Title	Fisheries Development Policy and Education in Papua New Guinea
Author(s)	MATSUOKA, Tatsuro
Citation	南太平洋研究=South Pacific Study, 15(2): 75-96
Issue Date	1995-03-20
URL	http://hdl.handle.net/10232/15584

South Pacific Study Vol. 15, No. 2, 1995

Fisheries Development Policy and Education in Papua New Guinea

Tatsuro MATSUOKA[1)]

Abstract

The fisheries development policy in Papua New Guinea is executed in the Sector Review and ADB Report, where new strategies such as promotion of market-oriented coastal fisheries and effective production with modern fishing gear and vessels are identified. Despite of the development policy, the fisheries education has declined since the 1980's. There is less correlation between the development policy and education. The two major fisheries educational institutions remain sparse production of higher-level technical manpower, whereas fishing technology is badly lacking. The redirection at UPNG appeared towards aquatic and biological sciences. However, management of fishing gear and methods such as, fishing technology for selective harvest and avoidance of incidental by-catch, unaccounted mortality and ghost fishing is emphasized in the recent draft of the Code of Conduct for Responsible Fishing. This principle is applicable to PNG where problems of discards of by-catch by prawn trawlers, an inconsistent mesh size regulation against fish size regulation in barramundi gillnet fishery and destructive dynamite fishing remain unsolved. The inconsistence between the industrial policy and its educational strategies may provoke deficient man-power production against future fisheries development. Fisheries education toward the sound combination of studies on resource assessment and selective fishing technology is required. Regional approach among the South Pacific countries is also important because of large cost of fisheries education.

Key words: Papua New Guinea, Fisheries, Education, Policy, Fishing Technology

Introduction

The fisheries industry is one of the primary sectors expected for development in most island countries in the South Pacific region. The industry has, however, peripheral history in those countries, therefore, man-power production is the urgent prerequisite for its development. It is ironic, however, fisheries education and training have little background in those countries. The present paper deals with fisheries education in Papua New Guinea (PNG) which has experienced drastic changes in recent years. This study compares the fisheries development policy and its education in PNG to review their inconsistency together with their circumstances, including the current status of the sector. It also highlights on the fisheries education competent with the latest trend in fisheries management. It is intended to provide a case study to consider the future fisheries

1) Faculty of Fisheries, Kagoshima University, Kagoshima 890, Japan

education appropriate in coastal developing countries in the South Pacific region.

Background and Present Situation of Fisheries

1 Physical Set up and Development Policy

Papua New Guinea (PNG) is located between the equator and 12° S, consisting of islands more than 1,400, of which the principal component is the eastern half of New Guinea Island (Fig. 1). The land area is 460,000km^2 with the population of 3.53 million, according to the 1990 national census [(1)], which has increased at 3.72% annually for the last decade. The state is composed of 19 provinces and the National Capital District of which 15 are coastal or of islands. The fisheries sector is administered by both the state Department of Fisheries and Marine Resources which gained the independent status from the former Department of Primary Industry in 1986 and the provincial Governments' fisheries offices.

The objectives for development of the nation has been documented in the Eight National Aims and the National Development Strategy (ANON., 1981), of which the concepts other than common rights of humanity and equality are summarized as;

(1) increasing proportion of the economy under the control of nationals and that of the income for nationals,

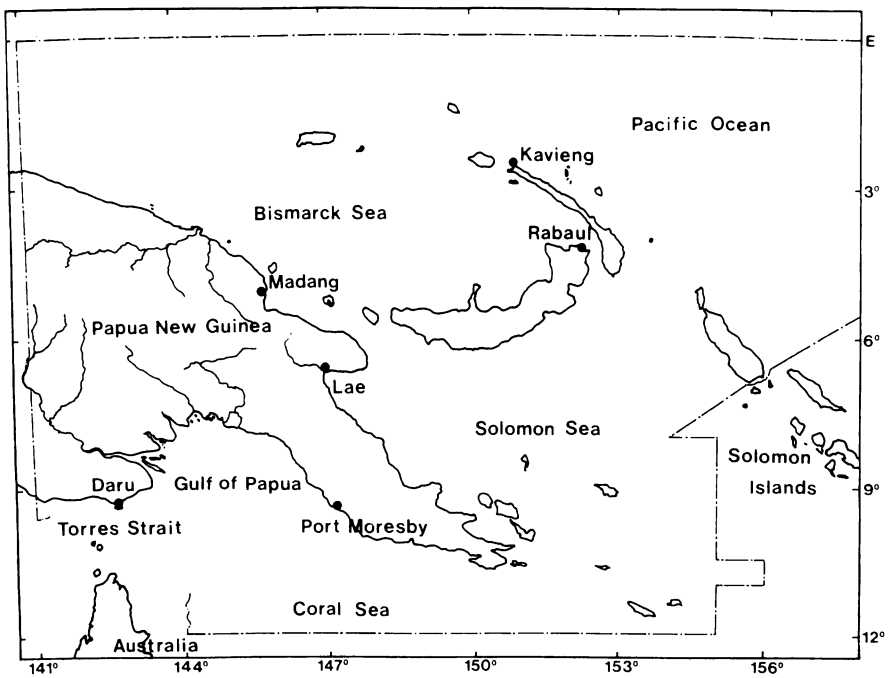

Fig. 1 Important locations relevant to fisheries industries and education in Papua New Guinea

(2) equal distribution of economic benefits among different areas of the country, and

(3) emphasis on small-scale business and decentralization of economic activities.

Reflecting these policies, the conception of 'localization' and 'rural development' have matured to become the major component of the current culture, which are applicable to a wide range of society and economy in the nation.

2 Aquatic Environment and Fisheries Resources

PNG possesses a total of 5,160 nautical miles of coast line and approximately 800,000 square nautical miles of Exclusive Economic Zone (EEZ), which was declared in 1978 (PERRY, publication year unknown). Its continental shelves are rather less extensive, which are approximately 1,740 km^2 (ANON., 1991).

Among its variety of marine resources, skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) tunas are the most abundant and stable. Their Maximum Sustainable Yield (MSY) is assessed approximately from 180,000 to 200,000 metric tons annually, while annual harvests are less than 50,000 metric tons in recent years (ANON., 1991).

There are a large number of resource species in coastal waters (MUNRO, 1967; KAILOLA 1987), however, a majority of them are thought to be diverted and hardly support large-scale development (ANON., 1979). Black tiger (*Penaeus monodon*) and banana (*Penaeus merguiensis*) prawns, in the Gulf of Papua (KAILOLA and WILSON, 1978) and Torres Strait (WILLIAMS, 1985b) are the most important resources at present, which have been developed in full. Spiny lobster (*Panulirus ornatus*) is currently managed jointly with Australia and only harvesting by divers is permitted (CHANNELLS, 1985). Distribution of barramundi or giant perch (*Lates calcarifer*) in a commercial quantity is limited in the southwestern coasts and adjacent rivers and lakes (OPNAI and TENAKANAI, 1987). Major sedentary resources are bivalves, such as pearl oysters (*Pinctada spp.* and *Pteria spp.*) and giant clam (*Tridacna gigas*), gastropodes mainly trochus shell (*Trochus niloticus*) and green snail (*Turbo marmoratus*) and a number of species of sea cucumbers (*Actinopyga spp., Thelenota spp.* and *Holothuria spp.*) (ANON., 1979), which have been increasingly harvested in recent years.

A majority of indigenous edible species in freshwater are assessed poor in size and quantity. Some species have been transplanted, among which common carp (*Cyprinus carpio*) and tilapia (*Tilapia mossambica*) are playing important roles in rural communities, while rainbow trout (*Salmo mykiss*) has peripheral significance [(2)], occurring in limited rivers and no lakes.

3 Present Situation of Fisheries Industry

Fishing industries in PNG are composed of four categories; foreign fleet fishery, industrial fishery, small-scale cash-oriented fishery and subsistent fishery, although this cognition has been minor in the country until recent years.

The industrial fisheries which have risen in the country are either PNG-based foreign

firms or joint venture projects. The tuna fishery has the greatest potential in terms of resources, however, it is deplorable that the resource is currently utilized little. Several overseas firms, mainly from Japan, started their operations in the adjacent waters, based in Kavieng, Madang and Rabaul before independence, in 1970-1972 (MATSUDA, 1986; DOULMAN and KEARNEY, 1987). It provided local people with employment opportunities as crew members and on-shore support workers. The industry reached a turning point in the late 1870's and entirely disappeared in 1982. Although one company based in Rabaul retried in 1984, the operation lasted no longer than one fishing season. Instead of utilization by capture of tuna, a cannery project has arisen with foreign investment and Government inputs in the early 1990's, of which the factory plant is under construction in Madang. The project includes construction of a domestic tuna fleet in the near future in conjunction with the cannery.

The most important industrial fishery at present is prawn trawling in the Gulf of Papua. The resource received interest in the early 1960's and joint-venture projects were formed in the late 1960's (GWYTHER, 1980). Three companies, involving 14 of 150 GT-type trawlers licensed for operation year round at present, produce onboard-frozen prawns for export. Although several changes have occurred in management by the Government and the status of companies, the prawn trawling has become steadily a domestic industry [3]. Some captains and engineers in addition to all crew members and most of onshore managerial and support staff are PNG nationals today.

Coastal fisheries development has been one of the priority fields so expressed by all the governments for the purpose of either rural development or production of export substitutes or even for export earning (ANON., 1979). The total MSY in the coastal waters is estimated 138,000 tons a year, of which the present harvest does not exceed 11% (ANON., 1989a). Resources well exploited in line with the above objectives, although in a limited extent, are lobster, barramundi, sea cucumbers and shells. Lobster is managed under the Torres Straight Treaty (WILLIAMS, 1985a) and barramundi regulation is set by the PNG Government [4], however, others remain unregulated and problems of over-exploitation are arising. A majority of coastal fisheries at present are not beyond the range of subsistent fishing. Full-time coastal fishermen are occurring only in limited places such as Port Moresby and Daru.

A majority of coastal people are conducting small-scale fishing for self-consumption and sale of surplus catch at nearby local markets. A small quantity of local fish products currently marketed is totally inadequate to substitute a huge amount of import of canned mackerel, so called 'tin-fish'.

Traditional smoking is the most usual processing technique. Icing is being promoted, however, ice is available only at limited stations and frequent break-down of ice makers sometimes results in no landing of fish for months [5]. The other first-hand or simple processing techniques are scarcely speculated with an exception of a recent attention to dried beche-de-mer as export stuff.

Development of aquaculture is beyond the range of possibility. Although prawn culturing has been considered, the future is unknown because domestic labour cost is re-

latively high in comparison to other developing countries such as in Southeast Asia, which are potential competitors. Fresh water culture has been attempted mainly in highlands (ANON., 1973). Tilapia, carp and rainbow trout are target species. Trout farming has been tried in highlands, however, they have been abandoned because of the costly importation of eyed-eggs from overseas. An aided project of stock enhancement in Sepik River is on-going (ULAIWI, 1990).

The foreign fleet fishery within the EEZ is currently accepted only for large-scale tuna operation by the USA, Korea, Taiwan and Philippines (ANON., 1991). The operation by the Japanese tuna fleet has been forbidden since early 1987 due to expiration of the agreement and breakdown of negotiations (ANON. 1989a), remaining quite large discords unsolved between the two parties. On the other hand, a multilateral fishing treaty among the U.S.A. and the Forum Fisheries countries, including PNG, signed first in early 1987, for the U.S. tuna purse seiners (ANON., 1989a), was revised in 1992 for continuation. The foreign fleet tuna fishery is assessed to be an undesirable alternative to PNG since collapse of its domestic industry.

4 Fishing Industry in Domestic Economy

All the recent governments have given a high priority to the development of primary industries in line with the national development objectives. A total of 36% of the population is thought to be involved in cash economy, while the remaining people are assumed to live on self-reliant gardening and fishing. A majority of the former portion is, however, conjectured to be small-holders in rural areas (ANON., 1989a). Employment opportunities in rural areas are extremely sparse.

The primary industry plays important roles in the economy and the society. Though the production by the primary industries is approximately 30% of GDP, a total of 85% of the population is assumed to be involved in the sector (ANON., 1989a). Mining and oil industries which are typically capital-intensive are drawing attention recently in terms of economic development, however, the primary industry must be the principal sector to absorb the dominant portion of the increasing population.

A total of 125,000 people are assessed to be involved in the fisheries sub-sector among 500,000 coastal habitants (ANON., 1989a). A total of 2,000-3,000 among the above are conducting cash-earning fishing. The employees in industrial fisheries and relevant business, mainly prawn trawling, are only 400 approximately, where the commercial fishery is not affluent since collapse of the tuna industry in 1984, which provided job opportunities of 1,300 (Matsuda, 1986). The export statistics of fisheries products illustrate the situation of the sector (ANON., 1989b) (Table 1). The industry is fairly embryonic, however, it is quite important in PNG where creation of job opportunities is limited.

Table-1a Export statistics of fisheries products in PNG (kg)

Item Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
Prawns	993,514	798,008	887,099	322,125	1,165,450	1,100,970	1,507,872	1,467,150	1,096,713
Lobster	7,184	102,696	163,749	162,956	63,969	41,525	50,273	62,347	51,818
Barramundi	16,690	62,450	88,810	60,400	8,500	62,602	34,743	116,480	64,372
Trochus				134,326	355,703	312,172	437,334	535,120	441,963
Blacklip				836	13,327	6,128	4,016	5,121	16,329
Greensnail				21,943	29,405	71,982	11,745	10,087	15,960
Beche-de-mer				9,000	7,130	4,668	16,579	119,376	121,636
Clam meat				80	9,830	949	4,202	21,030	31,657
Tunas	26,945,000	34,099,000	24,029,000	520,000	864,070	2,964,668	10,509,240		
Sharks (whole)				107,595	80,000	30,000	110,000	173,000	
Sharkfin				1,000				500	
Other finfish				68,060	10,856	100,448	38,206	71,736	16,570
Crabs				150		221			174
Total	27,962,388	35,062,154	25,168,658	1,408,471	2,608,240	4,696,333	12,744,210	2,581,947	1,857,192

Table-1b Export statistics of fisheries products in PNG (1,000 kina)

Item Year	1979	1980	1981	1982	1983	1984	1985	1986	1987
Prawns	3,812,902	3,764,257	5,005,034	1,666,382	8,139,647	6,457,796	9,555,818	8,894,613	8,783,661
Lobster	59,526	819,051	1,355,189	1,580,712	887,355	519,818	578,883	870,256	763,711
Barramundi	66,433	257,900	398,120	293,740	41,500	346,375	244,717	357,895	346,514
Trochus				114,711	347,328	389,057	686,732	937,293	927,545
Blacklip				1,547	35,991	7,912	9,351	10,175	42,914
Greensnail				66,013	112,354	162,337	67,619	35,315	61,892
Beche-de-mer				27,586	23,939	13,472	59,022	361,336	322,536
Clam meat				71	13,294	3,407	24,684	157,652	336,262
Tunas	15,400,000	25,800,000	20,000,000	255,687	762,376	1,704,845	5,678,178		
Sharks (whole)				26,899	20,000	8,700	101,750	147,450	
Sharkfin				1,500				725	
Other finfish				23,652	22,620	144,854	71,765	89,825	53,059
Crabs					300		1,105		736
Total	19,338,861	30,641,208	26,758,343	4,058,500	10,406,704	9,758,573	17,079,624	11,862,535	11,656,830

Fisheries Development Policy in Papua New Guinea

PNG had established no integral fisheries policies until the relevant documents were executed recently, i.e. Fisheries Sector Review in 1989, Medium Term Development Strategy for the Renewable Resource Sector also in 1989 and Fisheries and Coastal

Resource Management and Development Report in 1991. The initiatives of the progressive policies seem to have been affected by the establishment of the government Department of Fisheries and Marine Resources in 1986 and endorsement of Planning and Budgetary Strategy 1988-1992 (KWARARA, 1988) in 1987, where the objectives of the exploitation of natural resources were defined as;

(1) achievement of sustainable economic growth,
(2) creation of income-earning opportunities in rural areas,
(3) establishment of fiscal self-reliance, and
(4) reduction of social and economic inequalities.

1 Coastal Fisheries Development Plan in 1979

The first national policy for the fisheries industry was the Papua New Guinea Coastal Fisheries Development Plan (ANON., 1979), although it did not incorporate whole issues in the sector, as its title indicates. Although the objectives in the Plan jumbled a number of secondary expectations from fisheries development, the core ideas are summarized as;

(1) development of cash economy to improve standard of living and welfare of coastal people,
(2) provision of potential employment opportunities for coastal youths, and
(3) self sufficiency of the nation on renewable resources currently wasted.

The elements of the principle which were reflected in the succeeding policy documents could be viewed in part, however, the characteristics of this plan appeared in its impractical strategy for implementation. It was planned for the public sector to visit villages by boats routinely to buy fish. The proposal emphasized social welfare, and consequently, relied upon surplus products of subsistent fishing to be put into a nationwide market or as much to be of export quality without improvement of fishing techniques. It was no later than the early 1980's when the plan folded.

The plan was reviewed by individual provincial offices, which often mentioned many constrains [5] in coastal fisheries. Although they were not officially documented, requirements for development are summarized as;

(1) increasing the capability to introduce or to develop new coastal fishing techniques,
(2) development of preservation and processing techniques for surplus production in high tropical temperatures, which will in turn raise marketability of catch,
(3) promotion of the consumption of fisheries products and expansion of marketing, and
(4) establishment of leading projects in areas where large markets are readily available, such as in Port Moresby and Lae.

Provincial sectors tried such an approach to promote commercially-oriented fishing projects on the basis of technical extension services instead of purchasing fish. These initiatives, however, had not been incorporated in the national policy until 1989.

2 Fisheries Sector Review Papua New Guinea

The first over-all fisheries policy emerged in the Fisheries Sector Review Papua New Guinea (namely Sector Review) (ANON., 1989a). Although this was created as the report of a project aided by the United Nations Development Programme, it seems to have been regarded as one of the proxy national fisheries policies these days. Its four objectives (Table 2) are summarized as;

Table 2 Objectives, key issues and strategies defined in Fisheries Sector Review

Objectives	Key issues	Strategy
A. Develop renewable fisheries resources within the limits of sustainable yields	(1) Resource availability high, but varies between provinces	Prepare provincial development plans
	(2) Access to resource may limit development	Review usage rights in fisheries to seek clear demarcation in the long term
	(3) Some resources are vulnerable to over-exploitation	Implement management plans for each major fishery and monitor exploited resources
	(4) Monitoring and enforcement required for planned and effective development	Reorganise and upgrade licensing, inspection, and enforcement of management plans and agreements
B. Invest public sector resources in economically viable small-holders which lead to the expansion of exports and import substitute and which will expand local food supplies and give small-holders increased access to the cash economy	(1) Skills and motivation are frequently lacking	Assess training and develop training programmes at all levels, including fishermen
	(2) Appropriate infra-structure is required to support development	Encourage localised self-sufficiency based on market access, availability of suitable vessels, ice supply and rationalise existing facilities
	(3) Strengthen provincial fisheries implementation	Increase level of technical support and resources to provinces from DFMR
	(4) Extension services needed in support of development	Upgrade extension skills at provincial level, and increase accessibility to fishermen
	(5) Inland yields can be enhanced with selective introductions	Continue Sepik River study and more effectively develop subsistence pond production of introduced species
C. Invest in improvements in national extension and monitoring of public project implementation, in order to improve the technical support offered to provincial divisions in the execution of fisheries projects	(1) DFMR not totally effective at present	Reorganise DFMR as proposed, recruit staff and address policy issues
	(2) Liaison with, and support of, provinces is poor	Upgrade linkages with provinces (development plans) and consider implementation of regional approach
	(3) Information needed in support of planning and management is badly lacking	Improve information services as a high priority and improve public relations
	(4) Fish consumption is low and product quality mediocre	Increase consumer awareness, promote product and improve quality standards, especially of exports
D. Promote commercial investment in the development of fisheries resources	(1) Few incentives are available for potential investors	Review investment policy and provide appropriate incentives
	(2) Infrastructure to support investment not readily available	Develop clear policy and provide support facilities where judged necessary

The table contents are exactly the same with those appeared in the source (ANON., 1989a) with an only exception of the numbers given to objectives as A. to D.

(A) resource development within the range of sustainable yield,
(B) promotion of economically viable small-scale fisheries in rural areas,
(C) enhancement of provincial expertise for project implementation, and
(D) increased investment to industrial fisheries by the foreign and private sector and their localization.

The objectives in the Sector Review traced those manifested in the Planning and Budgetary Strategy 1988-1992. The objectives (C) and (D) above were not directly coincident with those in the Strategy 1988-1992, however, the four objectives clearly correlated with the principles of the National Development Objectives such as, resource conservation for future generations, rural development and decentralization and localization of the industries.

In order to implement the objectives, key issues and strategies were identified (Table 2). This was, perhaps, the first official analysis of constrains in the sector, therefore, an extremely wide range of views were documented. The important strategies corresponding to the objectives are;

(a) implementing resource management plan, licensing, inspection and enforcement against over-exploitation,
(b) extension and skill training at all levels and techniques suitable for localized self-sufficient fisheries,
(d) reorganization and strengthening both national and provincial institutional structure, and
(e) review of the policies for foreign investment and development of infrastructure.

Particularly the second policy includes entirely new tactics to aim at market-oriented coastal fisheries, effective production with modern fishing gear and vessels and privatization of coastal fishing authorities. The forth policy is also quite practical which was not identified previously. These features were obviously in line with the new concept of encouraging domestic fishing industry, localized resource utilization and private fishing industry.

3 Medium Term Development Strategy for the Renewable Resource Sector

The Medium Term Development Strategy for the Renewable Resources Sector 1990-1994 (ANON., 1989b) seems to have transcribed on the Sector Review, because this document was partially photo-copied from the Sector Review. The objectives were exactly the same. The strategies in this document (Table 3) were, however, more workable in comparison to those in the predecessor. Their correspondence to the objectives is summarized as;

(a) researches on utilizable resources on which management programmes are formed to control their exploitation,
(b) training in extension, administration and fishing technology for cash-oriented artisanal fishing,
(c) marketing and products development strategy, and
(d) foreign investment in domestic and industrial fisheries (tuna), their localization,

Table 3 Objectives and strategies defined in The Medium Term Development Strategy for the Renewable Resources Sector 1990-1994

Objectives	Strategies
A.	(1) undertaking research to extend knowledge about the nature and potential of utilisable resources (2) developing resource based management programmes with controls on the level of exploitation where appropriate (3) collection of data and introducing management procedures to monitor and provide a basis for policing industrial fishing activities
B.	(1) implementing a programme of coastal fisheries development economically viable provide cash earning opportunities for artisanal fishermen with poor access to market (2) providing training in extension, administration and fishing technology
C.	(1) to establish marketing and product development strategy
D.	(1) encouraging foreign investment in domestic and industrial fisheries, especially tuna fishing industries and establish support infrastructure facilities (2) Obtaining a resource rental for under-utilised tuna resources through the negotiation of access agreements for foreign fleets (3) incorporating localisation of ownership and training of nationals into agreements with foreign interests involved in domestic industrial fishing

The table contents are the same with those appeared in the source (ANON., 1989b), however, they were not defined with correspondence with the objectives from A. to D., which are exactly the same to those in Table 1.

and fishing agreements with foreign fleets.

4 Fisheries and coastal Resource Management and Development Report

The Fisheries and Coastal Resource Management and Development Report (namely ADB report) was printed as the final report of the feasibility study of an extensive loan project allied by the Asian Development Bank (ADB) (ANON., 1991). This report also seems to have based on the principle of the Planning and Budgetary Strategy 1988-1992 and to have followed the Sector review, although, description was markedly changed.

One of the features of this report was that it rationalized the objectives by excluding issues on institutional restructure (Table 4). It altered the order, perhaps also the priority, of the objectives and strategies, too. It looked at more cash- and business-oriented fishing industries. Positive acceptance of foreign fleets, obviously within the range of control, and support to commercial fisheries, while supports to the subsistent fisheries were confined in stocking and aquaculture in highlands, were new. Inclusion of

Table 4 Objectives and priority fields defined in the report on the Fisheries and Coastal Resources Management and Development Project

Objectives	Priorities
A. to maximize national revenue from distant-water fishing efforts within the EEZ of Papua New Guinea	maintaining or increasing government revenues from licences and exercising control over utilization of EEZ resources through access agreement
B. to establish a domestic-based tuna industry	the necessary policy reforms to stimulate investment in and development of a domestically-based tuna industry
C. to improve support to other commercial fisheries	stock assessment, resource management, balancing of fishing effort to maximize sustainable yield, control of destructive fishing activities, improved extension activities, improved marketing and post-harvest services, and maximizing benefits within the context of the social and cultural traditions and local development opportunities
D. to promote localized self-sufficiency in the subsistence and artisanal fisheries	the alleviation of malfunction and increasing income and employment opportunities in the rural highland areas through increased productivity from aquaculture and from fish stocking

The contents of objectives are exactly the same to those appeared in the source (ANON., 1991b). Some unimportant words to construct sentences are omitted from those in the priorities.

workable issues such as; stock assessment, balancing between fishing effort and MSY and control of destructive fishing, was also significant. This reflected the feeble management of fishing techniques in coastal fisheries in PNG (MATSUOKA, 1990).

Fisheries Education in PNG

Fisheries education is offered by two institutions in PNG; the University of Papua New Guinea (UPNG) in Port Moresby and the National Fisheries College (NFC) in Kavieng. The former runs a 4-year long scientific programme for Grade-12 graduates and the latter, 2-year long technical training for Grade-10 graduates. In addition to the domestic under-graduate degree and post graduate diploma programmes, some ones gained their higher degree education overseas, e.g. in the United Kingdom, Australia, Japan and Canada. A number of personnel in the industry and the public sector have received half-year training in Japan through Japan International Cooperation Agency and Overseas Fisheries Cooperation Foundation of Japan. There are several institutions which may be useful in fisheries manpower production, however, their involvement is peripheral with an exception of the potential importance of the PNG Maritime College in Madang.

1 Diploma and Degree Programmes at Unitech and UPNG

The former Fisheries Department had run an integral fisheries programme since its establishment in 1976 first at the PNG University of Technology (UNITECH), Lae. A 3-year diploma programme was offered by the Department by 1985 at UNITECH. The Department was up-graded to a 4-year degree programme in 1983 and transferred to UPNG in 1986 to have become attached to its Science Faculty. The Department was merged into Biology Department in 1990 with large changes in the course structure and educational policy and the fisheries programme has become a small discipline of a reduced number of fisheries subjects.

Table 5 Degree programme offered by Fisheries Department, PNG University of Technology

Stream	Year	1st semester	Hours/w	2nd semester	Hours/w
Core subject	1	Biology I	3	Biology II	3
		Chemistry I	6	Chemistry II	6
		Mathematics I	5	Mathematics	5
		Physics	2	Physics	2
		Society, Technology & Development	2	Society, Technology & Development	2
		English for Fisheries Science	3	English for Fisheries Science	3
	2	Mathematics II	4	Mathematics II	4
		Analytical Chemistry	3		
		Organic Chemistry	3		
		Function of Management			
Professional subjects	1	Introduction to Fisheries Science	4	Introduction to Fisheries Science	4
	2	Fisheries Oceanography & Limnology	4	Aquatic Ecology	5
		Aquatic Invertebrates	3	Fisheries Microbiology	5
		Biology of Fishes	2	Fundamentals of Fishing Technology	4
		Elements of Nautical Science	2	Fish Processing I	5
				Introduction to Aquaculture	4
	3	Fisheries Biology	3	Inland Fisheries	3
		Pollution & Environmental Assessment	2	Fisheries Management	3
		Statistical Application to Fisheries	3	Fishing Gear Technology	5
		Fishing Gear Application	5	Mariculture	5
		Fish Processing II	5	Principles of Fisheries Extension	2
		Fish Culture	5	Advanced Communication Skills for	2
		Advanced Communication Skills for Fisheries Science	2	Fisheries Science	
	4	World Fisheries Organization	1	Fish Marketing	2
		Fisheries Law	2	Fish Behaviour and Fisheries	3
		Coastal Resources Management	3	Fish. Plant Management & Quality	5
		Fish Population Dynamics	3	Control	6
		Fishing Vessels Operation	5	Project	
		Fisheries Economics	3		
		Project	6		

Table 6 Degree programme offered by Fisheries Department, University of PNG

Stream	Year	1st semester	Hours/w	2nd semester	Hours/w
Core subject	1	Biology A	6	Biology B	6
		Chemistry I	6	Chemistry II	6
		Foundation Mathematics	6	Foundation Mathematics	6
		Physics I	6	Physics II	6
		Science English			
	2	Planet Earth	6		
Recommended subjects	2	Chemistry III	6	Introductory Ecology	6
		Physics III	6	Genetics & Evolution	6
	3	Chordate Biology	6	Invertebrate Biology	6
		Microbiology	6	Organic Chemistry II	6
		Elements of Computing	6		
		Organic Chemistry I	6		
Professional subjects	2	Basic Biology	6	Introduction to Fisheries	6
				Hydrography	6
	3	Fishing Gear Technology	6	Aquaculture	6
				Fisheries Biology	6
	4	Fisheries Management	6	Fisheries Economics & Marketing	6
		Muriculture	6	Aquatic Resource Management	6
		Advanced Fishing Gear Technology	6	Fish Processing Technology I	6
		Fish Processing Technology II	6	Special Topics in Fisheries	6

The curricula of degree programmes at UNITECH and UPNG are tabulated (Table 5, 6) (ANON., 1985: ANON., 1986: MATSUOKA, 1988). The UNITECH curriculum was designed on the principle to embrace four streams; fishing technology, aquaculture, resource and industrial management and seafood technology. The curriculum after the transfer became modified to fit in the common educational structure in the Science Faculty, UPNG. The Department offered only 14 subjects out of 23 (other than science core subjects at Year-1) required to graduate. The rest were free elective from subjects offered by other departments on the basis of the policy of liberal science.

The present fisheries programme (ANON. 1990) prepared by Biology Department (Table 7) is further reformed to suit marine biological studies, remaining a smaller number of technological subjects. The current UPNG programme seems suitable for providing personnel to fit into resource research and managerial positions in the public sector. The reduction of fisheries education at UPNG was mainly due to (MATSUOKA, 1988);

(1) a small number of student intake, and consequently, a lower efficiency due to

Table 7 Fisheries degree programme offered by Biology Department, University of PNG

Stream	Year	1st semester	Hours/w	2nd semester	Hours/w
Core subject	1	Biology A	6	Biology B	6
		Chemistry I	6	Chemistry II	6
		Foundation Mathematics	6	Foundation Mathematics	6
		Physics I	6	Physics II	6
		Science English			
	2	Planet Earth	6		
Recommended subjects	2	Chemistry III	6	Chemistry III	6
		Calculus I	6	Elements of Computing	6
		Quantative Genetics	6	Evolution & Ecology	6
	3	Chordate Biology	6	Microbiology	6
		Invertebrate Biology	6	Animal Physiology	6
		Resources A or Cell Biology	6		
	4	Biometry	6	Population & Quantative Ecology	6
		Marine Ecology	6	Free elective	6
Professional subjects	2			Introduction to Aquatic Sciences	6
	3	Capture Fisheries	6	Culture Fisheries	6
				Seafood Technology	6
	4	Fisheries Management	6	Fisheries Economics	6
		Limnology & Physical Oceanography	6	Special Topics	6

high cost for specialized training,

(2) a plan of rationalization of tertiary education under the previous Government, and

(3) a view during the 1980's to take tertiary fisheries education to be resource studies on aquatic biology and ecology.

2 Certificate Programmes at NFC

NFC is an internal body of the national Department of Fisheries and Marine Resources. Since its establishment, largely with Japanese aid in 1977, NFC has aimed at practically-oriented fishing training [6]. This is because it was anticipated to provide medium-standing fishing technicians for the tuna fishery, which was enterprising by PNG-based fleets invested by Japanese and Americans and, in turn, to develop modern domestic fishery industries. The PNG-based tuna fishery has, however, entirely gone. The educational objectives at NFC were, therefore, changed to produce general fisheries technicians during the mid-late 1980's [7]. In 1990, the NFC Interim Governing Council was formed and revision of its education was started.

In the curriculum (Table 8) during the 1980's [8], there were two distinguished streams in the technical aspect; i.e. (1) fishing gear and methods and (2) fishing craft, navigation and seamanship. Topics were, however, confined in a few variations of

Table 8 Previous certificate programme at NFC until 1993.

Stream	Year	1st semester	Hours/w	2nd semester	Hours/w
Elementary subjects	1	Mathematics	3	Mathematics	3
		English	3	English	3
	2	Mathematics	2		
		English	2		
Service subjects	1	Marine Biology	4	Marine Biology	4
		Fisheries Business Management	3	Fisheries Business Management	3
	2	Fisheries Extension	3	Fisheries Extension	3
		Fisheries Law & Surveillance	3	Fisheries Law & Surveillance	3
Technical subjects	1	Seamanship & Navigation	6	Seamanship & Navigation	6
		Fishing Gear Technology	6	Fishing Gear Technology	6
		Fishing Craft Maintenance	6	Fishing Craft Maintenance	6
				Fish Processing Technology	6
		Field Work (Line Fishing)	8	Field Work (Line Fishing)	8
	2	Seamanship & Navigation	6	Seamanship & Navigation	6
		Fishing Gear Technology	6	Fishing Gear Technology	6
		Fishing Craft Maintenance	6	Fishing Craft Maintenance	6
		Fish Processing Technology	6	Fish Processing Technology	6
		Field Work (night fishing)	12	Field Work (night fishing)	12

small-scale fishing. Many types of fishing gear and methods important in PNG, such as prawn trawl, barramundi gillnet and tuna fishing, were not taught. The training in the navigation and seamanship subjects were limited due to lack of proper training vessel. From the industry side, it was felt that the caliber of graduates had been declining compared to early graduates [9].

At the NFC Governing Council Meeting in 1991, several review reports were submitted. These reports dealt with issues from various view points, such as overall review of the NFC academic activities [10] and the national higher education policy in fisheries [11]. The representative of the industry emphasized strengthening technical training mainly required for industrial fisheries development [9], as the curriculum must put emphasis on sound understanding of capture fisheries, fish handling, navigational principles, basics of law and boat and engine maintenance. The discussion on the above resulted in the latest curriculum [12], which was designed with enhanced mathematics, science, and aquatic studies (Table 9). It was the justification that basic sciences and mathematics which had been distributed in technical subjects were structured. The professional subjects are consequently free from elementary topics and then can be strengthened. The new curriculum is under implementation from the Year-1 students in 1994.

Table 9 Revised certificate programme at NFC, since 1994

Stream	Year	1st semester	Hours/w	2nd semester	Hours/w
Elementary subjects	1	Mathematics	3	Mathematics	3
		English	3	English	3
		Applied Science	3	Applied Science	3
		Supplementary Mathematics (night class)			
Service subjects	1	Fisheries Biology	3	Fisheries Biology	3
		Oceanography & Aquatic Ecology	3	Oceanography & Aquatic Ecology	3
		Field trip (aquatic studies)	3	Field trip (aquatic studies)	3
	2	Fisheries Biology	3		
		Oceanography & Aquatic Ecology	3		
		Fisheries Business Management	3	Fisheries Business Management	3
		Fisheries Law & Surveillance	3	Fisheries Law & Surveillance	3
Technical subjects	2	Seamanship & Navigation	6	Seamanship & Navigation	6
		Fishing Gear Technology	6	Fishing Gear Technology	6
		Fish Processing Technology	6	Fish Processing Technology	6
		Fishing Operation (practical)	6	Fishing Operation (practical)	6
	3	Seamanship & Navigation	6	Seamanship & Navigation	6
		Fishing Gear Technology	6	Fishing Gear Technology	6
		*Marine Engineering	6	*Marine Engineering	6
		*Fish Processing Technology	6	*Fish Processing Technology	6
		Freezer Mechanics	6	Freezer Mechanics	6
		Fishing Operation (practical)	6	Fishing Operation (practical)	6
		Long offshore fishing trip		**Intensive course for seaman certificate or **Work experience in food industry	

*- and **-marked courses are respective pairs to be optional.

Discussion

1 Development of Fisheries Policy

Through the series of the documents, progressive fisheries development policy is observed. The early policies were apt to account conceptual items rather than the sector's forthright objectives; e.g. the Development Plan in 1979 enunciated as 'improving the welfare of coastal people by providing them with an opportunity for increased development' (ANON., 1979). They were also apt to confound objectives and strategies. For example, 'improvement of extension and monitoring' (ANON., 1989a) was included in the objectives in the Sector Review, although this must be simply one of tactics in administrative improvement. These defects have been overcome in recent versions. Sector's genuine objectives and strategies technically realistic have been progressively found. Those in the ADB Report are examples of achievement. Its strategies were doable, which listed (ANON., 1991), e.g.;

(1) to increase revenues from EEZ resources through access agreement,

(2) to stimulate investment in a domestically-based tuna industry,
(3) stock assessment and resource management,
(4) balancing of fishing effort to maximize sustainable yield, and
(5) control of destructive fishing activities.

Neither Sector Review nor ADB Report has been legitimated, however, recent policy-relevant documents, e.g. Prime Minister's Brief in 1992 [13], were drafted in line with the principles and even with sentences in these papers. The objectives and strategies in the ADB Report other than their order of priority can be, therefore, regarded as the latest consensus for fisheries development in PNG.

2 Assessment on Manpower Needs

At the NFC Governing Council Meeting in 1991, It was delineated that 'there will be a very large demand for skilled technicians on increasing interest in development of local industrial fisheries and on the assumption of the Government's long term policy' [9]. The required skills and qualifications emphasized by the Council members [9,10,11] were;

(1) fishing specialists (coastal fishing gear/methods, prawn trawling and tuna fishing must be included) qualified with on-deck certificates, such as coxswain, seaman, radio operator etc.,
(2) potential land-based fishing operation managers,
(3) marine engineering (at the level of out-board motor maintenance) and refrigeration technicians preferably with industrial certificate,
(4) seafood and fish processing technicians, and
(5) potential fish processing plant/factory managers,

Although the discussion was mainly concerned with medium-standing technician manpower, demands in technical aspects were distinctive. Table 10 analyzes manpower needs and potential responsibilities of the two institutions on the basis of the above discussion and the Government policy. The job description in the table may seem discriminative between the two institutions, however, it is justified by the strong bond between job status and educational qualifications in PNG.

3 Deficiency Between Policy and Education

In view of overall fisheries education in PNG, the combination of the programmes at UNITECH and NFC was oriented to technological issues and technical skills during the 1970's and the mid 1980's. It aimed so because of the industrial fisheries development for tuna and prawn resources those days. On the other hand, the aquatic resource management aspect was weak. This was reflected in that a number of graduates of UPNG Biology Department, before absorption of the Fisheries programme, were employed on resource biologist positions by the government Fisheries Division. Contribution by the two fisheries institutions in the active researches for resource assessment during the said period was sparse.

Generalization of the training contents at NFC and redirection of the programme to

biological sciences at UPNG since the 1980's seem to be attributed to that the fisheries sector as a whole lost the industrial bearings due to collapse of the tuna business and stagnated coastal fisheries development. The author reported [14] on the situation and problems of fisheries education in PNG at the Regional Fisheries Workshop organized by ADB in 1991. The Workshop members pointed out a risk to produce scant manpower against self-development of fisheries resources to the nation. It was also assessed that the deficit between liberal science education and technical training was becoming serious [15]. A working paper of the ADB Report spent a number of pages on the issue and described the situation as 'pathetic weakness' (RAKSASATAYA, 1991).

Table 10 also considers if the manpower needs are fulfilled by the two institutions with the latest curriculums. The largest deficit is the lack of the production of manpower in the following fields;

(c) potential managerials in industrial fisheries,

(d) rural development officers to supervise coastal people in harvest, preservation,

Table 10 Analysis of manpower needs in fisheries sector and appropriate institutions.

Industries	Job description	Appropriate institutions	
		UPNG	NFC
Industrial fisheries	(a) Fishing specialists, navigator and engineers for tuna and prawn trawl fisheries and seafood technologists,	-	x
	(b) Technicians such as operation managers for tuna and prawn trawl fisheries and cannery plants,	-	o
	(c) managerials in these industries,	x	-
Coastal fisheries	(d) Rural development officers to supervise coastal people in catching, preservation, processing and marketing of fish,	x	-
	(e) Mechanical technicians such as maintenance of out-board engines and ice maker machines in the extension services,	-	o
Foreign fisheries & international issues	(f) Inspectors with expertise in modern fisheries technology and resource management to be inspectors on foreign fishing fleets,	x	-
	(g) Scientists and administrators to work with international and regional fisheries cooperation bodies, such as FFA.	o	-
Administration, research & education	(h) Administrators with background for planning both coastal and off-shore fisheries development,	o	-
	(i) Resource management specialists competent in researches of fisheries statistics, resource analysis and fisheries economics,	o	-
	(j) Technologists to assess and develop the application of new fishing technology in the PNG conditions,	x	-
	(k) Fisheries educators in all the relevant fields.	x	-

The symbol 'o' and 'x' stand for either the institution's curriculum is designed to function or not in the responsibility to produce the described man-power and '-' stands for that the institution if not responsible.

processing and marketing of fish,

(f) inspectors with expertise in modern fisheries technology and resource management on industrial fishing vessels,

(i) technologists to assess and develop the application of new fishing technology in the PNG conditions,

(j) fisheries educators in all the relevant fields.

This implies that higher-level fisheries technical manpower which is emphasized in recent policy documents is produced scarcely. It must be a task of a university-level institution to satisfy these demands. Despite of strengthening the curriculum at NFC, this gap is hardly filled because of the nature of the college at the level of certificate programme. The recommendation made by the ADB Report for UPNG to focus on 'fishing technology especially fishing gear, vessels and food processing (ANON., 1991)' reflects that these aspects are badly lacking in PNG. Different directions and adverse correlation between the development policy and education are clear.

4 Current Trend in Fisheries Deveropment and Management

The redirection appeared at UPNG in the early 1990's was attributed to that tertiary fisheries education was regarded at UPNG as that in aquatic and biological sciences, as widespread during the 1970's to the mid 1980's. This recognition is thought also to have been affected by little incentive toward technological management of harvest by the government Department of Fisheries and Marine Resources [16]. There is, however, a new current of a combined management of resources and harvesting technology since the late 1980's over the world. Management of fishing gear and methods such as, development of fishing technologies for selective harvest and avoidance of incidental by-catch, unaccounted mortality and ghost fishing is emphasized in the Code of Conduct for Responsible Fishing recently drafted by FAO [17]. This principle is absolutely applicable to PNG where such problems as a huge amount of by-catch discards by prawn trawlers (MATSUOKA and KAN, 1991), an inconsistent regulations between mesh size and fish size in barramundi gillnet fishery (MATSUOKA, 1990) and destructive dynamite fishing around coral reeves remain unsolved. It has been also clarified that some long-line fishing gears are unsuitable in fishing grounds of tropical developing countries (MATSUOKA *et al.*, 1992), which must be taken into consideration in fisheries development and management (MATSUOKA, 1994). This principle also goes together with the strategy of 'control of destructive fishing activities' recommended in the ADB Report. Fishing industrial management is increasingly recognized as management of harvesting technology. Fisheries education toward the sound combination of studies on resource assessment and selective fishing technology is important.

The history in PNG teaches us another factor that extensive cost for fisheries education was too heavy even for PNG which is extremely large in every sense among the South Pacific island nations where fisheries industrial development is one of the highest priorities. Regional approaches is, therefore, important for successful fisheries education among the South Pacific countries.

Acknowledgement

This paper is based on the author's involvement in fisheries education in PNG for eight years, which was enabled by supports by many colleagues in Biology and Motupore Island Research Departments, UPNG and the National Fisheries College. The author thanks all the old friends and wish fruitful future of fisheries education in PNG.

Note

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(Accepted March 3, 1995)