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Government of Papua New Guinea

Programme Proposal:

**Capacity Building and Institutional Strengthening in
Development and Management of Inland Aquatic
Resources**

Phase One

**FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS
Rome, 1997**

This report was prepared during the course of the project identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

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EXECUTIVE SUMMARY

P.N.G. is not a “small Pacific Island State”, but in fact has a land area greater than that of, for example, Germany. P.N.G.’s official population census confirms that most people in P.N.G. live inland and have no direct access to coastal/marine resources. The five landlocked highlands provinces alone account for 37% of the nation’s population. Amongst the “coastal” or “islands” provinces, in most the majority of people also live inland. In total, 87% of the people of P.N.G. inhabit inland areas and their aquatic resources are in freshwater, not the sea. P.N.G. has two of the world’s largest river systems (the Sepik & Fly) and a number of other substantial rivers. A number of freshwater habitats are worthy of listing as World Heritage Sites. The country has over 5,000 lakes. Literally vast areas of freshwater swamps occur in most lowland areas. Areas at higher altitudes, besides having numerous lakes, are riddled with rivers generally in excellent condition. It is hard to move far on land in P.N.G. without coming across impressive freshwater habitats - in fact they are generally a major obstacle to land travel in most regions. Where these freshwaters are accessed by sufficient people, almost without exception, they support important fisheries. Table 1 provides a brief summary of population distributions and major aquatic resources by province.

Currently, catches of fish from inland (freshwater) areas total approximately 13,500 tons per annum; which is actually quite low and indicates substantial scope for improvement. All of this fish is caught by Papua New Guineans. The fishery is extremely varied and involves not only subsistence fishing but includes substantial fully-fledged commercial artisanal operations. The fishery has all, perhaps more, of the facets of the marine sector except large-scale industrial operations. There are even substantial freshwater fisheries for crustaceans (including freshwater prawns), molluscs and reptiles (including turtles). A considerable proportion of the catches are transported to coastal urban centres for sale.

The total freshwater catch exceeds P.N.G.’s coastal catch which is about 9000 tons annually (excluding P.N.G.’s major industrial fisheries, mainly for tuna, which are operated by foreign fleets). The economic value of freshwater catches is in excess of the annual revenue from P.N.G.’s entire industrial/commercial fisheries sector (including revenues from tuna). Despite their importance, previous inputs into the management and development of P.N.G.’s freshwater resources have been minimal. The current programme proposal, if implemented, would be the only significant activity in support of inland fisheries in the entire country as of 1997.

P.N.G.’s needs an annual increase in domestic fish supply of about 500 tons per year just to maintain current per caput supply (consumption) in the face of a population growth rate of 2.3% (1100 tons per year to do the same without increasing fish imports). These requirements are based on 1990 figures, i.e., since then an increase of about 7,700 tons is already required. Most of the domestic fish production in P.N.G. (i.e., fish caught and consumed by Papua New Guineans) arises from freshwaters. Due to the extent of the inland resources, but more importantly the population distribution, it can be expected, given appropriate management interventions, that the inland fishery will make the greatest contribution to future needs for increased fish supply.

Government policy includes (i) improvement of government services at national and provincial levels, especially to rural areas, and (ii) improvement of national food security. Government fisheries policy includes (i) the supply of fishery products from local sources to meet local demand, (ii) import replacement (especially for imported fishery produce currently running at three times the value of exports), (iii) maximising the involvement of Papua New Guineans in fishing, and (iv) the improvement of fish supply in rural areas. Consideration of the distribution of people in P.N.G., the availability of aquatic resources, current and potential fishing activities and development priorities necessitate that a major focus of P.N.G.'s fisheries programme must be to manage and develop inland aquatic resources. Notably, none of the recent initiatives in the commercial/industrial marine fishery sector, particularly P.N.G.'s mackerel canneries and proposed tuna canneries, will either reduce imports or improve domestic fish supply: the mackerel used is imported and Papua New Guineans are unlikely to adopt canned tuna *en masse* and the sole purpose of the cannery is for export. However, unquestionably, inland fisheries are crucial to national, regional and provincial food security.

It is conservatively estimated that the potential biological fish production from P.N.G.'s freshwaters, assuming adequate and appropriate management inputs, can be sustained at over 400,000 tons per annum. Making allowances for likely future trends in exploitation patterns the target for increased catches from P.N.G.'s freshwaters is from the current 13,500 tons per annum to in the region of 50,000 to 60,000 tons by the year 2025. An increase from 13,500 tons to 27,000 tons will be required over this period simply to maintain per caput catches/consumption of fish in inland areas (because the population will double over this period). The excess (from 27,000 t 60,000 tons) is to improve per caput catches (hence both nutrition and income) and reduce demand for imports.

These production targets are realistic, attainable and could easily be surpassed, but will require adequate management inputs and appropriate development initiatives to be achieved. P.N.G.'s inland fishery has the strategic advantage of not only having a significant resource but, more importantly, has the population which can, and does, fish the resource. Inland fisheries have excellent access to the major domestic market (or demand) for fish - simply because the fish is caught where the demand is (i.e., inland).

Threats to the sustainability of inland fisheries arise mainly from activities in other sectors. Following world trends, the degradation of freshwaters, including water pollution and habitat destruction, is already becoming apparent in P.N.G.. The main problems arise from unsustainable agriculture, mining or forestry practices affecting freshwaters; in addition to plain abuse of waterways by using them as cheap ways of disposing of effluents and refuse, especially in urban areas. Without improved and appropriate management inputs, this trend will seriously undermine P.N.G.'s natural freshwater assets and the security and social development of the countless communities they support.

This programme proposal aims to strengthen P.N.G.'s ability to manage and develop its inland aquatic resources - the rivers, streams, swamps, lakes and reservoirs, together with the important fisheries they support. The main focus of the programme is to strengthen existing technical capacities and infrastructures in provinces. Although provinces differ in the extent of their fisheries, freshwaters are important in all of them. Therefore, the proposed programme will target all of P.N.G.'s 20 provinces (including NCD which also has a substantial inland fishery).

As for marine fisheries, perhaps even more so, the management and development of freshwater fisheries requires a large amount of technical expertise in various fields: these include biology/ecology, fish processing, gear technology, marketing, resource development and management, socio-economics, environmental and fisheries management etc. A number of P.N.G.'s major freshwater resources are also shared between several provinces (e.g., some of the larger rivers). Expertise is required in the management of fisheries for sustainability in coldwater rivers in higher altitude areas (which includes the five highlands provinces but also most coastal provinces, all of which extend into the interior), larger tropical rivers and swamps in lowlands, and lakes (including reservoirs) in all areas.

Following the Organic Law on Provincial and Local Government Reform, P.N.G.'s provinces now have a greater role in the management and development of resources. However, in view of the limited public sector capacity in individual provinces, it is anticipated that provinces will wish to pool resources for overall management purposes. Some provinces may focus on management of lake fisheries, others on rivers; some may specialise in processing and marketing, others on biology/ecology etc., but provinces will need access to expertise in all technical areas. Whilst the overall expertise within the country can be enhanced in this fashion, provinces will be able to implement their own localised development programmes, as and where appropriate, under a framework of improved management and policy guidelines and better access to technical support.

The programme will require a modest core of staff to co-ordinate training and capacity strengthening across provinces and to act as a central source of management, policy and technical advice. A suitable infrastructure for this co-ordination and planning role may be the establishment of an institute for the management and development of inland aquatic resources. Most countries with substantial freshwater resources have institutes devoted specifically to their management and development. There are also several precedents for such institutes in P.N.G. (e.g., forestry research, coffee, cocoa, coconut, the new national agricultural research institute etc.). The institute may have a small core of permanent technical/managerial staff but will obtain most of its human resources by involving counterparts from provinces.

The concept of the institute refers to the infrastructure - not a physical structure or building. It is intended that most staff associated with the institute will remain in provinces except for periods of training at the institute (or elsewhere). The institute will serve to facilitate appropriate management and development in provinces and act as an appropriate co-ordinating mechanism between them.

The institute's functions will include research but will focus mainly on economic and social development based upon the sustainable exploitation of inland (freshwater) aquatic resources. Aquaculture considerations in freshwater may, subject to the feasibility study, be included under the mandate of the institute in a fashion compatible with the relative (lower) importance of that sector and subject to government policies.

Phase one of the proposed programme centres on the development of appropriate programmes and activities for the benefit of provinces. It includes a feasibility study for the institute (or alternative infrastructure if more appropriate) which will simply be a mechanism of implementing such programmes. Provinces will be fully involved with appropriate planning processes to ensure the programme remains responsive to their requirements.

The programme will initially be funded from national government sources (including the possibility of aid) as part of transitional arrangements under the Organic Law on Reforms to Provincial Governments. In effect, phase one will be to create an infrastructure which will support appropriate management and development in provinces and enable recent changes to the government system to be effected. Once established this infrastructure (the institute or alternative mechanism) will serve as a vehicle for obtaining further investment in the sector. It is anticipated that following its establishment the institute (or alternative infrastructure) will be controlled or managed largely by provinces but may be funded from central government (or aid) sources. The initial requirement from provinces is:

- (i) an indication of general interest/support for the programme proposal, and
- (ii) an indication of the number of existing provincial staff that may, in the longer-term, be allocated to the development area in question, irrespective of their intended technical area and assuming that appropriate training and facilities were made available.

Provinces are not required to make any commitment of funds from provincial sources at present.

It is anticipated that phase one will run for two years and will include a feasibility study for the most appropriate way of supporting, co-ordinating and strengthening technical capacities in provinces. It is envisaged that this will be followed by an at least five year phase two programme which will focus heavily upon training and capacity building in provinces in order to strengthen the various technical areas as identified and prioritised under phase one.

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COUNTRY BACKGROUND

Papua New Guinea includes the eastern half of the world's largest tropical island (New Guinea) with associated smaller islands of the Bismarck Archipelago, northernmost Solomon Group and numerous other islands. The land area covers about 462,840 km², mostly on the large mainland landmass (New Guinea). The nation is situated between the equator and 12 degrees south latitude, but most of the main landmass is situated between 3 and 8 degrees south. The main island and most larger islands have a rugged geography, generally with steep mountain ranges leading down either to a relatively narrow coastal fringe or into major river floodplains dominated by lakes and swamps. The region experiences very high rainfall. Some areas receive 10 metres per year, and the average ranges between 2000 and 4000 mm according to region. Rainfall, in general, is also very reliable.

Whilst popularly recognised for its marine and terrestrial environments the country also lays claim to some of the world's finest relatively unspoilt freshwater environments. The island of New Guinea contains three of the world's largest rivers based on mean discharge. Two of these, the Fly and Sepik, occur in P.N.G. and the discharge of either alone exceeds the run-off of freshwater from the entire Australian Continent.

Contrary to the popular perception of P.N.G. as a small "South Pacific Island State", in fact, by comparison, P.N.G. has a land area 1.9 times larger than the United Kingdom, 1.25 times larger than Germany, and 1.7 times larger than New Zealand. It is 16.5 times bigger in land area than the largest "other" South Pacific island nation - the Solomon Islands. Based upon P.N.G.'s official statistics (National Statistical Office 1994) approximately 87% of the country's population do not inhabit the narrow coastal fringe¹ at all but actually live inland (Table 1). The five landlocked highlands provinces alone account for approximately 37% of the population (Table 1) and these have no access to marine resources at all. Of the other provinces only the National Capital District, i.e., essentially Port Moresby (itself with a higher population than most provinces), Milne Bay and Manus have a higher coastal than inland population (Table 1). Most provinces have impressive freshwater resources including those often classified as "coastal" (Table 1). Whilst Madang, for example, has a deserved reputation as a coastal town with attractive marine/coastal environs, Madang Province itself, in fact, has probably the most diverse freshwaters in P.N.G. ranging from the occasionally snow-capped summit of P.N.G.'s highest peak, Mount Wilhelm (4509 m), to the vast floodplains of the Sepik and Ramu Rivers. Other "coastal" provinces also have vast interiors, most reaching to the highest mountain ranges, accompanied by extensive and varied freshwater resources (Table 1).

According to Frielink (1983), there are a total of 1,944 rural coastal villages in P.N.G. This compares with 2878 rural villages in the Sepik-Ramu basin alone (Coates & Mys 1989) -

¹ The definition of "coastal" is obviously open to wide interpretation. Here it is meant living in an area with direct access to marine resources. Where measured directly is assumed here to mean having a house located within 5 km of the sea. However, P.N.G.'s strict traditional resource ownership systems mean in reality that generally only those people living actually adjacent to the sea (i.e. within a few meters) actually have access to marine resources - and often only a proportion of those actually have access rights. Therefore, the "coastal" population mentioned here is actually a gross over-estimate. The definition of "inland" is simpler and means anywhere not considered coastal.

an area which accounts for less than 25% of P.N.G.'s interior. Overall, rural villages inland probably outnumber those on the coast by a factor of ten to one.

The extremely high rainfall in P.N.G. provides the country with an impressive array of freshwater habitats including over 5,000 individual lakes and very extensive river systems. It is impossible to travel far over land in P.N.G. without coming across freshwater habitats in one form or another. In fact, it is perhaps the extent of these resources that has, more than anything, restricted the development of road networks in P.N.G. Even a modest P.N.G. river presents a significant challenge for engineers to cross; non of the larger rivers have yet been bridged. All highlands regions have an intricate network of rivers, often accompanied by swamps, which gradually join and enter large rivers as they descend into lowlands, usually associated with extensive areas of lowland swamps and flooded forest along their floodplain belt. A brief summary of freshwater resources by province is provided in Table 1.

P.N.G. had a population of about 4,121,000 in 1990 (Table 1) with an annual growth rate of approximately 2.3%. The population doubling time is currently about 30 years. Population by the year 2025 is expected to be in the order of 7.8 million people. The gross national product is approximately \$US 3,500 million with a GNP per caput of \$US 822. There is, however, a large disparity of incomes between the minority in gainful employment and the majority. In 1995, GNP growth was estimated at -4.7%. Over the past decade GNP per caput has decreased.

The urbanisation rate is a low 15.4% (Table 1), i.e., of the total population of P.N.G., only about 15% live in urban centres (in other words - about 85% live in rural settings). Approximately one third of the urban population of some 634,555 live in the National Capital District (Port Moresby). Outside of urban areas villages are very small and widely dispersed. Most people live in rural locations, in small scattered villages throughout the country. Lifestyles are dominated by subsistence activities including gardening, hunting and fishing. Formal agriculture chiefly involves small-holder production of tea, coffee, cocoa, copra, rubber and oil-palm (non of which, incidentally, provide food for a growing population).

Socio-economic conditions are poorer than the gross statistical indicators suggest. Mining, logging, and oil industries, for example, employ negligible numbers of people but account for a large proportion of GNP. Agriculture employs the greatest numbers but involvement in formal agriculture is limited to those populations with access to arable land. Only about 5% of the total land available is effectively arable including those areas where only low intensity use is possible. Less than 1% of the land area is currently under formal agriculture and most of the remainder is already in cultivation by small-holder or subsistence farmers.

The bulk of the population live subsistence lifestyles in rural areas and for most intents and purposes are outside the formal economy. Male life expectancy is currently 55 years. Infant mortality has recently actually increased to 92 per 1000. Maternal mortality is very high at 1%. In large tracts of the country socio-economic conditions are much worse than these average indicators, particularly in the interior.

Table 1: Population numbers, Provinces and inland aquatic resources in P.N.G.. All population figures are estimates from the 1990 census which includes details of where the people live.

PROVINCE	TOTAL POP. 1993	% POP. LIVING INLAND	% POP. LIVING IN RURAL AREAS	ESTIMATED TOTAL POP. LIVING INLAND	MAJOR INLAND AQUATIC RESOURCES	EXISTING INLAND FISHERIES ²	POTENTIAL FOR INCREASED PRODUCTION FROM INLAND WATERS ²
Western	121,208	85%	82.4%	103,026	Vast rivers and lake systems of the Fly River and its tributaries including P.N.G.'s largest lake - Lake Murray. Bensbach floodplains.	Very Large	Huge
Gulf	75,452	70%	89.9%	52,816	Vast inland habitats, including extensive mangroves, associated with the Turama, Kikori and Purari Rivers. Numerous lakes.	Very Large	Huge
Central	154,989	70%	95.2%	108,492	Coastal streams and rivers including Laloki and Brown Rivers. Extensive mangroves. Numerous lakes. Mori and Kemp Welch wetlands (total 6147 km ²). Lake Kumu wetland. Kuriva River. Lake Iarguma. Aroa, Hisiu and Kanosia lagoons.	Moderate	Large
National Capital	214,677	0	0	0	Waigani Swamp. Brown and Laloki River floodplains	Moderate	Moderate
Milne Bay	174,292	40%	93%	69,716	Rakua wetland (590 km ²). Lake Lavu. Numerous coastal streams, rivers and wetlands and numerous lakes.	Moderate	Moderate
Northern	105,918	85%	85.4%	90,030	Mambare wetland (3441 km ²). Musa wetland (1797 km ²). Numerous rivers and lakes.	Moderate	Moderate
Southern Highlands*	348,450	100%	97.6%	348,450	Extensive rivers of the upper Kikori and Purari Rivers. Numerous lakes including Lakes Onim, Wololo, Wongabi, Kutubu (810 ha) and Kopiago.	Large	Large
Enga*	258,575	100%	98.2%	258,575	Extensive rivers of the upper Strickland (Fly), Purari and Sepik Rivers. Numerous lakes including Lakes Birip, Ipea, Papapali and the Marient Basin. Parago and the Kandep basin. Sirunki wetland.	Large	Large
Western Highlands*	360,022	100%	93.7%	360,022	Extensive rivers of the upper Purari and Sepik Rivers, numerous lakes.	Large	Large
Chimbu*	201,811	100%	96.1%	201,811	Extensive rivers of the upper Purari. Numerous lakes	Large	Significant

Table 1 - continued.....

Eastern Highlands*	330,021	100%	91%	330,021	Extensive rivers of the upper Ramu and Purari catchments. Numerous lakes. Yonki reservoir (1800 ha).	Large	Large
Morobe	417,254	90%	73%	375,528	Markham river floodplain. Ramu River tributaries. Numerous other smaller rivers. Extensive number of lakes. Lake Wanum, Red Hill Swamp	Moderate	Moderate
Madang	277,932	90%	85.8%	250,138	P.N.G.'s most diverse Province extending from the snow capped peak of Mount Wilhelm to the extensive lowland swamps. Includes most of the catchment of the Ramu River extending into the vast Sepik floodplains. Includes numerous very large lakes and several Sepik River tributaries.	Very large	Huge
East Sepik	279,223	95%	89.5%	265,261	Vast floodplains and lakes of the Sepik River including extensive areas at higher altitudes with Sepik tributaries.	Very large	Huge
West Sepik	153,586	90%	91.7%	138,227	Vast floodplains and lakes of the Sepik River including extensive areas at higher altitudes with Sepik tributaries. Considerable section of the upper Fly/Strickland catchment.	Very large	Huge
Manus	36,048	45%	82.3%	16,221	Extensive network of small rivers and swamps. Numerous lakes. Malai wetland (147 km ²). Kelana wetland.	Limited	Modest
New Ireland	95,498	50%	90.5%	47,749	Smaller rivers and associated swamps.	Modest	Modest
East New Britain	203,578	75%	87.8%	152,683	Smaller rivers with associated swamps. Numerous lakes including Lake Hargy (930 ha - shared with WNB). Toru wetland (813 km ²).	Moderate	Moderate
West New Britain	142,909	55%	85.1%	64,309	Smaller rivers with associated swamps. Numerous, and often large, lakes including Lakes Dakataua (48,000 ha), Namo, Hargy (930 ha). Namo wetland (2050 km ²).	Moderate	Moderate
North Solomons	169,045	75%	NA	126,783	Smaller rivers with associated swamps. Numerous lakes including Lake Lehalu (5500 ha). Abia wetland (297 km ²). Empress Augusta Bay wetland (901 km ²).	Moderate	Moderate
TOTAL	4,120,488	84-88%**	84.6%	3,459,641			

¹ "Inland" is defined as not living on the coast.

² Where existing fisheries or potential fisheries are listed as "inoderate" this does not mean that investments and management inputs are still not justified.

* landlocked province - no access to marine resources at all

** Gross figures for percentage living inland are 84%, excluding National Capital District (itself larger than most provinces) the figure is 88%.

FISHERIES SECTOR BACKGROUND

(1) Marine and industrial fisheries

The marine fisheries sector in P.N.G. is often misrepresented. Whilst the country has a vast marine jurisdictional zone (EEZ) of over 2 million km², most of this is inaccessible to the bulk of the population. The majority of P.N.G.'s inshore, mainly coral-reef, resources are unlikely to be exploited in the near future due to a lack of manpower and the costs of moving fish² produce to remote markets, the major one being in inland areas. P.N.G. has jurisdiction over substantial off-shore tuna resources but, currently, the catch is taken almost exclusively by foreign fleets. The estimated catch of approximately 100,000 tons per annum is also processed offshore and few, if any, Papua New Guineans are directly involved with the fishery. Excluding tuna, approximately 9,000 tons of fishery produce are landed in P.N.G.'s marine fishery. Of this, approximately 1200 tons are high value prawns caught by a small industrial fishing fleet, a small amount of lobster and about 1000 tons are sea-cucumbers, the bulk of which are exported. This leaves a marine, chiefly artisanal coastal fin-fish, catch of about 7,000 tons per annum.

There are plans to try to domesticate the tuna fishery by basing the processing operations in P.N.G., thereby increasing revenues. To this effect at least one tuna cannery may potentially start operations in P.N.G. in the near future. It should be noted that the sole purpose of this cannery is for export, although no doubt some produce will be offered for sale domestically. Two canneries presently operate in P.N.G. for the production of canned mackerel to supply domestic demand. Both of these can import fish (the mackerel in question does not inhabit P.N.G.'s waters) and have resulted in increased costs of tinned fish to rural communities which currently depend greatly upon this product in the subsistence diet.

It is the distribution of people that has the greatest bearing on realistic options for domestic fisheries development in P.N.G.; a point which is widely neglected. A dispersed population means a dispersed domestic market. Moving fresh/frozen fish within P.N.G. is very expensive. The urban centres that do exist are also small (including the largest - Port Moresby) and the demand easily saturated if large quantities of fish are landed at one point in time. Once this occurs, there is limited scope to market surplus produce in surrounding areas. Villages are simply too small and widely dispersed making moving fishery produce expensive. Not least, most of P.N.G.'s population is inaccessible by road, that population which has road access has, generally, inadequate economic resources with which to pay the costs of transportation of fresh or frozen fishery produce.

The often promoted concept that major domestic demand (or need) for fresh fishery products can be met through industrialised fishing operations, landing large quantities of fish

² In this document the term "fish" is as defined in the *Fisheries Act* - i.e., it includes other aquatic organisms, besides fish, such as crustaceans and molluscs. This is equally so with freshwaters where crustaceans (e.g. prawns), molluscs (e.g., freshwater clams) and reptiles (e.g., freshwater turtles) are also included as fishery or fish produce. Inland waters also produce significant quantities of aquatic plants as food. Although these are not defined as "fish" they would be included as "inland aquatic resources".

subsequently distributed to the “needy”, is untenable in P.N.G. There are serious doubts about whether this can even be achieved for the major urban centres. Even if it were, less than 15% of the population would be serviced (even assuming it would reach urban centres inland). Such an approach would also undermine P.N.G.’s existing artisanal fisheries at both the coast and inland, which combined already produce in excess of 20,000 tons per annum, with dire socio-economic consequences and quite possibly civil unrest. The net result might be best described as a government subsidised mechanism for destroying self-sufficiency amongst local artisanal fishing communities. Despite this, the suggestion is regularly taken seriously. In relation to canned produce, whilst P.N.G.’s tuna policy is in itself sound, and may likely lead to significantly improved revenues, the concept that it will supply significant amounts of canned fish for domestic consumption (thus reducing demand for imports) is questionable and not in fact the main purpose of the policy itself.

Most informed experts agree that the way to supply the major demand for fishery products in P.N.G. (i.e., relatively cheap produce for the mass population) is to satisfy local demand from local sources. This avoids having to move produce too far and has the considerable advantage of benefiting local communities. This implies small-scale artisanal fisheries which are also labour intensive (hence increasing employment in the sector). Once accepted, this concept implies that demand for produce for the bulk of the population, who live inland, must be met from inland areas (not the coast).

The considerations for high value produce, e.g., prawns/lobster etc., are somewhat different but domestic demand for such products is limited. Equally, the considerations for preserved fish are also different (because it is cheaper to move) - but there is no logical reason why production of preserved fin-fish should necessarily occur at the coast. In point of fact, currently, the inland fishery produces the most preserved fish.

(2) Inland fisheries

The combination of the population distribution, socio-economic conditions and the availability of freshwater habitat result in P.N.G.’s inland fisheries being arguably the most important in the country. Current catches from freshwaters are estimated at 13,500 tons per annum. At a conservative value of K 2.5 per kilogram this represents a net value of K 33.75 million per annum. This is well over twice the current total value of P.N.G.’s entire marine industrial/commercial fisheries sector (including tuna). This freshwater catch is taken entirely by Papua New Guineans and entirely consumed domestically (with the exception of a small amount of barramundi). Therefore, although inland fisheries are still relatively poorly developed, production already exceeds that from coastal regions. Whilst mean catches per fisherman may be much lower inland than at the coast, the much higher number of participants in the fishery results in the greater total catch.

Neither is the importance of inland fisheries limited to rural areas of the interior. For example, despite Madang town being located adjacent to some of the best marine fishing grounds in the South Pacific, up to 43% of the annual landings at the Provincial fisheries depot come from freshwater (Table 2). In fact, these freshwater fish originate from the lower Ramu River and are brought approximately 200 km by road in order to supply a demand not met by the more locally advantaged marine fishery. Similarly, in Port Moresby, the capital, whilst the majority of fish landed at Koki market comes from adjacent coastal fishing grounds, that

landed at other markets, at Waigani, Erima & Gordons, comes almost exclusively from freshwater (chiefly Brown River and Waigani Swamp). This flow of fish from inland areas to the coast is contrary to what many might expected. Some of the reasons for these circumstances are:

- (i) because of the more deprived socio-economic circumstances and limited economic opportunities inland, compared with the coast, inland fishermen can be more highly motivated,
- (ii) most people living in coastal urban centres originally migrated there from the interior and, therefore, prefer freshwater to marine fish, and
- (iii) in general, freshwater fish tends to be cheaper than marine produce (but not always).

Table 2. Freshwater fish as a proportion of total fish landings at the Provincial Fisheries Depot in Madang. To fully appreciate these figures it should be noted that the depot is less than 5 meters from the marine fishing grounds but the freshwater fish is caught over 200 km away and brought to the depot by road. (The freshwater fish is almost entirely tilapia from the lower Ramu River floodplain).

Year	Total landings (kg)	Total freshwater fish (kg)	% freshwater fish
1990	5,800	297	5.1
1991	13,892	890	6.4
1992	25,694	11,033	42.9
1993	14,728	3,713	25.2
1994	20,569	4,358	21.2
1995*	27,425	8,796	32.1

* estimated based on landings to Oct. 2 1995.

In contrast, with the exception of limited quantities of high value produce such as prawns and lobster, there are few, if any, examples of domestically caught marine fishery produce being supplied to meet consumer demand outside areas where it was caught. In fact, a large proportion of the frozen marine fish sold in urban centres is imported.

For over 40 years, various fisheries development policies have assumed that the coastal fishery will “feed” inland populations. Many tens of millions of Kina have been “invested” as a result of this concept. The facts belie this assumption. In reality, coastal fisheries are having problems supplying fish to coastal regions let alone elsewhere and, in fact, the net flow of produce is likely from inland waters to the coast.

Any significant advances in increased domestic landings (supply) of fish in P.N.G. need to be based on the concept of overall improvements in average catch (landings) per person

within communities, regions and nationally (whether in the coastal or inland fishery). Large catches by individuals, in national terms, are relatively unimportant. What will greatly increase fish supply is modest improvements in catches applied across large numbers of people. Whilst this approach to increasing production is well entrenched in the agriculture sector, the concept has yet to be acknowledged in the fisheries sector in P.N.G. Since the majority of people live inland, this approach means that inland fisheries must be developed in order to make any significant headway. For example, if the mean catch per person living inland is increased by only one kilo per year (hardly excessive), the net increase in fish landings would be 3,600 tons per annum. Such improvements are also relatively inexpensive to achieve. Recent improvements in fish catches in Yonki Reservoir (Eastern Highlands Province), undertaken as a side line under a larger project, had a non-recurrent modest cost of only hundreds of Kina but have already resulted in sustainable increased landings of 60 tons per annum. Strikingly, there are examples of tens of millions of Kina being invested in coastal fisheries to produce smaller returns.

(3) Aquaculture

Despite substantial investment over the past 40 years, current production from aquaculture in P.N.G. is estimated at less than 5 tons per annum. Interest in the sector continues but significant public investments have yet to be followed by greatly increased production (a conspicuous trend through most of the South Pacific). Tantalising projections for production gains are often based solely on technical considerations. Whilst modest theoretical potential exists, there remain significant socio-economic obstacles to aquaculture development in P.N.G. Excessive optimism should be avoided.

Recent government policy is that commercial aquaculture should be private sector driven with only policy, and where feasible technical, guidelines provided by the government. Investment should come from the private sector. Regarding subsistence/rural aquaculture - government policy is that capture fisheries, where necessary improved through fish stock enhancement (stocking), have priority. This is a sensible approach given that inland capture fisheries have a current production of about 13,500 tons per annum of which at least 7,000 tons comes from previous stock enhancement activities. This compares with less than 5 tons from aquaculture, despite the much greater public investment in that sector. Inland catches are also rapidly increasing compared with a stagnant, or rather still-born, rural aquaculture sector. However, significant inconsistencies remain at government level between policies and actual activities and investment in the aquaculture sector.

If aquaculture does develop in P.N.G., the availability of suitable habitat, technology and world-trends suggest that developments in freshwaters, not the sea, will dominate. Despite this, it is surprising how often mariculture (sea-culture) is promoted in P.N.G., invariably by consultants who often, putting it kindly, are less than impartial.

Aquaculture and inland capture fisheries overlap in the area of fish stock enhancement and stocking. The latter require the efficient operation of hatcheries and stocking itself is defined as an aquaculture activity. Equally, the use of exotic species in pond culture leads to inevitable escapes into the wild and, therefore, always results in stock enhancement activities which can have impacts upon capture fisheries. P.N.G. can count itself lucky that, so far, such escapes have proved mainly beneficial but it would be unwise to assume this state of affairs will

continue. Close co-ordination and liaison between inland aquaculture development and inland capture fisheries is required in order to promote rational management policies for inland aquatic resources. For both, the use of exotic species should be managed appropriately. This should apply equally to P.N.G. native species moved to areas of P.N.G. where they did not previously occur.

(4) Food balances - imports/exports

Despite the emphasis on fisheries exports, export receipts from the fisheries sector have peaked and troughed since independence in 1975, but have never been significant. In 1993, export earnings totalled K13.2 million. On the other hand, domestic imports of fish products amounted to more than K40 million during the same year. Imports are steadily increasing. In addition to this, considerable quantities of other low-cost animal protein are imported - chiefly cheap cuts of meat from Australia and New Zealand (e.g., lamb-flaps). Unless alternative food supplies are produced domestically, pressures for increased imports of food will escalate with growing population numbers.

(5) Government policy

The two priority areas for government investment in the primary industry sector are:

- (i) improvement of government services at national and provincial levels, especially to rural areas, and
- (ii) improvement of national food security.

The overall fishery policy of the government is aimed at:

- (i) increasing revenues to the country, especially through the domestication of currently foreign dominated industrial fishing operations and increasing exports from the fishery sector,
- (ii) the supply of fishery products from local sources to meet local demand, promoting localised self-sufficiency, especially the commercialisation of artisanal fisheries,
- (iii) the provision of domestic produce to substitute and eventually eliminate imports,
- (iv) maximising the involvement of Papua New Guineans in employment in fishing, and
- (v) the improvement fish supply in rural areas, thereby contributing to improved nutrition and socio-economic well-being.

In relation to the population distribution of P.N.G., and the current level of participation in fisheries, with the exception of the first objective above, all of the others

necessarily imply that P.N.G. will develop and improve its inland fisheries. These are the fisheries that chiefly supply produce on a local basis (because most demand is inland) and offer currently and potentially the greatest scope for improvement.

(6) Regional inputs

P.N.G. is the only country in the South Pacific region (excluding Indonesia) that has such significant inland fisheries (although Solomon Islands and Fiji both have notable inland fisheries). Therefore, neither of the two major regional fisheries agencies (South Pacific Commission and Forum Fisheries Agency) have any involvement in the management or development of inland fisheries. Inland food fisheries are also limited in Australia (which has very poor freshwaters since it is mainly desert) and New Zealand. Freshwaters there are managed mainly for recreation. P.N.G.'s closest neighbour, Indonesia, has substantial inland fisheries but technical co-operation between the two countries in fisheries matters appears non-existent despite P.N.G.'s major river basins, the Fly & Sepik, being shared (a problem which would be greatly alleviated if P.N.G. were to join the Asia-Pacific Fisheries Commission, APFC).

REQUIREMENTS FOR DOMESTIC FISH SUPPLY

The realities of fisheries development in P.N.G. are stark and are best illustrated by considering per caput fish supply (and consumption) in the country.

Based on the latest figures (1990), P.N.G.'s population was approximately 4,100,000 people. Domestic fin-fish production is approximately 13,500 tons for the inland fishery and 7,000 tons for the coastal fishery. Discounting the fact that some of the latter is exported, this gives a per caput fresh fish supply of 5.0 kg per person per year. Total fish consumption is higher when the large amounts of imported fish are included. The most recent figures for imports (1990) are about 25,000 tons at a net value of K40 million. The latter figure does not include large amounts of imports of other cheap animal protein such as beef and lamb flaps, which, combined, are just as substantial.

P.N.G.'s current population growth is 2.3%. Therefore, P.N.G. needs to increase domestic fish supply by about 500 tons per year just to maintain per caput fish consumption at current levels. In order to maintain current imports at the same level, domestic supply needs to increase by about 1100 tons per annum. Were there to be a policy to reduce imports substantially (to negligible, say over 25 years) domestic supply would need to increase by about 2200 tons per annum.

These figures are, of course, rough estimates but accurate for the present purposes. They serve well to illustrate the challenge facing P.N.G.'s fisheries sector. Perhaps most enlightening of all: these figures apply to 1990 and it is now 1997. Therefore, to maintain 1990 consumption levels (without increasing imports) would have required an increase in domestic supply of 7,700 tons to date. Whether this was achieved nobody knows, there is no serious attempt to collect the data required. In all likelihood domestic supply of fish (fish caught and eaten by Papua New Guineans) is declining on a per caput basis and demand is being met by increased imports.

Due to resource availability, but more especially the population distribution, P.N.G.'s freshwaters are well placed to supply the requirements for increased domestic fish supply - provided appropriate management inputs are applied.

RECENT CHANGES TO NATIONAL AND PROVINCIAL GOVERNMENTS AND THE PUBLIC SERVICE SECTOR

As of 1997, as a result of the Organic Law on reforms to Provincial Governments, most fishery programme activities will be implemented by Provincial Authorities. The National Fisheries Authority (NFA) will, ostensibly, still control licensing and provide advice on suitable management policies to the Provinces. However, the NFA has already indicated that it will not make a major commitment to inland fisheries, if any at all. The reason for the latter is NFA's intention to concentrate on "revenue generation" (i.e., chiefly the industrial fisheries for tuna, prawns and lobster). The development and management of inland fisheries will, therefore, be in the hands of the Provinces but there will be no central source of management advice, rational policy or technical expertise.

IMPLEMENTATION OF THE PROJECT

In view of the above, it is suggested that one option for administering this project proposal will be to place it under the National Planning Office, within the Department of Finance and Planning. Such a move is consistent with the transitional arrangements under the Organic Law on Reforms to Provincial Governments. Eventually, the project will be administered under its own arrangements (see later). This mechanism will enhance the outcome of the Organic Law and enable adequate technical support to the Provinces to be maintained in the interim period. Alternatives to this infrastructural setting do exist but it is difficult to see, without either the commitment nor expertise, how the programme could be effectively administered by the NFA.

CURRENT CAPACITY AND INFRASTRUCTURE FOR THE DEVELOPMENT AND MANAGEMENT OF INLAND FISHERIES

Up until 1996 most management activities for inland fisheries were undertaken by a modest number of staff at the Department of Fisheries & Marine Resources (DFMR). These related primarily to a successful inland fisheries development programme, based on stock enhancement using approved fish species, in the Sepik-Ramu river basin (P.N.G.'s largest river in the north of the country). This programme, which included highlands areas draining into the Sepik-Ramu, included technical assistance from the FAO.

With the ratification of the *Fisheries Act* (1994) in 1995, some of the functions of DFMR were taken over by the NFA. As of January 1997, NFA will have limited, if any, role in the development and management of P.N.G.'s inland fishery.

Currently (early 1997) the NFA has one senior scientist (only part-time) and one junior scientist (currently employed on a casual basis) actively involved in inland fisheries (including

extensive aquaculture or stocking). The junior staff requires further training beyond his current BSc level (+ limited field experience). The senior scientist is trained mainly in aquaculture and has additional duties that will inevitably restrict the attention that can be given to the inland sector. It is uncertain that even these inputs into the management of inland aquatic resources will be maintained by the NFA as the junior scientist has to work within a unit otherwise devoted to aquaculture. This is out of a total staff strength within the NFA of approximately 165. The logic of placing the management of P.N.G.'s largest fishery sector (producing 13,500 tons per annum) as a subservient unit under aquaculture (producing less than 10 tons) is not known.

Currently, only two Provinces (East Sepik and Gulf) have staff actively involved in inland fisheries development. Both of these involve running small processing and marketing plants (although it is government policy that such activities be privatised). None of the provinces have trained staff (including the aforementioned) capable of taking the lead role in the development and management of inland aquatic resources at provincial level.

Needless to say, there is considerable scope for improved technical capacity at both national and provincial level in the relevant fields.

RATIONALE OF THE PROJECT

The project seeks to develop P.N.G.'s inland fishery resources through the strengthening of technical capacity in appropriate provinces in the development and management of inland aquatic resources. In order to achieve this, human resources in provinces will be improved through appropriate training. Physical infrastructures will be improved where necessary. This will provide a core of expertise in each relevant province which will take the lead role in development and management at field (provincial) level.

Ultimately, it will obviously be of benefit for activities in the various provinces to be streamlined and closely co-ordinated. With few exceptions, major freshwater resources are shared between provinces. There is significant potential for provinces to pool and share human resources, experiences and facilities. This is especially so where provinces share the same freshwater resource systems (e.g., shared river basins). Co-operative management approaches between provinces will also be necessary in order to optimise and sustain production from these shared resources. In order for inland fisheries development to be co-ordinated a system will be developed that will enable inland fishery activities to be harmonised between provinces. Subsequently, all appropriate provinces will benefit from improved resource exploitation.

Appropriate co-ordination between provinces will result in considerable savings. Obviously, it makes little sense for each of the provinces involved to each have a separate project along the current lines. Naturally, there will be ample scope for each province to invest in its own localised micro-projects (e.g., processing and marketing inputs, licensing local fisheries, the commercialisation of local fisheries etc.). The current project will, however, create the institutional capacities in provinces which will be capable of developing and managing such local initiatives. Subject to satisfactory prior evaluations, and subject to the wishes of provinces, this co-ordinated approach may include the establishment of an *institute (or similar mechanism) for the development and management of inland aquatic resources* to serve all relevant provinces equally (what is meant by an "institute" is explained in detail

later). Due to the declared limited capacity of the NFA in the field, such an institute would have to function independently of the NFA. But a close liaison between the institute and the NFA should be maintained.

PROVINCES TO BE INVOLVED

All 20 provinces, including the National Capital District, have inland fisheries that require management inputs to sustain or improve production (Table 1). Most of them have either large or huge inland fisheries potential (Table 1). In all of these significant gains in fisheries production from freshwaters can be made. Only two provinces have modest potential - Manus and New Ireland. Even here both still have over 40% of their populations living inland and their respective freshwater resources need managing for sustainability in the face of severe threats from other sectors, especially unsustainable agriculture and logging practices. Even amongst those provinces with only moderate potential, that potential is still worth realising. Milne Bay Province, for example, has already expressed an interest in developing freshwater resources in its extensive areas where people have no access to the sea. The same can be said of Northern Province.

It is anticipated that all 20 provinces will desire to be included broadly under the umbrella of activities relating to this project and at least 16 of them will wish to be significantly involved. Even N.C.D. will likely be interested in further development of its freshwater fisheries in Waigani Swamp and Brown River area, provided their existence is adequately acknowledged.

Provinces will be approached both individually, and collectively, to ascertain their provisional interest in the project. It will be the task of the feasibility study for the institute (see later) to ascertain what level of commitment might eventually be made by each individual province.

SUSTAINABLE DEVELOPMENT ISSUES

The proper development and management of inland waters, including their fisheries, is fundamental to the sustainable development of the country. The intimate relationship between people and their environment, together with the population distribution scattered mainly in rural areas, results in freshwater resources being of crucial importance to sustained and appropriate development growth. Obviously, therefore, improved management of those resources will be crucial to sustainable development of the nation as a whole. There are also extremely important linkages between sustainable development, food security and freshwaters.

The improved utilisation of freshwaters for fishery and other purposes in a sustained fashion will inevitably contribute to their improved long-term management. In areas where significant inland fisheries already exist, freshwater resources are safeguarded and protected avidly by local communities if they are able to do so (although localised problems of over-fishing etc. can be manifest due to the exigencies of rapid population growth). But, in areas where inland fisheries are currently less important, freshwater resources can be more easily abused, either by local communities or by activities upstream (such as the discharge of agricultural/industrial pollutants). The improved exploitation and management for sustainability

of inland waters will improve the attitudes of local communities to those assets. In short, the way to manage and sustain freshwaters in P.N.G. is to optimise their benefits to local communities and enhance the capacity of those communities to manage the resources themselves.

Rivers are regularly abused for carrying the effluents from unsustainable practices inland. Soil erosion, for example, poses a threat to P.N.G.'s coral-reef resources - but the soil travels there first via P.N.G.'s rivers, disturbing inland aquatic resources on its way. Improved management of inland waters will, therefore, also have spin-off benefits for coastal resources.

FOOD SECURITY

A major challenge for P.N.G. over the next 25 years or so is securing its food supply in the face of a population growth rate of 2.3% per annum. It is widely accepted that diets in many rural areas, i.e., for the majority of the population, are already inadequate to sustain healthy lifestyles. Malnourishment is widespread. It is estimated that, overall, something in the order of a 100% increase in the availability of high quality animal protein in the present diet might be desirable. Whilst this may seem a large increase note that consumption of quality protein is, in most rural areas, currently very low. Diets in urban areas are not representative of the country as a whole. In the present sense, "availability" for many people means they grow or catch this food themselves simply because most people have limited, or no, income with which to purchase extra food, especially protein which is expensive. Even if rural incomes significantly improved, somebody, somehow, would still have to produce the food.

Taking into account an at least doubling of the population over the next 25 years, the Government's target for improved food supply (for quality protein) is 400% (four-fold) over the same period. This is equivalent to a target of approximately a 75% increase in food production (supply) every five years - a substantial challenge. At even half these estimates the task is enormous.

Significantly, much of the increased demand for animal protein, and other foodstuffs, is presently being met through increased imports. This is inherently an in-secure system. Even most wealthy countries, let alone P.N.G., have a policy of food self-sufficiency. Whilst a proportion of the requirement might obviously be met by agriculture, that sector is running short of arable land and current traditional food production systems are already under stress. Most of the best land is also devoted to non-food crops for export such as tea, coffee, cocoa, rubber, oil palm and coconut.

Recent development policies in P.N.G., by concentrating on export crops (including fish), have aimed at improving GNP and revenue. Food import bills clearly show that one cost of this policy has been a weaker domestic food production sector. Whilst clearly a food in-secure situation, the macro-economic advantages of this trend are also questionable. In 1990, the last year where full statistics are available, P.N.G. exported K160.2 million in food commodities (primarily cash crops such as coffee, tea, cocoa, etc.) but imported K 194.62 million worth of food. Between 1990 and 1993 exports actually fell even lower. In short, the country is making a substantial loss on its trading of primary products. Growth in primary produce exports is stagnating, due partly to the constraints of limited land availability for increasing export crops. At the same time, pressures for increased imports are escalating in-line

with population growth. Therefore, it makes sound economic sense to boost the economy (let alone food security) by reducing imports through improved domestic food production. Food preferences and lifestyles are also rapidly changing. Many of P.N.G.'s policies have promoted an import dependent society, at great economic costs and risk.

Currently, economic growth in P.N.G. is lagging behind population growth. In effect, the country is getting poorer (per caput). Formal economic development is obviously welcome but the benefits of such progress are disproportionately allocated. There is limited prospect that an improved economy will negate the need for greatly improved domestic food supplies.

Inland fisheries are well-placed to make significant contributions to these targets for food-increase. Resources are extensive and widely dispersed. The potential for increased fish production from freshwaters is substantial (see below). More importantly, the majority of people who are in need of this food already live in areas with access to inland aquatic resources. There are also few cultural constraints to increasing food production from freshwaters. In most, if not all, inland communities, fishing is already a significant activity.

In a recent review of the global contribution of fisheries to food security by FAO, inland fisheries were highlighted as playing a crucial role (FAO 1995). In fact, P.N.G. was highlighted as one country where inland fisheries already made a significant contribution and where substantial scope for improvements existed.

THE EXTENT OF FRESHWATER RESOURCES AND IMPORTANCE OF INLAND FISHERIES

Extensive freshwater resources occur everywhere in P.N.G. where there is a reasonable amount of land area. The high rainfall throughout the country makes freshwater unavoidable in most places. The importance of these resources varies according to location and the concentrations of people. The type of water resource available varies considerably by specific location. As a general rule, all areas have rivers (normally extremely large for the size of the country). Highlands areas often have significant lakes (there are over 5000 in the entire country) in addition to excellent river resources. Lowlands tend to be characterised by swamps, generally adjacent to very large rivers, accompanied by seasonally inundated floodplains and both seasonal and permanent lakes.

The best documented freshwater system is that of the basin drained by the Sepik & Ramu rivers, which are interconnected. This region has been the subject of two prior fisheries development initiatives (see below). This river basin illustrates the importance and extent of freshwaters and associated fisheries. The area is very varied but for the present purposes can be regarded as relatively typical, the Fly or Purari Rivers, for example are similar, as are the smaller river basins, except, obviously, for their smaller catchments. The Sepik-Ramu basin encompasses approximately 100,000 km² of land area draining much of the northern section of mainland P.N.G. (i.e., areas whose rivers ultimately draining into the Sepik or adjacent Ramu Rivers). Whilst the Sepik River itself has a main channel length of over 1100 km, entering Indonesia briefly before meandering back into P.N.G., the cumulative length of tributary rivers (wider than 10 m) is in excess of 160,000 km within P.N.G.'s borders. The Sepik River discharges approximately 7,000 cubic metres of water every second into the Pacific Ocean. The river has a massive and productive floodplain of approximately 35,000 km². There are

about 750 km² of permanent lakes. Over 1,000,000 people live within this basin - less than 0.1% of them within 5 km of the sea. The largest town in the catchment is Kainantu with less than 3,000 people. The remaining 997,000 people live in small villages with an average size of about 400 people, widely scattered (although, on average, highlands villages are larger than those in lowlands).

In lowlands, every single person in the Sepik-Ramu lives adjacent to an extensive water body (either lake, swamp or river channel) - where fishing activity is relatively intense. In highlands areas (the upper catchment) over 75% of the population live within 0.5 km of a major river or lake - most live adjacent to freshwater resources (in P.N.G., with so many rivers, it makes sense to construct villages close to water for obvious reasons, although not too close, if possible, so as to risk the effects of flooding). Fishing activities in the highlands vary considerably between areas. Overall, about 45% of the highlands population of the Sepik-Ramu go fishing (men, women and children combined). Fishing activities in other areas of the highlands, e.g., the upper Fly or Purari catchments, are similar.

In the newly constructed small reservoir (1800 ha) at Yonki (Eastern Highlands), fishing activity started immediately the lake appeared. Although the valley (catchment) supports no more than 7,500 people, over 2000 of these have been recorded fishing in a two day period. Yield from the lake was 45 tons in 1994 (only two years after filling), 65 tons in 1995 and is anticipated to reach a sustainable level of at least 250 tons per annum in the near future (if managed properly). Utilising extensive aquaculture techniques (i.e., fish stocking), combined with other management techniques, potential yield is conservatively estimated at 750 tons per year. This is from a single small lake under moderately intensive management - similar lakes/reservoirs in other countries often produce in excess of this. Fresh fish caught from Yonki reservoir is now sold in two markets adjacent to the lake. It is anticipated, as the fishery develops, that fish will be transported to Lae and Goroka for sale (if not bought before it reaches those markets). This very small fishery currently has an economic value of 130,000 Kina (at a conservative K 2 per kilo - well below the traded value of fish in the highlands). The sustainable economic value (when fully developed) will be in the order of at least K600,000 and up to K2.7 million. This is from a single small lake - and P.N.G. has 5000 of them, although not all have the same potential.

The biggest demand for fish occurs in the highlands, if for no other reason because this is where the highest concentrations of people occur. Significantly, highlanders prefer fresh meat/fish to preserved (e.g. tinned) meat/fish. Fresh trout and carp caught from local rivers are sold quickly to passing consumers at recorded prices in excess of K10 per kilo (a price that will presumably drop as supplies increase - in itself desirable). Eels, which have greater ceremonial value, can fetch over 25 Kina per kilo in major markets (almost twice the price of premium marine prawns).

Overall, P.N.G.'s official figures put total fish production from inland waters at currently about 13,500 tons per annum. This estimate includes the relatively accurate data for the Sepik-Ramu basin but does not include allowance for the known, but as yet un-quantified increase in yield achieved through the recent stock enhancement programme for that area. Whilst this is a significant amount by P.N.G. standards, making it by far the biggest of the domestic fisheries, this represents a very low yield by world standards based on considerations of both resource area and population. In effect, although representing a substantial amount, there is considerable scope for increased production.

POTENTIAL YIELDS FROM INLAND FISHERIES

The sustainable yields of any fishery are based on a complex of factors including the biological production of the resource and the level of exploitation (up to a sustainable limit). Potential exploitation (fishing effort), especially in P.N.G., is highly dependent both upon the local population density, demand for fishery products and, in particular, access to formal markets.

Considerable data and experience from other freshwater fisheries elsewhere indicate that the potential biological production from P.N.G.'s freshwater capture fishery is in excess of 400,000 tons per annum; published and peer-reviewed estimates are in excess of 180,000 tons for the Sepik-Ramu basin alone. This assumes appropriate, but modest, management inputs. This, incidentally, is equivalent to ten times current total imports of fish or four times the total offshore tuna catch taken from P.N.G. waters. Whilst this figure truly reflects the actual potential, estimates should be tempered in relation to two known constraints:

(i) it is known that in some areas, P.N.G.'s freshwaters are naturally more resource limited than elsewhere (i.e., yields are naturally higher elsewhere). However, this problem has already been addressed in a significant fashion in many regions, notably the Sepik-Ramu, by fish stock enhancement (fish introduction) programmes (see later). Resource bases are already approaching those achieved elsewhere, i.e., improved management can mitigate these constraints, and

(ii) population densities of people in P.N.G. are presently much lower than the norm in most tropical areas, therefore, levels of exploitation (fishing effort) are low, as is total (cumulative) demand for fish (on a comparative basis to many other countries).

From the above, two important conclusions can be drawn:

(a) potential biological production is not limiting for the fishery in the long-term - provided aquatic habitats are not degraded and fishery resources are managed appropriately (although, in some areas, further enhancement of fish stocks may be desirable to optimise production); and

(b) as human population numbers increase, given appropriate management regimes, yields can increase significantly from existing levels and well within the limits of sustainability. In other words, there is significant scope for increased production, given appropriate management, to supply projected increases in demand for fishery products.

As a broad quantitative indicator, given appropriate management inputs, it is quite reasonable to expect that *total yield from inland fisheries can be increased four fold over the next 25 years*. That is, given the right conditions, yield could easily go from 13,500 tons to 50-60,000 tons during this period (*a net increase of about 40,000 tons*). Increased yields could well be in excess of this. Even assuming that average catches per person remain the same over this period, total yield will double simply due to a doubling of the population, and hence a doubling of fishing effort, provided the resource base is managed for sustainability. The first

priority for management inputs must, therefore, be to ensure that mean yield per person does not decrease (which would signal pending disaster). The second, associated, task of management inputs is to improve mean yields per person in order to improve diets, the economy and reduce imports.

Similar, often less modest, claims are regularly made for many of P.N.G.'s fisheries, particularly in relation to the country's vast marine jurisdictional zone. However, notably, the present ones for the inland fishery are based on hard data and conservative projections. Most significantly, the inland fishery has several strategic advantages over P.N.G.'s other fisheries. Some of these are that the inland fishery has:

- (a) the habitat availability,
- (b) the biological resource (given appropriate management), and
- (c) most importantly the people (= both consumers and fishers),

in order to achieve these targets. In addition, most future increased demand for fish will occur inland, simply because that is where most absolute population growth will occur (it is very unlikely P.N.G. will experience a major population re-distribution to the coast by 2020).

The paramount advantage inland fisheries have in development is that all the fisheries are close to the demand for fish. That is, for the bulk of P.N.G., the government's policy of supplying demand for fish from local sources effectively means developing inland fisheries. Whilst certain of P.N.G.'s marine fisheries have their own strategic advantages in some other respects, ease of access to the bulk of domestic consumers is not among them.

GENDER, CHILDREN AND FAMILY ASPECTS

Women are intricately involved with all aspects of inland fisheries. Although social systems vary greatly between regions, as a general rule, both women and men fish. In some areas commercial fishing is dominated by men. In all areas, women undertake the majority of processing and marketing. Interestingly, fishing is perhaps the only "hunting" activity where female participation is generally allowed (often actively encouraged). The high profile of women, especially in marketing, results in the nutritional and/or economic benefits of inland fisheries being channelled more directly to meet family needs in comparison to many alternative activities. Much of the benefits of cash cropping, for example, coffee, by-pass the family entirely as the marketing activities are dominated by men who often expend much of the "profits" on, for example, alcohol.

Children form a considerable workforce in all inland fisheries in P.N.G. The youngest active participant in fishing yet recorded by the FISHAID project was age 18 months (a small child on a canoe being taught by her four year old brother to use a hook and line). A watchful eye in inland areas will soon confirm that such instances are far from unusual. One prize-winner in a recent fishing competition at Yonki reservoir (Eastern Highlands Province) was a child aged six (the grand prize for biggest fish overall was awarded to a woman). The small individual catches caught by the myriad of children, generally fishing in an informal fashion with hand-lines, small nets, bare hands, rocks, stones, bows and arrows, and spears, contribute significant total fish landings in most communities, much of which is often sold for cash.

EMPLOYMENT GENERATION

The inland fishery, in common with the coastal fishery, is currently dominated by artisanal/small-scale activities. Most of the produce is consumed directly by local communities. However, notable exceptions exist. In the Sepik -Ramu floodplains large quantities of fish and crustaceans (e.g., freshwater prawns) are already caught, processed and marketed commercially. A significant commercial fishery for barramundi has existed in the lower Fly, Kikori and Purari Rivers for a number of decades, although recently in decline. As already mentioned, considerable quantities of freshwater fish are already being brought from the interior to major urban centres, including Port Moresby. Fresh fish markets are starting to appear in the highlands for locally caught fish, two are already documented near Yonki Reservoir. All of these activities generate income for rural communities.

A priority of the government is to “commercialise” P.N.G.’s artisanal fisheries, for obvious and justifiable reasons. The “artisanal fishery” in P.N.G. is already dominated by the inland fishery sector, much of which is already commercialised, with considerable scope for intensification. Oddly, there is, however, a common perception amongst fisheries planners in P.N.G. that artisanal and/or commercial fisheries only exist in salt-water.

The concept of “employment” is somewhat complex in P.N.G.. A more appropriate term might be “cash-earning opportunities” or involvement in the cash economy. Inland fisheries are likely to play an increasingly important role in creating opportunities for cash income. In many areas freshwater fish are already traded in a significant fashion for cash. As infrastructures, such as roads etc., improve, freshwater fish can be expected to become increasingly important in the cash economy. The sector may, in fact, experience exponential growth as rural fishing communities, prompted by the desire for better lifestyles that increased cash income brings, begin to respond to new market opportunities arising from improved communications and ever growing demand for fish. Moreover, opportunities for small-business involvement in processing and marketing are certainly likely to escalate over the next decade or so. All of these developments will have a positive impact upon the rural, and hence national, economy.

EXPORT EARNINGS AND IMPORT REPLACEMENT

The high costs of exporting fresh produce from P.N.G. is a severe constraint to both the inland and coastal fisheries sector in terms of export revenues. Economic circumstances will, of course, change. As they do it will be a mistake to assume that export potential will be limited to marine fish. Tilapia fillets, for example, are already a major internationally traded commodity (and P.N.G. incidentally has one of the world’s largest known tilapia fisheries). Similarly, the barramundi has historically been a major export earner for P.N.G. (although, strangely, rarely acknowledged as an inland fishery). Global consumer demand for fish is set to increase rapidly, along with prices. There is no reason to assume that processed and packaged freshwater fish will necessarily be exempt from tapping the new opportunities on offer, unless, of course, government policies dictate so. As an indication of the potential on offer, there are many nations with more limited freshwater resources than P.N.G. that already have export based inland fisheries of national economic importance.

However, the greatest revenue aspect of the development of inland fisheries is undoubtedly their potential to reduce imports. Unfortunately, domestic fish production is not reflected in revenue figures, and, therefore, its importance can be neglected. Quite simply, in low-income food deficient countries such as P.N.G., in broad economic terms, fish produced and consumed domestically has a value at the very least equivalent to that of equivalent commodity exported. Equally, any increase in domestic supply that reduces demand for imports is at least as economically valuable as an equivalent increase in exports. Many, including the author, would argue that domestic production has an economically higher value. The desire of the government of P.N.G. to increase revenues is understandable. However, fisheries policies would be more rational if the contribution of domestic fish production to the national economy was properly accounted. Acknowledging the distinction between government and national revenues might also help clarify policies. The formal economic value of inland fisheries needs to be acknowledged in macro-economic policies.

Few would deny that increasing the domestic supply of fish would reduce demand for imported produce. Since the inland fishery already provides much of that supply, and as argued above has the potential to increase the supply, it is, therefore, self-evident that inland fisheries have a major economic role to play in the sustainable development of P.N.G. This project proposal, in part, serves to enable that role to be acknowledged and supported through appropriate public sector investment in inland fisheries development and management.

OPPORTUNITIES FOR REVENUE GENERATION

Recent policies of the government have, with some justification, been directed towards the generation of government revenues where possible. However, there has been scant attention to the revenue generating potential of inland fisheries. There is no particular reason to assume that marine fisheries offer more revenue potential than inland waters (except, of course, in areas of access agreements by foreign fleets and the "industrial" fisheries such as tuna). It is a common practice in many countries for inland fisheries to be managed for revenue and many contribute significantly to public coffers. In a number, revenue collected from licensed artisanal fishing operations in inland waters greatly exceed those from marine fisheries even where the latter are important in their own right. Revenue from the fisheries sector is, of course, based 100% on inland fisheries in all landlocked countries.

The reasons why "revenue" aspects are not considered with inland fisheries in P.N.G. are partly due to marine biased approaches. Whilst it may not be easy to rapidly increase revenue, or GNP, from the inland areas there are no reasons to assume that the task will be any more difficult than with P.N.G.'s marine artisanal fishery sector.

A licence fee of only K 10 per annum for each inland fisher in P.N.G. would generate a public revenue of approximately K 15 million per annum (assuming only "serious" fishers were licensed). This rivals current revenue from the entire marine sector (including tuna). Such revenue would, however, be difficult to collect (although the same consideration has not halted attention to potentially increasing revenue from coastal areas). What is more feasible is to licence inland artisanal fisheries as they gradually commercialise. Since in many regions government services will, and should increasingly, contribute to improved profits it is quite logical that users of the resource pay a "resource fee" when exploited for profit (no less so than with marine fisheries). Neither is this an extravagant suggestion - an excellent opportunity

already exists. The fishery on Yonki reservoir (Eastern Highlands Province) has developed entirely at public expense, including the building of the reservoir itself and the fish resource in it is based entirely on fish stocked by the government. Whilst subsistence activities might be allowed to continue unencumbered, the fishery is showing signs of rapid commercialisation. Not only is a licensing regime desirable in order to generate revenue (in part to support fishery management activities) but the fishery itself will soon be in need of active management for optimal production. Licensed access for commercial gears, e.g. gillnets, may well be the best way to achieve this.

During stocking activities undertaken by the FISHAID project two fishes with considerable sport angling potential were brought to P.N.G., both types of “mahseer” fish from India/Nepal (although neither were imported solely for this purpose). This was also at substantial government expense. These fish are so revered as game fish in their native range that they are now over-exploited and stocks there are threatened. Anglers visit these countries from as far away as Europe, Australia and North America, to catch these dwindling stocks. Should these fish do as well in P.N.G. waters as is anticipated a significant sport fishery for them is likely to develop. This again, will require a licence system. Not only will licences generate revenues directly but it is not unrealistic to suggest that the fishery may, in time, contribute significantly to revenues from tourism. None of this will materialise without proper management.

Despite these needs, there is currently no infrastructure capable of either establishing or managing a licensed fishery inland anywhere in P.N.G., at either provincial or national government level. A major focus of the infrastructure proposed to be developed by this document will be to look at optimising public revenues from inland fisheries as and where appropriate.

PREVIOUS INITIATIVES

There have been two major initiatives in the inland fisheries sector in recent times. Both of these have operated at national government level and aimed at improving the fishery resources in all provinces in the Sepik-Ramu basin (East & West Sepik, Madang, Eastern and Western Highlands and Morobe). Technical assistance was provided mainly by FAO. In 1987, the Sepik River Fish Stock Enhancement Project began a major study of the fishery resources of the Sepik-Ramu, including studies of the biology and ecology of the aquatic systems and socio-economic assessments of the fishing communities. Because of the peculiarities of the fish fauna of that river basin a fish stock enhancement exercise was recommended in 1990 and initiated in the same year. In 1993, the FISHAID project took over the stocking activities of the Sepik project. The FISHAID project brought, on behalf of the government, a number of new fish resources to P.N.G. and in particular focused on stock enhancement of rivers in the highlands regions (but only of that basin). These projects provided extensive background information on inland fisheries in P.N.G.. The current project proposal is partly based upon the technical data generated by these previous inputs.

The aforementioned two projects dealt with specific resource issues in these inland areas on behalf of the relevant provinces (at that time implemented through national government). It is now up to those provinces to initiate their own management and

development programmes for their freshwater resources (as for other provinces in other regions).

The current proposal is not another phase of the above two projects, activities under which finish in March 1997. Whilst the current proposal will incorporate any necessary attention to follow-on stocking requirements after the FISHAID project terminates - this will be only a minor part of the proposed work programme under the current proposal. However, the impetus for the current project stems from the importance of inland fisheries as highlighted by these previous projects. This current programme initiative is also in part based upon the extensive technical data generated by these prior activities and will rely heavily upon national staff trained partly under the above two projects.

The DFMR, in conjunction with provinces, previously had a long-standing management role in the modest Gulf of Papua barramundi fishery (most of which is caught inland).

There have been numerous small-scale initiatives by local communities in the inland fisheries sector in recent years. Some of these have been mentioned previously.

In view of the significance of P.N.G.'s inland fisheries these prior inputs can only be regarded as less than minimal. The current programme proposal, therefore, does not seek to restore a previously more active sector but to redress the previously serious imbalance in fisheries sectoral planning.

CURRENT MANAGEMENT APPROACHES TO FRESHWATERS

Apart from the above mentioned management initiatives by DFMR (stock enhancement and management of the barramundi fishery) there are no formal management regimes for any inland fisheries in P.N.G. at either national or provincial level. The one significant management intervention that existed, the FISHAID project, terminated in March 1997.

The recent *Fisheries Act* (1994) describes the mandate, and jurisdiction, for the management of P.N.G.'s fisheries, including the inland fishery resources. The Act is modern and quite comprehensive. It allows for any foreseeable management regime/regulation. None have yet been applied to any inland fishery. Although subject to national laws, each province may have separate legislation, or the ability to make it, in relation to inland fisheries. None have so far done so. Although empowered, and mandated by the Government, to manage inland fisheries, both the NFA and Provinces lack trained personnel in inland fisheries management and development.

Traditional management systems in many rural communities are, however, very well-developed. Most important resources are controlled by local communities. These frequently apply their own traditional management systems which can include restrictions on types of gears used, sizes of fish caught and the voluntary imposition of closed seasons, often by both area and gear-type. These management systems are, however, gradually breaking down in the face of rapid population growth and the inevitable increased pressures being placed upon resources. There is considerable scope for placing such community based management approaches on more modern grounds - through community involvement and community driven management regimes responsive to sound scientifically-based management advice. This is

particularly so where fisheries are starting to become commercial, resulting in greatly increased localised fishing effort. Unfortunately, at present such communities have no source of professional technical advice on any aspect of inland fisheries.

The existence of widespread community-based management systems for inland fisheries in P.N.G. bodes well for advances in sound management approaches. In many countries management approaches are now attempting to promote community-based involvement (e.g., fisheries “co-management” between resource users and government agencies). Not only is community-based involvement in resource management well entrenched in P.N.G. - it is almost impossible to disregard. There is some considerable potential for closer liaison between formal “fishery managers” (at national and provincial government level) and rural communities in order to grasp the opportunities that P.N.G.’s traditional natural resource management systems offer for improved management of fishery, especially inland, resources. This should not only involve “managers” working closely with fishing communities but also include key community-based representatives being involved directly with the training opportunities offered by the current project.

Oddly enough, whilst the world is shifting towards community based management systems, and promoting greater participation of resource owners, P.N.G., despite being placed firmly at ground level in these respects, appears to have fisheries programmes that are oblivious to these developments. The lack of support to inland fishing communities is only one example of this disturbing trend.

Whilst there is considerable scope for improved management of inland resources from within the fishery, the general situation from without the fishery can only be described as one of total non-management. One of the greatest management problems for the fishery is the growing disregard for maintaining the environmental integrity of freshwaters. Abuse of freshwater resources is manifest in soil erosion from unsustainable logging and agricultural practices, run-offs of pesticides and herbicides, deliberate spillage of pollutants into rivers and blatantly using rivers and other freshwaters simply as vehicles for disposing of waste. For example, literally bulldozing coffee wastes directly into rivers is a common sight in the highlands (although technically illegal) - the result is the total obliteration of fish habitat for a significant distance downstream. A number of mines deliberately discharge toxic waste into some of P.N.G.’s major rivers, most with government approval. However, by world standards P.N.G., at least as a whole, is still relatively fortunate. Most freshwater resources remain in a relatively healthy state. The comparatively low population density and limited development has resulted in only localised disturbances of freshwater environments in most areas. However, without improved management, this situation is likely to rapidly deteriorate.

LEGAL OBLIGATIONS FOR MANAGEMENT

The *Fisheries Act* (1994) requires that all P.N.G.’s fisheries (without exception or priority) be managed on the basis of sustainability for the benefit of Papua New Guineans. The *Organic Law* obliges the national government to provide technical back-stopping and policy guidelines etc. to Provincial Authorities for all fisheries.

Various other Acts relate to fisheries. Some of these are: the *Animal Disease and Control Act*, *Quarantine Act*, *Fauna and Flora Protection Act* - all of which deal with the

control, release, quarantine and movement of aquatic organisms for fishery related purposes. There are also several P.N.G. laws and regulations relating to environmental protection and management of aquatic environments including freshwaters.

Various international obligations relate to fisheries in P.N.G.. Amongst these is the UN Convention on the Environment and Development (UNCED 1992), Agenda 21 of which (The Convention on Biological Diversity) requires that P.N.G. manages its aquatic resources (including freshwaters) on a sustainable basis with due regard to the maintenance of biological diversity.

Obviously, all of the aforementioned relate to the management and development of inland fisheries in P.N.G. and the aquatic habitats which sustain such fisheries. In addition, there is as yet an unfulfilled legal obligation for there to be an effective co-ordinating mechanism at national (central) level able to support and advise on management and development activities at provincial level.

THREATS TO SUSTAINABILITY OF FRESHWATER RESOURCES

(1) Overfishing

At present, overfishing in inland areas is a localised phenomenon. It occurs especially where higher population densities have easier access to major markets or where local demand for fresh fish outstrips resource availability. Fortunately, in general, P.N.G.'s inland fishery is exploited by a relatively dispersed population with a relatively large resource area. However, fishing pressure is likely to increase exponentially as population numbers increase and rural communities take up commercial fishing in response to new market opportunities. The most vulnerable areas are those regions of the highlands close to main urban centres and freshwater resources near major coastal towns. Such regions are subject to the greatest population pressures. Pressures on fish stocks in these areas are likely to remain very high and, without improved management, exceed the limits of sustainability. However, in comparison with most other countries, P.N.G.'s inland fishery is well-off. Even allowing for population growth, densities of people will still be comparatively low by 2020 and areas of freshwater aquatic habitat available are exceedingly large. Management will, however, become increasingly necessary especially in those areas where commercial activities become more prominent.

The use of natural poisons (especially extracts of various poisonous plants such as *derris*) is a traditional activity in most inland areas in P.N.G. Traditionally, the practice was sustainable, as long as it involved infrequent use for ceremonial purposes. In recent times the practice has become un-sustainable in a number of areas, especially when used for commercial gain where industrial chemicals (such as cyanide, insecticides and herbicides) are substituted for natural *derris*. Improved management is obviously required in this field, perhaps focusing on community awareness campaigns. The use of explosives for fishing inland is not well researched but possibly not very widespread. This is partly because inland communities, although having adequate access to explosives, have better resource management approaches, or fishing rights systems, than counterpart communities in the marine sector where dynamite fishing is becoming an increasing problem. In contrast to the sea, it is also rare to find remote locations inland where dynamiting can be practised without the watchful eye of local resource owners.

(2) Habitat and environmental degradation

As already mentioned, habitat and environmental degradation resulting from other sectors, in particular agriculture, forestry and mining, pose the greatest threats to the sustainability of inland fisheries. To this list can be added industrial pollution if, or when, water polluting industries become more prominent in P.N.G.. The scale of potential impacts that can be anticipated in P.N.G., without improved management, can be seen from many other regions. Water courses in some of these other countries, including major lakes and river channels, are already officially described as biologically dead. For P.N.G. to follow the same route would be a tragedy of national proportions. Where the mistakes of un-sustainable growth have been recognised elsewhere, re-habilitation of water resources is now an increasing trend. It is, however, becoming clear that the re-habilitation of habitats is inordinately more expensive in the long-run than adopting sustainable management approaches whilst resources are still in a reasonable state of repair.

The best way of mitigating the impacts of other sectors on freshwaters in P.N.G. is to manage freshwaters with an exploitation based approach. The more people benefit from clean and healthy freshwaters, the more they are likely to resist habitat degradation from other sources and the more likely they are to reduce the impacts of their own destructive activities. Active management of freshwaters for fisheries will make significant contributions to maintaining aquatic environments in a healthy state. The more that the public, and government, become aware of the value of such resources, the more likely is co-operation from other sectors in their sustainable management. In order for this to be achieved, P.N.G. needs an effective management infrastructure for inland aquatic resources - especially the fisheries they support.

AQUACULTURE *VERSUS* CAPTURE FISHERIES DEVELOPMENT

There is often confusion in P.N.G. regarding the opportunities offered by aquaculture *versus* inland capture fisheries. The debate is somewhat redundant, not least because it is extremely difficult to define the difference between the two activities. In fact, FAO (the body responsible for the compilation and dissemination of fishery and aquaculture statistics) is currently wrestling with the problem of definitions. For example, when fish are reared in ponds the activity is generally thought of as "aquaculture" but when fish are released into a reservoir to be subsequently caught by "fishers", the latter is often considered the product of a fishery (in reality, it is what is more correctly termed a culture-enhanced fishery, or extensive aquaculture). This distinction is based on the physical attributes of ponds and reservoirs (not the activity itself) - but at what size does a "pond" become a "reservoir" (or lake) ?

In general, the global trend has been one of gradual intensification of the exploitation of inland water-bodies. At one end of the spectrum is the exploitation of fish stocks in open waters with minimal or no interference in biological processes (a "capture fishery"), at the other extreme are the highly intensive farming processes seen in advanced farming systems where fish are reared in high densities in small enclosures and maintained almost entirely by human control of biological processes (= "intensive aquaculture"). In between is a vast array of activities combining both approaches. The most sensible approach with any particular

biological resource and socio-cultural system is to determine what level of intervention (management input) is most appropriate under the circumstances in question. With regard to P.N.G., there is little rational argument against the fact that, in general, the exploitation of freshwaters is very much at the first end of the aforementioned spectrum. The greatest gains, therefore, are to be had by gradually increasing the exploitation of freshwaters from this basic level; i.e., to increase production from the open water capture fishery.

The major reason why “aquaculture” (i.e., rural fish ponds) is de-emphasised in the current proposal is plain common sense in response to the hard facts. Despite over 40 years of considerable public investment in aquaculture in P.N.G., present production is estimated (optimistically) at no more than 5 tons per annum, and has likely never been more than 10 tons. In fact, the only tangible benefits of prior investments in aquaculture have been spin-off benefits for capture fisheries as aquaculture species escape and contribute to enhanced fishery resources in rivers and lakes.

Whilst there are no doubt small localised opportunities for aquaculture to supply rural demand for fish these will likely develop slowly. There may be some potential for the development of modern commercial aquaculture and, quite possibly, for export markets. However, such developments are far better driven, and funded, by the private sector. The government’s role might focus on managing the environmental aspects of such private sector developments.

Despite popular belief to the contrary, most aquaculture development in P.N.G., if any, is likely to occur inland, not in the sea (mariculture). This is in-line with world trends. Freshwaters currently account for 65% of world aquaculture production. With the exception of pearl farming in the early part of this century (long since defunct) all aquaculture ventures, and most proposals, have been land based in P.N.G., for freshwater species. Further reasoning for assuming future developments will likely take place mainly in freshwater is that aquaculture is basically farming and undertaking it effectively requires knowledge of farming. Most farming activities in P.N.G., whether small-scale or larger commercial operations) are located inland.

Whilst aquaculture is de-emphasised in this proposal, or rather placed in its correct context, this proposal does include attention to aquaculture activities inland. Some reasons for this are:

- (1) there is a close relationship between “aquaculture” and “fisheries” - especially in the area of stocking, including both overlap of the two technical areas and the requirement for similar facilities in order to undertake both (fish reared for stocking rivers and lakes are reared in exactly the same way as those stocked into ponds);
- (2) there may be some areas where management inputs and/or public sector investments into stocking and village pond culture result in competition and/or a duplication of effort. In order to promote the optimal use of government resources an impartial approach to development in inland areas is required which results in the most appropriate strategy being adopted in any particular area. This requires that people managing fisheries are also aware of, and well-versed with, aquaculture development and *vice versa*, and

(3) exotic organisms (including both imported types and native P.N.G. species moved to areas of P.N.G. where they did not previously occur) will always “escape” from aquaculture establishments into the wild and, therefore, impact capture fisheries directly (potentially in either a “positive” or “negative” fashion).

At present it is unclear which government infrastructure will take the lead role in rational aquaculture planning, management and development. The current proposal mentions aquaculture considerations only in the above context, but should be flexible in relation to future initiatives and/or investments in the aquaculture sector through other programmes. At a later stage aquaculture considerations might be incorporated under the present proposal (if revised accordingly). This should be done in a rational fashion, in-line with the above principles, and to an extent commensurate with the actual relative importance of the sector.

WHY ARE INLAND FISHERIES NEGLECTED ?

Inland fisheries are under-valued in many countries. This is partly because of the dispersed nature of the fisheries which are also dominated by informal activities. This tends to lead to poor statistical data on their value in comparison to the marine sector where more visible activities tend to occur. Further reasons for the lack of attention to freshwaters in P.N.G. are:

- (i) working in inland areas, many of which are difficult to get to and characterised by “unpleasant swamps full of mosquitoes” (etc.), is far less appealing to most scientists/managers than working along P.N.G.’s palm fringed coasts with its relatively easy access and more relaxed lifestyle.
- (ii) the popular perception of P.N.G. as a small “Pacific Island State” does not help - in fact mainland P.N.G. comprises half of the world’s second largest island (surpassed in size only by Greenland which is covered mainly by ice) and the largest tropical island. P.N.G., for example, is larger than Germany. It is unique amongst South Pacific nations although this fact is often neglected.
- (iii) fisheries development in P.N.G. has been historically influenced by management inputs, policy guidelines and scientific training from Australia. However, Australia, being 90% desert, has poor freshwater resources and few inland food producing fisheries (inland waters in Australia are managed more for recreational fishing). Australia also has an usually highly urbanised society and all urban centres are located at the coast (in contrast to P.N.G.). This has contributed to increased bias in P.N.G. towards marine fisheries.
- (iv) P.N.G. is the only South Pacific Nation where freshwater resources are so extensive and, therefore, regional programmes etc. focus entirely on the marine sector.

It is perhaps also true that these factors have influenced, and on occasion severely biased, the planning advice provided to P.N.G. by a multitude of consultants, aid donors and international banks since independence.

The current proposal seeks to place P.N.G.'s freshwaters in their proper context within planning processes for the fisheries sector in P.N.G.. It is hoped that future planning will be based not on popular mis-perceptions of the nation but on a more realistic approach whereby attention is given to hard data on the availability of aquatic resources, the distribution of people, and hence domestic demand for fishery produce, and the involvement of the population in fishery related activities. However, experience suggests that this will be an up-hill struggle. Educating planners on the importance of freshwater resources in P.N.G. will be a major task of the proposed institute.

THE JUSTIFICATION FOR INVESTMENT IN DEVELOPMENT AND IMPROVED MANAGEMENT OF INLAND FISHERIES

Current production alone justifies significant inputs into the management of inland fisheries. In addition, the potential on offer seals the argument. Currently, by far the greatest proportion of investment in P.N.G.'s fisheries development is aimed at the marine sector. In fact, the current proposal is the only one in the non-marine sector for 1997. At the artisanal level, this is despite inland catches being well in excess of those from the coast. This project proposal seeks to partly redress this imbalance. It is based on the rational consideration of the distribution of people, aquatic resource availability, current fishing practices, and existing and potential domestic demand for fishery products.

It is a clear, unequivocal and justifiable policy of the government to: (i) further commercialise present artisanal (small-scale) fishing operations where feasible, (ii) promote import replacement of fishery products, and (iii) improve the nutritional well-being of the people and food security of the nation. Within the fisheries sector, the only rational way in which to achieve these goals is to invest in the development and management of inland fisheries. Improved management of P.N.G.'s inland resources is required in order to sustain their use. Management should be aimed at optimising production for the benefit of the nation along the lines of the aforementioned goals.

For P.N.G.'s inland fisheries to be managed and developed in the most appropriate manner it is necessary for P.N.G. to have an infrastructure able to develop and manage these resources. This project aims to promote and develop such an infrastructure based on the concept of maximum involvement and control by provincial authorities.

THE PROPOSED INSTITUTE³

Establishment of the proposed institute

³ The term institute is used here to describe the infrastructure under which activities outlined in this proposal are organised and co-ordinated between provinces. An suggested alternative has been to have an inland fisheries "task force" but the term institute is preferred at present as it gives such a task force a viable working framework and one under which funds in support of the sector can be secured. Later studies may decide whether the "institute" approach is the best solution, or an alternative mechanism is more appropriate. If an alternative mechanism is eventually decided upon then it should be assumed that such a mechanism is the "institute" for the purposes of this document.

Currently it is difficult to envisage exactly how provincial infrastructures will develop, be co-ordinated and how public and private sector investments will be optimised in the absence of a co-ordinating body for the management and development of inland aquatic resources across the relevant provinces (NFA does not presently have the facility nor desire to become heavily involved in inland fisheries). It is proposed that an institute may be established to cater for these requirements. However, in relation to the proposed institute the following should be noted:

(a) Before plans, and funding, for the institute are finalised the proposal should be subject to a detailed study which will then be scrutinised by all interested parties prior to further action being taken. As such, only facility for a pre-establishment study is included in this current project proposal. If deemed justifiable and desirable, the establishment, including siting, staffing and equipping of the institute, will be included in phase two of the current proposal or a separate but related proposal as appropriate.

(b) The institute may have a small core of centrally recruited staff to administer and co-ordinate activities. However, the bulk of the staff will be provided by the Provinces. These may or may not, as appropriate, actually be located at the Institute's central office (wherever that will be). Staff can remain within Provinces and still be attached to the Institute (Note: the "Institute" refers to the infrastructure - not a physical building). If each Province, for example, identifies only two (hopefully more) staff to "assign" to institute-related activities then the institute will have a core staff of at least 30+ without any increase in public service positions. Positions for central institute staff can be made available within existing public service resources. The institute will not (necessarily) result in an increase in public service positions.

(c) The purpose of the institute will, broadly, be to promote, at provincial level, and defend at national level (e.g., by securing adequate investments from national government etc.), the management and development of inland aquatic resources. This will include a research role where necessary but it will not be an "academic research institution". Its activities may include, for example:

(i) the collection, analysis and dissemination of relevant data on inland aquatic resources, especially fisheries, as gathered and provided by provinces,

(ii) the development and promotion of sound resource management plans and policies for implementation by provinces, especially those needing to be based on an aquatic ecosystems/resource systems approach (e.g., management approaches for river or lake basins, mangrove areas, estuaries, coldwater highland rivers etc.),

(iii) advice to national government on issues of national interest, e.g., requirements for legislation etc., quarantine, import controls for live fish, fishery licensing requirements etc.

- (iv) public education programmes aimed at promoting the objectives of the institute and inland fisheries development in provinces,
- (v) co-ordinating and optimising the securing of funding, including aid, for the development of inland aquatic resources, especially fisheries,
- (vi) within-country training of provincial staff in inland fisheries development, and co-ordinating overseas training of provincial staff as necessary,
- (vii) attention to cross-sectoral considerations in relation to the sustainable development and management of inland aquatic resources (e.g., liaison with the forestry and agriculture sectors ref. soil erosion, the mining sector ref. pollution, the Department of Environment and Conservation ref. conserving aquatic biological resources, etc.).

(d) The institute will engage in activities in relation to their current and realistic potential importance. In particular, aquaculture considerations in freshwater may be included where relevant to the objectives of the institute (and provinces), particularly in areas where aquaculture and capture fisheries activities merge. Formal aquaculture (i.e., fish ponds and cages) will have a secondary role to capture fisheries until such time as the aquaculture sector warrants substantial public investment (it is assumed the most appropriate funding source for aquaculture will be the private sector).

(e) The purpose of the institute will be to develop and manage inland aquatic resources. This may include capture fisheries, aquaculture and/or other uses of inland aquatic resources. The current emphasis is on capture fisheries because this is the most important aspect of inland aquatic resources at present. However, the institute will need to be flexible and respond to changes in circumstances.

(f) The financial overheads of the institute should be very modest. The institute will, at least initially, need to be funded from national government sources. At present, provinces have not been allocated financial resources with which to fund the institute but this might be a longer-term objective. Additional funds invested in the sector for the benefit of provinces (e.g., for training of provincial staff etc. through the institute but on behalf of the provinces) can be co-ordinated through the institute. In other words, establishing and running the institute will be a low-cost exercise, but this will need to be supplemented with funds specifically for such activities as training and research.

(g) Funds for specific projects, province by province, will still be administered at provincial level. The current suggestion refers only to those activities for the benefit of all provinces, e.g., training, research, quarantine, etc., undertaken through the institute.

Infrastructure and staff requirements:

It will not be possible for each province to have staff trained and expert in all aspects of the management and development of inland aquatic resources. This is further sound reasoning for having the institute. It is envisaged that each province, whilst developing an improved level of general technical competence, will eventually acquire expertise in specific fields. For example, one province may have particular expertise in fish processing, another in biology/ecology, yet another in aquaculture and stocking etc. A primary purpose of the institutc will be to co-ordinate the exchange of knowledge and experience between provinces utilising, where necessary, the strategic advantages of certain provinces for the benefit of others (and *vice versa*) as and where necessary.

The management and development of inland aquatic resources requires the availability of considerable and varied technical expertise. This expertise will be distributed between provinces and shared between them accordingly. The institute will serve to draw upon the strategic technical advantages of the various provinces to their mutual advantage.

It is envisaged that within five years there will be at minimum of 40 professional/technical staff "attached" to the institute (i.e., associated with and working through the institute but not necessarily physically located at the institute headquarters). This does not include more junior positions for existing support staff at provincial level. (*Note - most of these will involve existing public service positions, this is not an overall increase in manpower*). Most of these staff will be obtained by training existing public servants, mostly in provinces. As a general guide the following targets for technical staff might be set (it is not envisaged that these staff will be available in the short-term):

(a) central staff (at the Institute H.Q.), in 3 years time:

- one Director preferably at PhD. level
- one senior ecologist/biologist (at least at M.Sc. level)
- one senior economist/socio-economist (at least at M.Sc. level)
- one senior resource development specialist (including processing, marketing etc.)
- one aquaculture specialist (including quarantine)
- preferably one licensing/legal specialist
- modest support staff as necessary

These staff will form the central co-ordinating unit supporting staff from provinces as follows:

(b) from Provinces (equitably divided amongst them), and at least half of these available in 5 years time:

- six biologist/ecologist (at least 3 to M.Sc. level or above)
- six socio-economists (at least 3 to M.Sc. level or above)
- two aquaculture specialists (at least 1 to M.Sc. level or above)
- three fish health specialists (at least one to M.Sc. level or above)
- six fish processing and marketing specialists (at least 3 to M.Sc. level or above)
- six artisanal fishery small business advisers (at least 3 to M.Sc. level or above)
- six licensing and inspection specialists
- six environment/sustainable development specialists (at least 3 to M.Sc. level)
- support field staff as necessary

The above personnel should be devoted entirely to the inland aquatic sector both at the institute headquarters and in Provinces although they may advise any marine fisheries sector personnel as required. They should not be marine fisheries personnel given inland resources as a secondary role.

This level of staffing is not over-ambitious. This suggested technical capacity is spread across all the provinces. To put this in perspective, the above is in total for the whole country less than 25% of the human resources currently allocated only at national level to the management of marine fishery resources (i.e., national staff excluding provinces). On a comparative national basis (i.e., core institute personnel relative to NFA staff), the above represents an allocation of human resources to the inland sector in the order of only 4% relative to the marine sector. This is in order to manage inland fisheries resources already producing more fish, at artisanal level, than the marine sector. The above figures, therefore, should be considered a minimum goal which will need to be surpassed to put inland fisheries on proper parity with the marine sector.

Office facilities:

The institute will require a modest central office facility. This could utilise an existing vacant building or share a building with another public service department or NGO. Each province already has an infrastructure (including offices etc.) under which its own staff (attached to the institute) can work. However, these will no doubt need improvement.

Training requirements:

All of the above staff, including core institute staff, will require extensive training for a period of at least five years, overall, from the establishment of the institute (preferably starting before this time). This will be a significant task. One approach might be to train key staff who

will then instil their knowledge to others through institute channels. As far as possible, the bulk of the training should be within country, practical hands-on training. The institute will play a vital role in co-ordinating such within country training.

Much can be achieved by utilising international experts, attached to the institute, working within P.N.G. on training (hands-on) in the required fields. As far as possible, this approach should maximise the involvement of low-cost experts, for example, qualified volunteers or Associate Professional experts through FAO's field programme. The training programmes and activities should, as far as possible, involve P.N.G.'s formal higher educational institutions in order to optimise training and assist institute staff to obtain suitable qualifications assisting their future career development prospects.

Short-term training can be arranged at overseas establishments in suitable fields. This might include, for example, attending appropriate workshops. Technical co-operation between P.N.G. and overseas countries can be fostered through the institute utilising appropriate channels (e.g., FAO's technical co-operation between developing countries programme). Study visits, or staff exchanges, with other countries with well-developed inland fisheries is one priority area for training inputs. Formal links already exist between P.N.G., mainly through the FISHAID project, and several overseas countries that are already collaborating at the technical level. Some of these include India, Nepal, Malaysia and Brazil.

A limited number of staff will require more formal training overseas to at least M.Sc. level. The first priority, however, might be to establish an effective working group within P.N.G. (i.e., get the institute up and running) and then to select appropriately qualified, experienced and motivated staff for appropriate formal higher educational courses. By such a time, the specific strengths and training requirements for Provincial staff will be better known. Active searches should be made, through the institute, for aid funding for such training. A number of existing channels for such training inputs already exist.

Precedents for the institute:

Almost all countries with significant inland aquatic resources have institutes dealing specifically, and exclusively, with the research, development and management of their inland fisheries. Many countries, such as Indonesia, Thailand, India, China, Pakistan, Nepal, most in Latin America, have several institutes for this purpose - often with one in each province or managing each major fishery (e.g., each river basin or major lake). It is not suggested P.N.G. go this far, one good institute should be able to adequately service the whole country; although regional sub-offices/facilities, may likely eventuate.

Within P.N.G. there are several precedents. Amongst these can be cited the Coffee Research Institute, Forest Research Institute, Cocoa Research Institute, Rubber Research Institute and Coconut Research Institute. The Department of Agriculture & Livestock are currently establishing a National Agriculture Research Institute especially to handle domestic food crops. The proposed inland aquatic resources institute might be along similar lines except that its mandate will include management and development in addition to research.

Feasibility study:

There is a need for a feasibility study prior to establishing the institute or determining a more appropriate alternative. The above is an outline of how the institute might function in order to illustrate the concept. All relevant provinces will be intimately involved with the feasibility study. The institute, after all, must respond to, and be directed by, requirements at provincial level.

The feasibility study will investigate in depth the current technical strengths and weaknesses of both national and provincial authorities in the relevant fields, existing physical infrastructures (buildings/offices/laboratories), training requirements and existing educational/training opportunities both within P.N.G. and overseas. The feasibility study will look at all aspects of the institute including the:

- (a) legal aspects of its establishment, including suitable mechanisms by which the institute will be governed in order for its work to be responsive to both its technical mandate and requirements of the provinces,
- (b) framework under which it may operate (including whether it will be semi-autonomous or be associated with an existing government agency),
- (c) desirable core-staffing arrangements,
- (d) desirable provincial staffing arrangements,
- (e) training requirements for the above staff,
- (f) the technical mandate of the institute - i.e., precisely what it will and will not do, including:
 - technical areas to be covered (e.g., inland fisheries, aquatic habitat management, environmental and conservation aspects, fish processing, marketing, business development, etc.)
 - research objectives
 - resource management objectives
 - resource development objectives and requirements
 - the role of aquaculture in inland fisheries
- (g) funding requirements over a specified period, involving considerations of national, provincial and foreign aid requirements, including:
 - staff costs
 - training costs

- equipment costs

- building/office/laboratory costs (if any) for the institute headquarters (if necessary) and/or facilities in the provinces

(h) investigation of appropriate sources of aid-funding especially for capital and training inputs

(i) suitable location for the institute based on considerations of centralised location, ease of access to major freshwater resources, ease of communications and support to provinces, options for suitable sites (with buildings) within provinces.

Some of the above tasks may need the inputs of experts/consultants (as listed in inputs later). In addition, there will need to be an initial core staffing to undertake feasibility studies alongside such experts, and indeed to arrange for the feasibility study itself. It is anticipated that the feasibility study can be undertaken in less than 12 months but that the actual legal establishment of the institute (or alternative infrastructure), and arranging its formal funding, may take longer. It is therefore projected that the feasibility study might take two years (this does not infer two years of consultancy inputs). Securing any aid-funding for projected activities may be included in this two year period. Hopefully, the project will run smoothly from a core of staff running the feasibility into the eventual establishment of the institute. At that point staff from Provinces will be assigned to the institute and the work programme proper of the institute can then start in earnest.

DEVELOPMENT OBJECTIVE

(i) primary objective

The project supports P.N.G.'s desire to improve its food supply, and economic base, through the improved and sustainable exploitation of inland aquatic resources in Provinces. This will include improving exploitation of inland aquatic resources, managing them for sustainability and assisting with mitigating any associated impacts upon freshwaters from other sectors which may undermine the sustainability of those resources.

(ii) mechanism of achieving the objective

This will be achieved by capacity and infrastructure strengthening in Provinces in the required technical areas for the improved management and development of inland aquatic resources. This will include improved co-ordination mechanisms through which the Provinces can assist each other, harness their own respective technical strengths, share human and physical resources and facilities and co-operate in areas of mutual technical interest.

(iii) quantified objectives for fish production increases from freshwaters

The overall objective is to increase production of fish from inland waters from its current level of 13,500 tons per annum to 40,000 tons by the year 2025. Within the limits of resource and fishing effort availability, and market demand, these increases should be distributed equally both within and between Provinces. In particular, of this increase, at least 10,000 tons per annum should be produced by fisheries within highlands Provinces (i.e., excluding fish brought in from elsewhere).

The current economic value of freshwater fish is conservatively estimated as at least K2.50 per kilo (on average). Current landings from freshwater therefore represent a net value of K 33.75 million. The target economic value (at today's value) by the year 2025 is K 100 million.

TRANSITIONAL INFRASTRUCTURE

Until such time as "the institute" (or alternative co-ordinating body) is established it is suggested that this project will be administered by the P.N.G. National Planning Office. This is justified as part of the transitional arrangements required under the organic law on reforms to Provincial Governments. When a working infrastructure, or co-ordinating mechanism, is created (e.g., the institute or similar) it is anticipated that this will become relatively autonomous from the National Planning Office. The feasibility study, by liaison with Provinces, will determine the precise mechanisms of operation but it is anticipated that such an infrastructure will be governed by the Provinces collectively and may, or may not, have a loose association with the NFA.

The project cannot be administered by NFA, under current arrangements, because NFA will have limited, if any, involvement in inland fisheries commencing January 1997. Unless NFA devotes at least 10% of its professional/technical resources entirely to inland capture fisheries in P.N.G. it is unlikely that any change of approach at NFA will adequately address development requirements in this sector. It is assumed that NFA will maintain at least one or two staff members to liaise with the said infrastructure (institute) on matters pertaining to legislation under the *Fisheries Act*. Alternatively, it is a relatively simple matter for the National Executive Council, at an appropriate time and if necessary and appropriate, to delegate the relevant powers under the *Fisheries Act* to the proposed institute. Precise arrangements can be determined by the feasibility study.

IMMEDIATE OBJECTIVES, OUTPUTS AND ACTIVITIES

Objective 1: Establishment of necessary infrastructure to support the management and development of inland aquatic resources at Provincial level

Activity 1: Feasibility study for an institute for the management and development of inland aquatic resources

Activity 1.1

- determine major kinds of freshwater resource exploitation, management requirements, areas of interest, development requirements and technical capacities in provinces

Activity 1.2

- study of options for suitable infrastructures including the establishment of an institute based on the concept of modest core staffing requirements and optimum involvement of staff from Provinces

Activity 1.3

- determine management and development objectives of the institute based upon the concept of the sustainable exploitation of inland aquatic resources for the betterment of the people of provinces and of the nation as a whole, and especially in relation to requirements for:

research (including biological, ecological and socio-economic), both by the institute on behalf of provinces and/or by provinces co-ordinated and assisted by the institute,

the formulation of policy guidelines for the development and management of inland aquatic resources to assist planning in both provinces and at national level,

the consideration of cross-sectoral issues, in management considerations, including the impacts of activities in other sectors upon aquatic resources (e.g., habitat destruction, water pollution, etc.),

existing and potential licensing regimes for inland fisheries,

technical inputs into improved marketing systems for inland fisheries,

improved processing and preservation techniques for inland fisheries,

any assistance to secure funding for specific projects in provinces relating to the management and development of inland aquatic resources, and

any other relevant matters.

Activity 1.4

- study the options for the infrastructure of the institute including its:

institutional setting,

co-ordinating mechanisms between national and provincial administrations,

governing mechanisms, including the possibility of a governing board or council, to ensure the institute remains relevant to the requirements of the sector in provinces, and

location of headquarters.

Activity 1.5

provisional costing for the optimal framework of the institute based on:

low-cost inputs obtained via minimising requirements for new public service positions and optimising involvement of existing provincial staff or those at national level, either by direct transfer or loose association with the institute,

costs of buildings required including for the institute headquarters and any liaison offices and/or laboratories in provinces,

costs of administrative and other equipment required to operate the institute (capital and recurrent costs), and, if necessary in provinces,

excluding costs of research or other programmes in provinces and investments in human capital (e.g. training) - which will be costed separately in order to distinguish costs of the institute from investments in capacity strengthening. (Note: establishing and running the institute is a separate requirement to larger investments in capacity strengthening. The institute itself is capacity strengthening at its minimum. The institute needs to be established and running, followed by further investments in the sector prompted, and promoted, by the institute and channelled through the institute).

Activity 1.6

Completion of the arrangements for the institute in full consultation with provinces, joint consideration of the options for the institute including its location, functions, optimum staffing arrangements, control and governing mechanisms, linkages with provinces and national government, provisional budgets etc.

Activity 1.7

Establishment of the institute under a proper legal framework and functioning as determined above including securing funding for sustaining its functions over a suggested preliminary five year period.

Objective 2: Clarify management and development goals, priorities and activities

Prior to embarking on a fully fledged training and work programme through the institute, those involved should obviously clarify exactly what the management goals and objectives will be in relation to the management and development of inland aquatic resources. Following this, the technical requirements for the institute's activities, and hence activities in the provinces, will be clarified. The institute will need to be involved in a very large number of fields in order to provide optimum management advice to provinces. The only way to do this is to develop appropriate technical strengths in provinces, each perhaps specialising in a different area, and provinces sharing their expertise through the institute. The following will definitely be required:

Activity 2.1

- the establishment of data collection systems for fishery statistics for freshwaters

This is a major requirement. The main use of freshwaters is currently for the production of fishery products. In order to manage and develop fish production from freshwaters it is necessary to monitor fisheries activities - especially landings. Much fish is caught and consumed directly by local communities in rural areas, but a number of commercially driven enterprises are rapidly emerging. With these, large amounts of fish are being marketed through more formal means, including transportation over large distances. Provinces will need to take the lead role in monitoring these trends.

Such statistics are also required in order to monitor the "health" of freshwaters. For example, any effects of pollution or habitat degradation will first be felt upon the fishery.

Monitoring activities might consist of long-term monitoring at key locations (especially where fresh fish markets occur), supplemented by rapid, local, resource assessments by mobile teams.

A considerable statistical database already exists for the Sepik-Ramu basin (including Yonki reservoir and other areas of the highlands) but this needs to be kept regularly up-dated. Monitoring systems need putting in place for other regions.

Activity 2.2

- establish a monitoring system for environmental quality of freshwaters at selected sites

In order to monitor the health of P.N.G.'s freshwaters the institute will need baseline data on environmental and habitat quality at selected sites where major freshwater ecosystems occur. These should include monitoring water quality and the biological attributes of selected sites (e.g., records of the aquatic biodiversity etc.). Only when these data are available can changes to the ecosystems be monitored and, hence, freshwaters be managed properly.

A considerable amount of information already exists in selected areas. In particular, a good database for the Sepik-Ramu exists (undertaken by previous fisheries initiatives) and considerable data are available for the Fly via monitoring done by the Ok Tedi Mining Ltd. (although that area has already been subject to severe environmental changes). Sources of other data on freshwaters should be identified and used where necessary. For example, the P.N.G. Bureau of Water Resources has some good historical data on water quality at a number of sites. There are innumerable environmental reports on selected rivers or locations, including a major international study of the aquatic environment of the entire Purari River basin.

The thrust of this activity should be to initially compile a database from these other sources. A central "registry" of freshwaters should be established. The institute may need to initiate spot surveys in Provinces in various fields, as required. The need for long-term monitoring, in order to be able to establish longer term trends, should be considered as an on-going activity of the institute and provinces.

Activity 2.3

- prepare a resource inventory of P.N.G.'s freshwaters including data on the distribution of people and their socio-economic activities.

In order to manage and develop P.N.G.'s freshwater resources the institute needs to know (i) exactly what resources are available and where they are, and (ii) where the people are in relation to these resources and what they are doing. [Incidentally, it is the lack of attention to such information that has resulted in numerous poor planning initiatives in the aquatic resources sector].

An inventory is required that lists freshwater resource (habitat) availability by location, type and area, combined with an inventory of the locations of people (who ultimately will be exploiting and managing such resources). Data for freshwater habitat availability are already on hand in P.N.G.'s topographic maps (recent satellite imagery is also readily available) and P.N.G.'s population

(including locations of villages) are well documented in the 1990 population census (which is regularly up-dated). A resource inventory, including people, is already available for the Sepik-Ramu catchment. This needs extending to all other areas. Such data enables the institute to determine which kinds of habitats, or which kinds of fisheries, require management in which particular areas. The database should, eventually, be compatible with other such databases in P.N.G.. For example, compatibility with databases on agriculture could be used to determine in any particular area the development options available.

Activity 2.4

- determine research requirements

The institute will need to look at existing information bases, management requirements, available human resources and development objectives (with priorities) in order to determine any research requirements in the relevant fields. Without such planning inputs, especially incorporating the wishes of provinces, it is not appropriate to prioritise research activities here. However a list of concepts and possible requirements follows:

Research inputs should be aimed at the development priorities in the sector in question, and therefore the major objective of the institute. Broadly, these are to manage and develop P.N.G.'s freshwater resources on the basis of sustainability. The approach should be very much exploitation based. That is, the objective is to improve the sustainable benefits of freshwaters for P.N.G.'s people, at the local, provincial, regional and national levels. This implies that emphasis be placed on fisheries related issues. But this would include any factors or activities which have a bearing on the sustainability of the benefits of freshwaters. In particular, "academic" research would be a low priority (although the institute might support such activities undertaken by others) and research on the "environment" should only have priority where directly relevant to improving the sustained exploitation of freshwater resources. The main thrust of the research is anticipated to be in order to feed P.N.G.'s rapidly growing population and reduce dependency on food imports.

Some main fields where research might be considered are as follows (this list is not meant to be exhaustive):

- collection and analysis of fishery statistics for inland waters (as outlined above) in order to monitor trends in the fishery and identify management needs,
- monitoring water quality at key sites,
- relevant socio-economic studies relating to fishing communities, their desires, aspirations and options for activities and/or business ventures (high priority),

- improved preservation techniques for inland fishery products, especially those based on traditional methods (particularly smoking),
- monitoring the impact of previously stocked fishes in relation to the benefits provided to the fishery and the need, or otherwise, to extend stocking programmes into new areas or with new species,
- further commercialisation of the inland artisanal fishery,
- introduction of improved gears, especially in response to improved fish stocks resulting from stocking (for example, cast nets might be introduced for fishing faster flowing rivers in the highlands),
- estimations of maximum sustainable yields by resource type and location,
- studies on the socio-economic constraints to aquaculture development (in relation to the interface between aquaculture & capture fisheries and any potential conflicts between the two activities),
- it is anticipated that biological/ecological orientated research will have a relatively low priority, except in relation to studies required for stock management and/or improvement, and
- taxonomic research will be a low priority, especially as the taxonomy of P.N.G.'s freshwater fishes is already quite well known.

Activity 2.5

- develop the exploitation of P.N.G.'s inland resources in provinces

Based on sound data, analysed by trained and experienced personnel, and in full consultation with provinces, the institute will advise on appropriate management interventions by provinces which will lead to the improved exploitation of inland fisheries.

As outlined above, given appropriate management inputs, it is quite reasonable to expect that total yield from inland fisheries can be increased four fold over the next 25 years. That is, given the right conditions, yield could easily go from 13,500 tons to 50-60,000 tons during this period (a net increase of about 40,000 tons). The benefits of this increase should be distributed between the relevant provinces in relation to the extent of their freshwater resources.

Needless to say, this will be an on-going activity throughout the duration of the institute.

Objective 3: Capacity and infrastructure strengthening in provinces

Once the institute is established and functioning one of its first tasks will be to improve technical capacities and infrastructures in the provinces. In order to do this the following must be known:

- (i) existing technical capacities and strengths in the provinces,
- (ii) the required technical fields in which strengths need improving (see above),
- (iii) the options for training inputs,
- (iv) the costs of training inputs, and
- (v) the optimum time frame under which capacity building and training should be provided in relation to a rational target capacity/strength.

Much of the following will, therefore, need to be flexible in order to respond to more specific requirements as determined by future deliberations by the feasibility study, institute staff, provinces and external inputs as required. The capacity strengthening role of the institute will also be a long-term function. Priorities during, say, the first five years will need to be identified.

Activity 3.1

Determine existing technical capacities, strengths and weaknesses in provinces in relation to inland aquatic resources development and management (see also activity 1.1).

Activity 3.2

Determine technical capacity requirements in relation to management objectives.

Activity 3.3

Study options for training etc. to improve technical capacities to level required.

A long-term view will need to be taken. Initially, a five-year training programme might be envisaged. Much will depend upon the availability of staff and funds.

Where possible, training should be undertaken within P.N.G.. This should especially include staff working alongside experts within the country, possibly in conjunction with formal training establishments (e.g., the University of P.N.G.) in order to broaden training inputs and enable staff to obtain qualifications in support of career development.

There are quite limited training opportunities overseas, especially regionally, for the management of freshwater resources (although an adequate number of opportunities do exist). Training in aquaculture may form a valid technical area for only a limited number of staff attached to the institute. The over-supply of aquaculture training opportunities in the region (often accompanied with funding) should not be used to provide inappropriate training for the needs of the sector in question (inland aquatic resources management and development).

Activity 3.4

Prioritise training and capacity building requirements.

In view of the wide variety of fields in which capacity strengthening is required, and the limited availability of staff and funds, inputs will need to be prioritised. This requires priorities to be related to management and development objectives (see above). This will be an important exercise and should obviously involve staff across all sectors and external inputs where necessary. Possibly, a workshop to this effect may be held to which experts in the various fields might be invited.

Activity 3.5

Commence optimal training regime as required.

This will obviously depend upon the staff and funding available, training requirements and options and priorities.

Objective 4: Education

There is a great need for education across the board on matters relating to the management and development of inland aquatic resources. The institute should play a major role in this. Educational outputs are required directed at the following sectors: provincial and national authorities, business communities, the commercial and industrial (inc. mining) sector, forestry sector, the general public and, most especially, through schools. Education might include:

- the functions and activities of the institute,
- the importance of freshwater resources in P.N.G.,
- the need for management of such resources for sustainability,
- the need to reduce or mitigate the negative impacts of other sectors/activities on freshwater resources,

- benefits and opportunities of improved resource exploitation,
- benefits of improved fish intake in the family diet, and
- the opportunities for cash earning activities or businesses in the sector, and
- educational programmes for small business ventures.

Activity 4.1

commence educational/awareness programmes as above

Objective 5: Begin management and development of P.N.G.'s inland aquatic resources

This is the obvious ultimate output of the institute. Through a blend of the above, and other, activities carried out in a timely and appropriate fashion, the institute will promote the better management and improved development of inland aquatic resources. The precise way in which this might best be achieved will be subject to further consideration, through the feasibility study and through further consultations with the provinces. It will be the major task of the institute to determine how best to proceed towards this objective based upon the aforementioned considerations. As such, it is not possible to give a detailed outline of activities here. Although the institute will result in improved management inputs from the instance it is created (simply because it will be the creation of a co-operative management infrastructure) it is envisaged that major, specific, management and development programmes will not transpire until one year after the establishment of the institute (= possibly two years after the start of this current proposal).

Activity 5.1

commence major management and development programmes

INPUTS

In order to achieve the ultimate objectives various stages of inputs are required. Broadly these inputs relate to requirements for, first, a mechanism established which will enable the feasibility study to be arranged and implemented, second, the feasibility study, third, the establishment of the institute (or alternative), and, fourth, more elaborate capacity strengthening in provinces and the institute. The fourth requirement can only be specified in detail after the first three inputs have helped clarify the exact requirements. At present, therefore, inputs are only specified (in detail) for the first three requirements. This might be considered as "phase one" of the project. However, it will be inevitable (unless the proposal is cancelled at the feasibility stage) that there would be a phase two. Inputs for phase two will need to be estimated during phase one and this task would form an integral part of the feasibility study.

It is proposed that the first three inputs (the "feasibility phase") occur over a two-year period. This feasibility phase includes an in-depth feasibility study of 12 months. This could, in theory, be achieved in less time (hence, more cheaply). This, however, would mean that the institute would be established in a less well thought-out fashion. Such a situation would then require that similar technical inputs be devoted to refining the mandate and activities of the institute after it was established. Therefore, this would not represent a true saving. In effect,

the more effort is devoted to the feasibility study for the institute, the less is required once the institute is established. It should be noted that the current suggestion involves not only the feasibility for the establishment of an institute (in itself a relatively simple task) but also incorporates a plan of activities for the management and development of inland aquatic resources across all provinces - to be administered through the institute. It is the latter which requires the greatest inputs. However, if necessary, it would be possible to establish the institute more quickly. Once established the institute could serve as a mechanism to refine its own longer term management and development plans.

A proposed budget and implementation schedule for these inputs are provided in the annex.

(i) transitional arrangements - establishment of an administrative/managerial mechanism

Inputs:

- one senior national inland fisheries/aquatic resources specialist, full-time
- two junior inland fisheries/aquatic resources specialists, full-time

These staff will help arrange, implement and be involved with the feasibility study. It is assumed that these staff will eventually form part of the core staff for the institute. These staff might be made available from within existing public service ceilings through the appropriate re-distribution of existing staff. If this is not feasible, contingency for employment of these staff on a casual basis should be allowed for.

- modest office space from which the above can work, which will also form the base for the feasibility study

It is assumed that the team will be allocated use of an existing office. This should be adequate and in proportion to the activities to be undertaken. It should also enable the team to concentrate on their tasks with minimal interference from other sources.

- adequate resources with which to operate such an office including:

utilities (electricity, phone and fax charges)

operation and maintenance of office equipment

operating costs for a vehicle

office consumables (stationery etc.)

secretarial support (if necessary)

[It is assumed that the short-term requirements for capital equipment may be met by transferring equipment from the FISHAID project which is scheduled to terminate March 1997. This includes a vehicle and modest amount of office hardware although in a longer term these items will need to be replaced].

Time frame:

2 years from day 0 of the project (assumed to be 01/01/97)

It is assumed that these inputs will be absorbed by the institute when it is established. If establishment is delayed these inputs will be maintained until establishment of the institute is finalised.

(ii) feasibility study for the institute**Inputs:**

- one senior inland fisheries expert/ technical adviser (international input) for 12 months

Terms of reference for the expert are provided in the annex.

- one legal/administration expert (3 months)

Preferably local recruitment, with knowledge of institutional/public service administration in P.N.G.. Terms of reference are in the annex.

- one training specialist/consultant (3 months)

Terms of reference are in the annex.

- travel and other costs for the feasibility study team

The team will be required to travel extensively within P.N.G. in order to liaise appropriately with provinces in the feasibility study.

It may be desirable for a limited number of team members to visit institutes servicing the inland aquatic resources sector in nearby regions. A number of long-established and well respected institutes exist regionally (e.g., Malaysia, Indonesia, Thailand, Vietnam, India, Nepal, China - note: non exist in Australia or New Zealand as these countries do not manage freshwater fisheries for food production). Others, such as for freshwater capture fisheries in Cambodia, are in the process of being established. These may form good models, or provide valid experiences, for the P.N.G. institute.

- review of preliminary findings

There should be a review of the preliminary findings of the feasibility study prior to final presentation of the study recommendations. This review process should involve a wide range of inputs of P.N.G. specialists and two or three external experts.

The costs of this input relate mainly to securing external inputs which may represent 2 x one week short-term assignments plus travel expenses (experts from within the region should be preferred, as should those on a low-cost basis from regional organisations)

- workshop on the establishment of the institute

Once the final recommendations of the feasibility have been subject to review, and endorsement, they should be presented to a full workshop attended by all interested parties. This will mainly involve provincial representation. The provinces will be briefed on the proposals and have the opportunity to improve or modify the proposals, if necessary, prior to implementation of the recommendations.

The costs of this input relate mainly to travel expenses for provincial representatives to attend a centralised meeting.

Time-frame:

The feasibility study phase will run for the first two years of the project. This includes four months to arrange the feasibility study proper, 12 months feasibility study proper, and an allowance of 8 months to implement the recommendations of the feasibility study (including obtaining the necessary funding for the next phase). If the feasibility study should proceed to the implementation of recommendations faster than this (e.g., the institute is established quicker than expected) it is assumed that these inputs will run into that phase (i.e., the inputs will be absorbed by the institute).

schedules of inputs for specific activities are:

- senior technical adviser

starting approximately four months after establishment of the base staff (above)

- legal/administration expert

approximately 7-8 months after the commencement of the study (by which time a clearer idea of requirements will be on-hand)

- training specialist

approximately 3-5 months after the commencement of the study

- review of preliminary findings

approximately 10-11 months into the study

- workshop on the feasibility study findings

at the start of the last month of the study

- establishment of the institute (if recommended)

This should occur as soon as possible and before the end of the second year. If delayed (e.g., any delays in legislative requirements), the core staff/inputs identified in the transitional arrangements (as above), but not the feasibility study, will need to be maintained temporarily until such time as the institute is established.

PHASE TWO

The current proposal is for the establishment of an infrastructure (institute) together with in-depth management and development plans for inland aquatic resources, including training and capacity strengthening requirements in the provinces (and institute as necessary) in order to achieve these objectives. It is implicit within this process that there will be a phase two.

“Phase two” will involve the implementation of management, development and training programmes as determined in phase one. In effect, phase two will be the day-to day, year to year, running of the institute including any required inputs to achieve its aims. Phase one of the project will provide detailed costing of input requirements for these future activities.

RISKS AND ASSUMPTIONS

It is assumed that provincial governments will support the concepts embodied in this proposal, subject to their appropriate inputs and modifications, as necessary. Although most provinces may desire to have their own specific development projects, it is assumed that most, if not all, provinces will wish to co-operate in the sector in question especially in terms of pooling and sharing technical resources as outlined in this proposal.

Concerning risks associated with these assumptions: In view of the importance of freshwater resources in most provinces, and the minimal investments currently being required from provinces for this proposal, it is considered extremely unlikely that most provinces will opt-out of this proposal. In fact, it would be surprising if any did. In any event, it is the purpose of the first phase of this proposal to incorporate the wishes/interests of provinces in future planning processes. This is, therefore, considered a virtually nil-risk assumption.

It is assumed that the proposal is implemented in a timely fashion and that the inputs are of the desired quality.

The greatest risk with the implementation cycle is a mis-timing between the recommendations of the feasibility study and P.N.G. government fiscal/budget cycles. The study needs to aim for its final recommendations being available prior to the cut-off date for financial planning for the following year. In effect, the study must be completed before June 1998 in order for any funding for an institute to commence in 1999.

There is a second risk that the establishment of the institute may be delayed through administrative, and in particular legal, delays.

It is mainly for these reasons that the first phase of this proposal may take two years - although the feasibility study itself could be done in less than one year.

REFERENCES

- Coates, D. and Mys, B. M. F. (1989) Preliminary report on population statistics and socio-economic data for the Sepik and Ramu River catchments. FAO/P.N.G./85/001 Field Document No. 4. 50p.
- FAO (1995). Inland capture fisheries and enhancement: status, constraints and prospects for food security. Report of the International Conference on the Sustainable Contribution of Fisheries to Food Security. Kyoto, Japan, 4-9 December 1995. Government of Japan. Document # KC/ FI/95/TECH/3. 85p.
- Frielink, A. B. (1983) The rural coastal population of Papua New Guinea. Department of Primary Industry, Fisheries Research and Surveys Branch, Report 83-11.
- National Statistics Office (1994). Report on the 1990 national population and housing census in Papua New Guinea. National Statistics Office, Port Moresby, P.N.G.. 397p.

ANNEX

Draft terms of reference for the technical inputs for phase one

Senior Technical Adviser

Duties:

The senior technical adviser will have overall responsibility for supervising the feasibility study as outlined in this proposal. He/she will work in conjunction with support staff (as made available) and in full co-operation with relevant provincial and national authorities. In particular the expert will:

(1) Prepare options for infrastructures to promote the co-ordination of the management and development, at provincial level, of P.N.G.'s inland aquatic resources, and especially freshwater capture fisheries, including the desirability of the establishment of an institute for this purpose, this will include:

proposed staffing arrangements,

linkages with provincial and national authorities, the private sector and rural fishing communities,

the infrastructure under which the institute will operate and its governing mechanism,

budgets to establish the institute and run it for an interim period (provisionally five years),

policies, work plans and implementation schedules for the institute in detail for the first five years and in outline for 20 years thereafter, policies and activities of the institute must be in-line with the objectives of management and development in the sector,

the institute should be staffed and funded on an optimum cost effectiveness basis, making the best use of human resources in provinces,

location of the institute headquarters,

legal requirements for the establishment of the institute.

The institute shall not be solely a research institute but shall cover all necessary activities involved with the management and development of freshwater resources. The institute shall act for, and on behalf of, provinces for the benefit of all provinces equally. The infrastructural setting of the institute will be such that it will promote and attract the financial and human resources necessary for the management and development of freshwaters in-line with the importance of the sector; both for the institute itself and in provinces. The institute shall not be

placed under another infrastructure that, irrespective of any written policies to the contrary, may constrain the management and development of inland aquatic resources by placing the sector as a low priority (priorities must be indicated effectively by the actual allocation of appropriate human and fiscal resources).

(2) Formulate detailed plans, policies and programmes for the development of P.N.G.'s freshwater resources for the good of local communities, provinces and the nation as a whole. Where necessary, such policies will be prioritised. These policies and programmes will form the core policies and programmes of the institute and provinces. Specific areas covered will include:

increasing *per caput* production from freshwater fisheries in order to improve both food security and the economy of rural communities, provinces and the nation as a whole,

research requirements (including biology/ecology, socio-economic or other fields) to achieve this aim,

licensing and inspection requirements,

statistical monitoring (catches and landings) requirements,

monitoring the state of aquatic environments (e.g. water/habitat quality),

integrated management of freshwaters (cross-sectoral considerations),

educational programmes,

fishing technology inputs (including gears, processing and marketing),

monitoring the impacts of and, if necessary, promoting the extension of, previous fish stocking programmes for inland waters,

any national and international legal obligations for the management of freshwater fisheries activities including the Fisheries Act, Animal Disease & Control Act, Quarantine Act, Fauna & Flora Protection Act, and the Convention on Biological Diversity.

(3) Prepare, in conjunction with the training specialist, an appropriate training programme promoting the strengthening of technical capacities in the required areas in order for P.N.G. to effectively manage and develop freshwater resources over a 25 year period (concentrating in detail on the first 5 years) in order to reach the development objectives. Such capacity strengthening shall be directed mainly at provinces based on the concept of human resources pooled and shared between provinces; co-ordinated through the institute. This shall include the investigation of the suitability, and availability, of aid funding for such a programme over an indicative five year period (including preparation of appropriate submissions).

Qualifications:

Required:

The expert will have a broad knowledge of the management and development of inland fisheries, particularly inland artisanal fisheries (especially in rivers). Specific expertise in the following areas should be substantiated by an appropriate record of publications:

stock assessment of river fisheries

monitoring of inland catches and landings

ecology/limnology of freshwaters

processing, handling and marketing

socio-economic aspects of inland fisheries development

fish stock enhancement techniques (in particular stocking)

integrated management of inland aquatic resources, especially river basins

Extensive experience at both research, resource development, management and administrative levels dealing with inland aquatic resources in developing countries.

Excellent command of written English.

Extensive knowledge of project formulation, budget preparation and project implementation.

Higher degree in an appropriate field (preferably at PhD level)

Knowledge of socio-economic conditions in P.N.G., especially as they relate to the artisanal fisheries sector.

Experience with inland fisheries in the New Guinea region a considerable advantage.

Draft terms of reference for the

Training Specialist

Duties:

Under the supervision of the senior technical adviser, and in full co-operation with other staff and provinces, in relation to the objectives of the project, the specialist will:

establish the existing technical strengths and weaknesses of both national and provincial staff in relation to the management and development of inland aquatic resources,

identify, and prioritise, appropriate training requirements for such staff in relation to the immediate management and development objectives, as outlined by the senior adviser on inland fisheries, which should, as far as possible, maximise the opportunities for training within P.N.G. or regionally, and

prepare appropriate and realistic budgets for optimal training programmes, indicating, where possible, the opportunities for aid-assisted training inputs.

Qualifications:

Higher degree in relevant field back-up by considerable experience in developing countries.

Extensive knowledge of training requirements and activities for strengthening technical capacities in the management and development of inland aquatic resources.

Wide knowledge of the requirements for the management and development of inland fisheries.

Wide knowledge of opportunities for regional training in the required fields.

Knowledge of project formulation, preparation and budgeting.

Knowledge of P.N.G. training infrastructures desirable.

Excellent English writing abilities.

Draft terms of reference for the

Legal/administration Adviser

Duties:

Under the supervision of the senior technical adviser, the legal/administration adviser will:

draft appropriate institutional arrangements, including any necessary legal requirements, for the establishment of an institute for the management and development of P.N.G.'s inland aquatic resources including, if necessary, drafting appropriate submissions to the government of P.N.G. for appropriate legislative action

advise on appropriate, effective linkages between the institute and provincial authorities, ensuring the institute remains responsive to the needs of provinces, the private sector and rural fishing communities

advise on suitable infrastructures for the institute, and related activities in provinces, as outlined in this project proposal, including consideration of staff welfare and career development opportunities

Qualifications:

An appropriate degree in administration or law or equivalent relevant field.

Preferably a higher degree in an appropriate field.

Extensive knowledge of public sector administration in P.N.G..

Extensive knowledge of appropriate P.N.G. laws, legislation of the public sector in P.N.G. and legislative procedures in P.N.G..

