which form the basis of the advice given to the Board, depend primarily on the quality of these assessments (IPA, 2006).

The Branch is responsible for carrying out the administrative and managerial functions of the Water Resources Act 1982. This includes water resource planning allocation, water management programmes, and impact assessment and mitigation strategies. Its functions under the Act include the processing of all Water Use Permits, the inspection and enforcement functions provided for in the Act and the provision of advice and support to the Minister, other government departments and other organizations on water-related issues (IPA, 2006).

Current budget allocations to the water and sanitation sector are relatively small, though the political climate for development in the water and sanitation sector is improving. The Government's 2001-2010 National Health Plan aims to prioritize these essential services with water quality monitoring and promotion of safe waste disposal alongside ensuring that water supplies are sustainable year-round even during droughts.

Finances

The Asian Development Bank (ADB) had made a loan for the water supply and sewerage development project in the urban cities in 1999 and 2000. In 2010, the new Port Moresby Sewerage System Upgrading Project was financed loans from the Japanese Official Development Assistance (Japanese ODA loans, 2010).

Policies and legislation

The Water Resources Act (1982) is the statutory instrument under which the allocation and management of water resources proceed (IPA, 2006).

ENVIRONMENT AND HEALTH

Land uses and waste disposal linked to population growth is affecting the capacity to supply water resources in terms of quantity and quality. Currently, there are few catchments that are directly accessible to the main urban towns and cities. The development of these sources to sustain demand is difficult when settlers are located in critical areas such as at headwaters, causing concern for pollution to the original source, etc. Land uses such as agriculture, cultivating crops that consume more water, deprive other users from benefitting from the same source. Catchments such as Laloki, Wahgi and Bumbu are overstressed with poor quality yields and high demand from various users. Further, there are no proper catchment management plans that would dictate the land-use type in the area and equally distribute water resources.

The constant increase in population has pushed communities and settlements to move into catchments that could not support different agricultural land uses, causing stress to the environment and water resources. Clearing of riverbanks are causing increasing erosion and depositing them into waterways (SOPAC, 2007).

More than 87 percent of the population is rural. Sewerage systems have been developed mainly in Port Moresby and urban cities. The sewerage systems were developed by Australia, which was governing the country, in the 1960s to the early 1970s before independence. They were constructed in the inland area of Port Moresby, and were extended in 1999 and 2000 in urban areas, Mount Hagen, Madang, etc., supported by a loan from the ADB. In Port Moresby, where the population is concentrated, three sewage treatment plants are in operation (Waigani, Gerehu, and Morata), which serve a population of 90 000 of the inland area of Port Moresby, which has a total population of 290 000. The treated wastewater quality of those sewage treatment plants is generally good.

However, some of the facilities need repair because they are ageing. On the other hand, there is no sewage treatment plant in the coastal area of Port Moresby, where 67 000 people are living. For this reason, sewage is once pre-treated in septic tanks and then discharged into the ocean through undersea discharge pipes, or discharged by underground seepage. The current quality is way above the standard tolerance value, 23-2 400 MPN/100ml of coli bacteria (environmental standard in Papua New Guinea: 200 MPN/100ml), 1.4-4.2 mg/litre of nitrogen (no standard in Papua New Guinea, 0.3 mg/litre for standard in Japan), 0.21-0.69 mg/l of phosphorus (no standard in Papua New Guinea, 0.03mg/litre for standard in Japan).

Discharge of such sewage of insufficient treatment to the ocean is causing water contamination in the coastal area, and is destroying the ocean environment including bleaching coral reefs, as well as causing deterioration of the sanitary environment of the local residents and affecting their health, especially those living on the sea. The ratio of water-borne diseases in the coastal area is higher than in the other areas. Average morbidity from diarrhoea is 31 percent in the coastal area, while 5 percent in the city (Japanese ODA loans, 2010).

The Japanese ODA loans financed a new project in 2010, called Port Moresby Sewerage System Upgrading. The objective of this project is to develop sewerage facilities in the coastal area of Port Moresby in order to provide sewerage services to the area, prevent the discharge of contaminated water to the coastal waters, thereby establishing a sanitary living environment of the area, as well as to improve the residents' living environment and activate the industries (Japanese ODA loans, 2010).

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

A main concern in Papua New Guinea is to develop a policy to regulate activities within critical catchments and provide equal distribution of the resources to all users (SOPAC, 2007).

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