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EDITORIAL

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THE ANSWER TO CENTRALIZED GOVERNANCE – DECENTRALIZATION OR FEDERALISM?

It has been observed that since the mid-twentieth century, the traditional trickle-down approach in development economic has not really been effective in alleviating Third World poverty and other ills of underdevelopment. Thus, many scholars and development practitioners have mentioned the need for new international and intra-national economic relationships amidst a center-down, free market framework that has led to a centralization and functional integration of power in state and private capitalist organizations as well as primate cities and large urban centers in developing countries, particularly the previously colonized ones. The center-down development paradigm as the framework of the trickle-down approach has, in turn, created spatiosectoral disintegration and/or leakages in the otherwise smoothly functioning institutional structures of Third World countries that ultimately led to continuing poverty, unemployment, dependence, exploitative dualism, and spatial imbalance. It has been shown in the genesis of the center-down paradigm that in pre-colonial periods there was relatively greater self-sufficiency, social cohesion, mutual help, non-absolute governance, communalism and autarky in traditional societies. It has also been shown that colonization established the centralization platform that integrated the hinterlands of colonized countries into the national and international markets amidst import substitution and export-led industrialization policies.

The siphoning or leakage process from local/rural areas and from the destitute sector of society that accompanied disintegration was seminally explained by the regional growth center models of Myrdal and Hirschman who incidentally stressed the role of political intervention in significantly minimizing backwash or polarization from local government units. Otherwise, the occurrence of the trickling down or growth center strategy will remain unsuccessful and conjectural amidst high incidence of poverty in the Third World. Thus, the rural growth center is recommended whereby development impulses would be infused directly to the small rural centers and local areas. However, in a free market economy where factors of production flow freely within countries, selective closure strategies have to be instituted in order to protect the local areas against unregulated leakages of developmental impulses. One way of doing this is through empowerment and entitlement that are made possible by decentralization and agrarian reform, respectively. But again, decentralization in unitary capitalistic countries where there are no constitutional guarantees for the functioning of the local government units can subject these units to arbitrary decisions of the central government. The federal structure may be recommended as seemingly the better alternative since the autonomous constituent states have their own constitutionally empowered local governments that can effectively regulate the flow of resources in their local units, particularly in the present unfettered market under the aegis of globalization.

The Strategy of Decentralization

Decentralization may be discussed first since, currently, it is popularly practiced by most countries of the world. Decentralization as a global trend is not actually a new concept. The term gained attention in the 1950s and 1960s when British and French colonizers prepared their colonies for independence by devolving responsibilities for certain programs to local authorities. In the 1980s, decentralization figured prominently in the development agenda together with the global focus on governance and human-centered approaches to socioeconomic development. Decentralization refers to the systematic and rational dispersal of power, authority and responsibility from the center to the periphery, from the top to the lower levels, or from the national to the local governments. There is, however, a particular type of decentralization that is most effective in effecting change and this is devolution, i.e., according to the UNTAP, "political decentralization and involves the transfer of power, responsibility, and resources for the performance of certain functions from the national to the local governments." Devolution aims to achieve the following: grant greater autonomy to local government units; make them self-reliant; allow them to improve their technical and administrative capabilities; expedite the delivery of public services; strengthen people's participation in the affairs of the government; and promote employment and economic activities. Usually, there are four approaches through which the decentralization of the bureaucracy can be identified, and these are: (1) devolution, (2) deconcentration, (3) privatization and (4) use of non-government organizations (NGOs) and other channels for service delivery. According to the UNTAP, deconcentration refers to "the delegation of authority and responsibility by the Central Offices to the regional, district, and other field offices of national offices". Privatization refers to the transfer of responsibility for certain governmental functions to the private sector. However, it is devolutionary decentralization that involves empowerment of the people, short of giving them total autonomy.

Decentralization in the Philippines

In the Philippines, decentralization has also been introduced in 1991 through the Local Government Code or R.A. No. 7160. The law aims to effect devolution to the local areas on such aspects as: (1) basic services or functions and personnel; (2) appointment of personnel and regulatory powers; (3) taxing powers and shares in nationally imposed taxes; and (4) people participation in local governance. Of the devolved powers that bear directly on poverty alleviation, those on basic services and taxation may be mentioned. The services/functions that have been transferred by the central government to the local government units (LGUs) and which are designed to improve the quality of life of the rural people are those on agriculture, health, social services, public works and highways, and environmental management and protection. The aspect of taxation has an even more direct bearing on poverty alleviation as it prevents the leakage of capital from the rural areas and is a forceful means to effect the spatial and sectoral trickling down of capital to such leakage-prone areas.

Decentralization has been in operation in the Philippines for a decade now and yet its significant provisions have not been fully implemented by LGUs. With regard to devolved services and functions, agricultural services and programs are the most commonly implemented but the most important service of health cannot be fully implemented particularly by lower-class municipalities. An issue that has been bothering the implementation of frontline services at the local level is the continued dominance of large-scale programs of national government agencies. Although the LGUs help in the implementation of these programs, they have actually little say in the process. An example of this is the national agency on environment and natural resources that is still exercising supervision, control and review over the implementation of services regarding environmental protection in local areas. On the aspect of taxation and fiscal matters, it has been observed that although the annual income of LGUs have significantly increased, the cost of devolved services have correspondingly increased, such that a number of local governments have incurred deficits in their financial operations. However, the inability to maintain sound fiscal operations stems partly from the lack of initiative and know-how of LGUs in fund sourcing. They have hardly ventured into public-private partnerships, bond flotation and inter-local cooperation—initiatives that are made more difficult by the private sector's view of LGU projects as high-risk investments.

It appears that the intervening variable in accelerating development in rural areas has to do with the values of both leaders and constituents. There is a need for political will or commitment among local chief executives and to adopt more creative approaches in socioeconomic development. Among the people, there is a need to imbibe the traits of self-reliance, industriousness, self-discipline and deferred gratification, among others, that one observes in both the Protestant and Neo-Confucian ethics as practiced by Western Europeans and East Asians, respectively.

Decentralization in Other Countries

In other countries, there are many political and economic reasons why governments adopt decentralization policies and there are numerous forms and degrees that decentralization can take. As Robert Ebel says:

The Western world sees decentralization as an alternative to provide public services in a more cost-effective way. Developing countries are pursuing decentralization reforms to counter economic inefficiencies, macroeconomic instability, and ineffective governance. Post-communist transition countries are embracing decentralization as a natural step in the shift to market economies and democracy. Latin America is decentralizing as a result of political pressure to democratize. African states view decentralization as a path to national unity.

Some scholars have made certain observations with regard to the relationship between decentralization and certain characteristics of countries. One of their findings is that *high-income countries are relatively more decentralized compared to low-income countries*. Also, countries with greater populations and area are more decentralized, since with increase in country size and population, sub-national governments are expected to play a larger role in service delivery. As reported in Government Finance Statistics, between 1980 and 1998, the average share of sub-national expenditures and revenues for 28 countries increased steadily. Based on shares of revenues and expenditures in 1997, 52 countries had some degree of fiscal decentralization. In 1998, of the 75 developing and transition countries with populations greater than 5 million, all but 12 claimed to be embarking on some form of fiscal decentralization. It has also been observed that decentralization has complemented the growth of democracies worldwide, with 80 percent of developing countries – which are mostly democracies – experimenting with some form of decentralization. One conclusion that may be made out of the above findings is that there appears to be a correlation between decentralization and countries with high per capita incomes. However, there is a need for more proof in order to establish clearly the causative influence of decentralization in the socioeconomic development of nations.

The Virtue of Federalism

Federalism may be considered as a more effective system in alleviating poverty among developing nations. A federal system of government is a system that institutionalizes the participation of local populations and communities to pursue development according to their particular competencies, culture and natural resources as operationalized through its own charter or constitution. The system observes the bottom-up or decentralized planning paradigm and one of its underlying principles is *subsidiarity*, where regions are given autonomy to allow them to run their affairs, manage their budgets and determine their development without having to wait for a central authority to act on their needs. Another principle is *sustainability* which can lead to poverty alleviation by allowing the responsible use of resources available locally while encouraging the regions to manage their own resource pool towards ensuring that the needs of future generations are served.

Unlike in a unitary system of governance where revenues are remitted to the national government, in a federal system the autonomous component regions take care of tariff, taxation and revenue. They retain a large proportion (up to 80%) of all collected revenues and remit to the national government the smaller part, in the process enjoying more fiscal autonomy. Also, unlike in a unitary system where basic governance falls under the jurisdiction of the national government, in a federal system regional governments take care of basic governance that would include peace and order, public works, social welfare, health, education, land and water use planning, agrarian reform, environment and rural development.

For the Philippines, the rationale for federalism is, first, to speed up the economic development of the entire nation and, secondly, to lay down the basis for a just and lasting peace in Mindanao. It may be observed that countries which have adopted the federal system of government seem to have more leeway to modernize and develop. In the case of the Moro unrest in Mindanao, the creation of a Bangsamoro Federal State would be a means of dissipating the causes of Moro rebellions that have remained intractable through the decades under the present unitary system of governance. It has also been pointed out, among others, that federalism will accomplish the following: increase citizen's capacity and willingness to solve their problems of poverty, unemployment, injustice, inadequate social services and infrastructure, and low productivity; spur inter-state competition and foster state self-reliance; and promote a strong national identity on the basis of economic, cultural and environmental diversity.

In a federal system, different independent state governments make public sector decisions and provide more opportunities than a decentralized unitary system for citizen participation at sub-national levels. A federal system lends itself easily to deconcentration since the administrative and political structures are already in place. In addition, the central government does not control member state officials in a federation, whereas sub-national governments in decentralized unitary states can only operate within the legislative powers assigned to them by the center. Thus, the workability of decentralization depends on the goodwill of the unitary central government, instead of relying on fundamental constitutional divisions of power as guaranteed in a federal state.

In the Philippines, under the current decentralized set-up where local government units have ample flexibility for creativity to make governance more responsible, the unitary structure has provided choke points to stop, divert and even deny the resources needed to implement poverty reduction programs. The diversity of cultures and languages and the archipelagic nature of the country are contributory hindering factors to localize the implementation of poverty reduction programs. Federalism may yet be the strategic institutional and structural reform the country needs to bring about genuine self-reliance and economic dynamism within clusters of local government units called federal states. The above observation is supported by findings in other countries which reveal that the average sub-national share of expenditures is 38 percent for federal countries and 22 percent for unitary ones.

However, it appears that the most important role of federalism in alleviating poverty in the rural areas of developing countries has to do with the significant minimization of the leakages of capital, labor, technology, entrepreneurship and resources from local areas. Stated otherwise, the federal structure of governance will drastically reduce the polarization or backwash process occurring in unitary states where developmental impulses are continuously siphoned off by the national government, the elite, the primate city and the large urban centers. In unitary countries which adhere to free enterprise capitalism, the leakage or polarization/backwash process occurs

unabated as there are no mechanisms for controlling the flow of development impulses to the hinterlands. In capitalistic federal countries, the deleterious leakage of capital goods and services to the national government and major urban centers would be significantly minimized as each autonomous region has the authority and means to regulate such flows as a sovereign state would using such trade instruments as tariffs, embargos, and fee impositions. The federal system can practice protectionism for the welfare of the component state and can practice the *selective closure strategy*, i.e., allowing only the beneficial influences to enter the autonomous state and preventing the entry of deleterious elements into it. Thus, the component state economy in a capitalist federated structure does not act like a perennially unplugged kitchen sink for it can either plug or unplug its entrances and exits despite operating in an open, free market economy. In a capitalist unitary structure, the component regions and urban centers act like unplugged kitchen sinks where investments introduced easily suffer leakages to higher administrative levels and parasitic places and sectors which can exert strong economic pulls and these would include the national government, the formal sector, the primate city, the advanced regions and the large urban centers. Disadvantaged in terms of the leakages of capital, labor, entrepreneurship and technology would be the rural centers, the local governments and the lagging regions – in the process perpetrating the condition of chronic poverty in them. Thus, federalism appears to be a better alternative for regulating the flow of developmental impulses among local government units particularly in pluralistic societies amidst a largely unfettered market brought about by globalization.

In the Philippines, under the current decentralized set-up where local government units have some flexibility for creativity to make governance more responsive, the unitary structure has provided choke points to stop, divert and even deny the resources needed to implement poverty reduction programs. The diversity of cultures and languages and the archipelagic nature of the country are contributory hindering factors to localize the implementation of poverty reduction programs. Federalism may yet be the strategic institution and structural reform the country needs to bring about genuine self-reliance and economic dynamism within clusters of local government units called federated states. The above observation is supported by findings in other countries which reveal that the average sub-national score of expenditures as percent of federal countries is 22 percent for unitary ones.

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TREND AND LEVEL OF DIFFUSION OF IRRIGATION AND ITS IMPACT ON THE ADOPTION OF AGRICULTURAL INNOVATIONS IN UPPER GANGA-YAMUNA DOAB

ATEEQUE AHMAD*
SYED KAUSAR SHAMIM**
FAZLUR RAHMAN**

ABSTRACT. *In the present paper an attempt has been made to examine the trend and level of diffusion of irrigation and its impact on the adoption of agricultural innovations in Upper Ganga-Yamuna Doab. Irrigation plays a dominant role in diversifying agriculture and for enhancing resource efficiency of related inputs like high yielding variety of seeds, chemical fertilizers etc. Using the empirical approach the authors have based their analysis on the primary and secondary data, which have been processed through relevant statistical and cartographic techniques. Analysis reveals that trends of diffusions of irrigation follows second degree curve, which is conformity with findings of individual districts. New package programmes have profound influence on the level of diffusion irrigation. Further, study shows that irrigation and the adoption of agricultural innovations is positively correlated in the region.*

Irrigation is indeed the life-breath of agriculture. Agricultural productivity generally depends on the availability of water, its proper use and management. Amongst the quick yielding inputs responsible for accelerating agricultural productivity during the short period, assured irrigation facilities not only help in increasing productivity but their availability is preconditioned for the application of other inputs. Irrigation is not only essential for the sustenance of agriculture but also its assured and timely supply is a prerequisite for diversifying agriculture and for enhancing resource efficiency of related inputs. Very often it plays the decisive role in selection of crops to be sown, cropping intensity, cropping pattern, extent of yield and time of sowing the crops. The adoption of certain agricultural innovations like chemical fertilizer, high-yielding variety of seeds, and plant protection chemicals solely depends upon assured and timely availability of water.

The study area has a vast reservoir of surface and ground water, fertile soils and better climatic conditions. The perennial river of the Ganga system, which has their source in the Himalayas, drains this region. The vast level plain and gentle slope

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provides every facility for the construction and development of the canal. Percolation from the rivers and canal contributes to maintaining the sub-soil water table. The region covers an area of about 20624 sq. km and consists of five districts, namely, Saharanpur, Muzaffarnagar, Meerut, Ghaziabad and Bulandshahr. The region lies in-between 28°4' to 30°24' north latitude and 77°2' to 78°29' east longitudes (Figure 1). According to 1991 census, it accounts for a population of 14,243,132, with a density of 690 persons per sq. km. It is a monotonous and fairly productive plain. Cultivation of crops has been the main occupation of the people in the region. The region receives 60 to 70 cm. rainfall, and 90

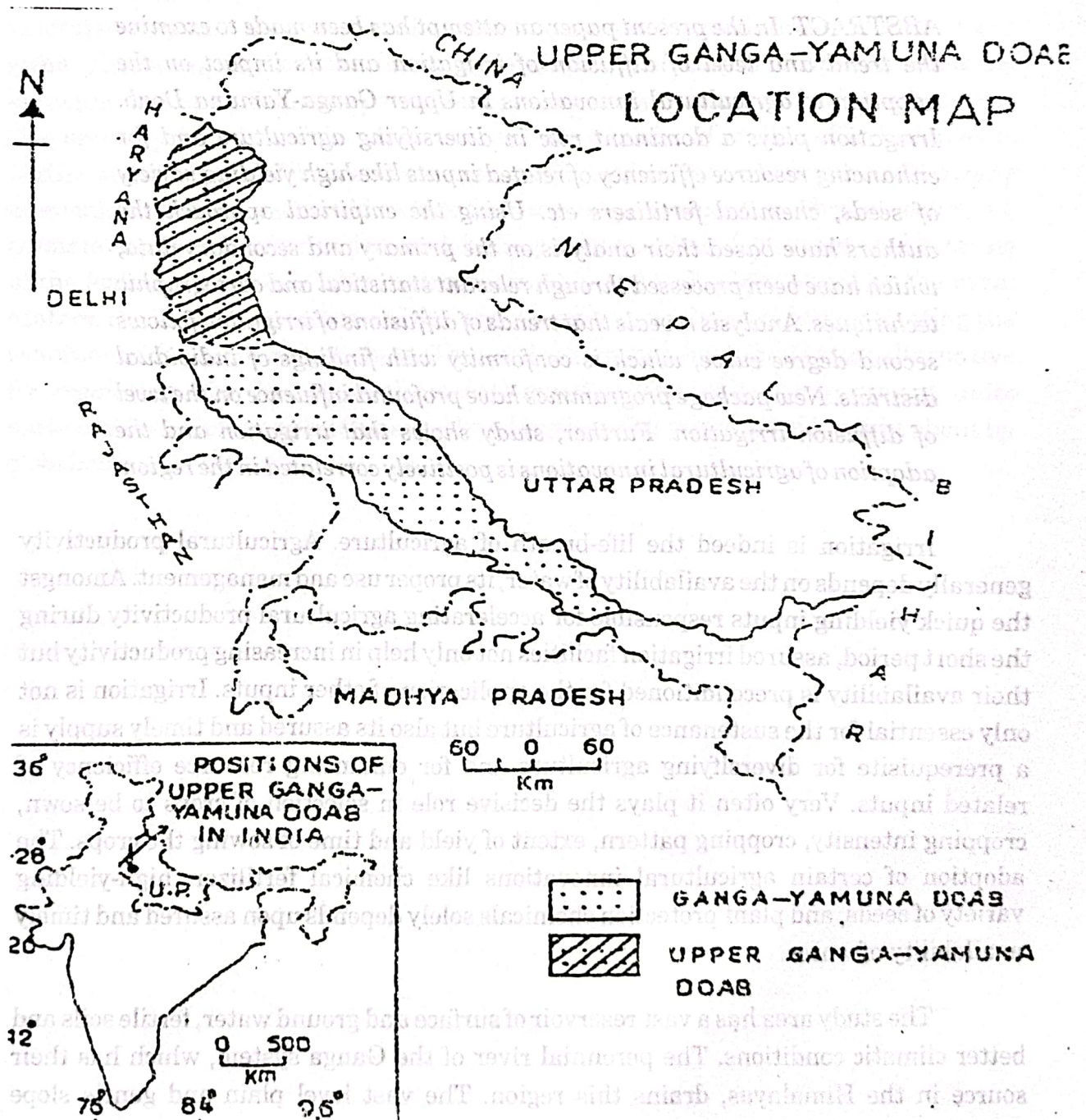


Figure 1. Location Map of Upper Ganga-Yamuna Doab.

percent of total rainfall occurs during the rainy season. During the rainy season, there are long dry spells in-between irrigation. Therefore, it is necessary for the growing of crops and desirable even in the rainy season to counter the effects of short dry spells. The study reveals that there was a massive expansion of irrigation between 1970-71 to 1993-94.

In the present study, an attempt has been made to examine the trend and level of diffusion of irrigation and its impact on the adoption of agricultural innovations through some statistical techniques. For spatio-temporal analysis, primary and secondary source of data has been used to examine the trend and level of diffusion of irrigation, two time periods, i.e., 1970-71 to 1993-94 and 1976-77 to 1993-94 for the individual districts and the region as a whole, respectively, because one of the districts of the region, i.e., Ghziabad, came into being in 1976. For the level of diffusion of irrigation, three points of time based on three years' moving average (1981-86-91) has been taken into consideration at tehsil level. The actual, second degree and logistic curves have been used to examine the trend of diffusion of irrigation. Second degree curve is represented by $Y_c = a + bx + cx^2$. Logistic curves are Pearl-Reed curve which is merely modified by exponential curve, i.e.,

$$Y_c = \frac{K}{1 + 10^{bx}}$$

Where K, a and b are constant and x is time variable

For the analysis of level of diffusion of irrigation, Z-score statistical technique has been applied, i.e.,

$$z = \frac{x - \bar{x}}{SD}$$

where Z = standard score, x = original value of the observation, \bar{x} = mean for all the values of x, SD = standard deviation of x.

The stratified purposive sampling technique has been used to examine the impact of diffusion of irrigation in the adoption of agricultural innovations. For this purpose, the region has been divided into five homogeneous strata and twenty sample villages composed of 3125 households were selected from these strata. Twenty percent of these households i.e., 625 households were taken in to account. The fieldwork was done in 1996-97 in both agricultural seasons. Further, scoring scheme, i.e., average adoption index, has been evolved to test the hypothesis formed.

Trend of Diffusion of Irrigation

Year	Table 1 Subanapur			Table 2 Marazottoport			Table 3 Maricut			Table 4 Fudabshahar			Table 5 Fudabshahar			Table 6 Upper Casapa - Yummas Mash		
	Gross Irrigated Area 10,000 hect.	Trend Values Second Degree Curve	Logistic Curve	Gross Irrigated Area 10,000 hect.	Trend Values Second Degree Curve	Logistic Curve	Gross Irrigated Area 10,000 hect.	Trend Values Second Degree Curve	Logistic Curve	Gross Irrigated Area 10,000 hect.	Trend Values Second Degree Curve	Logistic Curve	Gross Irrigated Area 10,000 hect.	Trend Values Second Degree Curve	Logistic Curve	Gross Irrigated Area 10,000 hect.	Trend Values Second Degree Curve	Logistic Curve
1970-71	2.49	22.22	3.92	34.20	33.43	4.40	36.32	35.29	0.10	38.07	7.02	.42	-	-	-	-	-	
1971-72	26.18	24.39	5.22	34.71	34.17	6.21	38.24	36.11	0.18	40.54	8.16	.87	-	-	-	-	-	
1972-73	27.05	26.42	6.74	35.16	34.90	7.85	38.52	36.83	0.34	36.76	9.27	.07	-	-	-	-	-	
1973-74	27.94	28.30	8.58	35.61	35.82	9.78	38.92	37.01	0.62	39.01	0.37	.67	-	-	-	-	-	
1974-75	28.74	30.04	11.08	33.37	36.32	17.09	40.58	37.42	1.14	44.78	1.45	.51	-	-	-	-	-	
1975-76	29.46	31.64	13.51	34.86	37.00	14.73	39.20	39.91	2.06	41.52	2.52	.04	-	-	-	-	-	
1976-77	31.07	33.10	16.89	36.79	37.68	17.89	39.56	40.01	3.67	40.72	3.57	.16	-	-	-	-	-	
1977-78	31.99	34.41	18.81	37.15	38.33	20.91	38.20	42.73	6.39	38.98	4.60	.21	-	-	-	-	-	
1978-79	34.92	35.58	22.51	39.53	38.98	24.29	40.01	43.11	10.65	39.83	5.61	3.42	-	-	-	-	-	
1979-80	37.29	38.60	25.71	40.58	39.61	27.71	45.32	45.83	16.89	48.82	9.81	8.43	-	-	-	-	-	
1980-81	38.53	37.48	29.71	41.56	40.22	31.07	44.45	48.66	24.08	48.91	7.59	5.27	-	-	-	-	-	
1981-82	37.50	38.22	32.12	40.30	40.83	34.25	45.28	48.99	31.70	50.23	8.55	2.22	-	-	-	-	-	
1982-83	38.87	39.26	35.15	41.44	41.99	37.15	50.24	47.83	38.25	59.30	0.43	8.98	-	-	-	-	-	
1983-84	39.84	39.57	37.88	41.16	42.55	39.72	45.51	47.80	43.07	49.40	1.54	4.92	-	-	-	-	-	
1984-85	41.50	39.73	38.99	44.65	43.10	41.95	47.70	48.33	46.22	50.75	2.24	9.71	-	-	-	-	-	
1985-86	42.43	39.75	40.90	43.84	43.63	43.64	48.57	49.44	48.14	53.40	3.12	3.28	-	-	-	-	-	
1986-87	43.41	39.63	42.65	44.83	44.15	45.10	49.52	49.69	49.24	54.42	3.98	5.82	-	-	-	-	-	
1987-88	42.75	38.30	43.83	45.34	44.65	46.68	50.75	50.55	49.85	58.01	4.83	7.54	-	-	-	-	-	
1988-89	43.10	39.95	44.53	46.17	45.14	47.68	51.90	50.69	51.20	54.42	5.68	8.69	-	-	-	-	-	
1989-90	43.32	40.17	45.35	45.61	45.62	48.50	51.16	51.31	50.33	57.72	8.47	9.43	-	-	-	-	-	
1990-91	43.86	40.87	48.15	45.02	48.08	46.14	51.48	51.01	50.49	57.90	7.27	9.91	-	-	-	-	-	
1991-92	44.09	41.0	46.37	45.47	46.53	49.64	51.58	52.22	50.55	57.69	8.04	0.22	-	-	-	-	-	
1992-93	45.73	41.21	47.00	46.85	46.96	50.03	52.02	53.11	50.58	57.20	8.80	0.42	-	-	-	-	-	
1993-94	46.15	42.28	47.12	47.69	47.38	50.33	53.48	53.75	50.60	58.60	0.55	0.54	-	-	-	-	-	

TREND OF DIFFUSION OF IRRIGATION

The trend of diffusion of irrigation has been examined district-and region-wise as a whole through actual values of irrigation and trend values of second degree and logistic curve.

Saharanpur

Table 1 shows the trend of gross irrigated area with the trend values of second degree and logistic curves. There is overall increase in the gross irrigated area from the base year 1970-71 to 1993-94. But there are some fluctuations, which may be attributed to the change in the cropping pattern. In Figure 2, the trend lines for gross irrigated area and computed values of second degree curves are plotted. A close view of the trend lines reveals that the actual curve runs very close to the second degree curve where as the logistic curve is set apart from both the curve but it has upward trend and crosses the second degree curve. It becomes closer to the actual as well as second-degree curve after

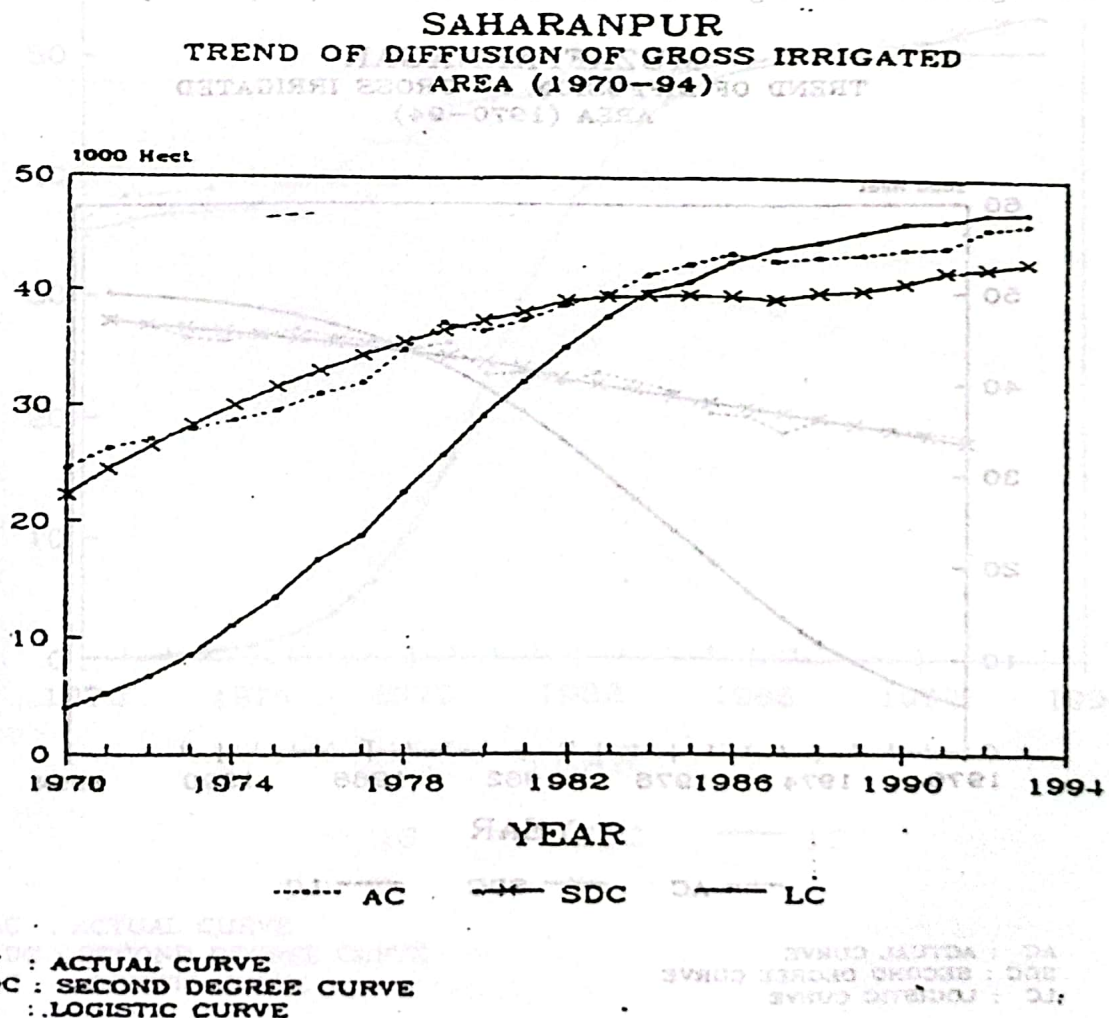


Figure 2. Trend of Diffusion of Gross Irrigated Area (1970-94), Saharanpur.

1983-84 and onwards. It proves that the trend of diffusion of gross irrigated area follows the patterns of the line of coefficient of correlation. The values of second degree and logistic curves are 0.5629 and 0.2986, respectively. Therefore, it is clear that the trend of diffusion of gross irrigated area follows second-degree curves.

Muzaffarnagar

Table 2 shows the actual value of gross irrigated area along with the trend values of the second-degree curve and logistic curve. There is general tendency of increase in the gross irrigated area but increase is very slow and steady. Figure 3 shows the curve of gross irrigated area and trend value of second-degree curve and logistic curve. Both the curve of gross irrigated area and the second-degree curve run very close to each other. But the logistic curve reveals the upward trend and becomes very close to second degree curve and actual curve which indicates that process of diffusion of gross irrigated area follows the actual curve very closely and logistic curve from 1983 and onwards.

The result of coefficient of correlation also proves those same facts. The value of second-degree curve and logistic curve is 0.6843 and 0.4975, respectively.

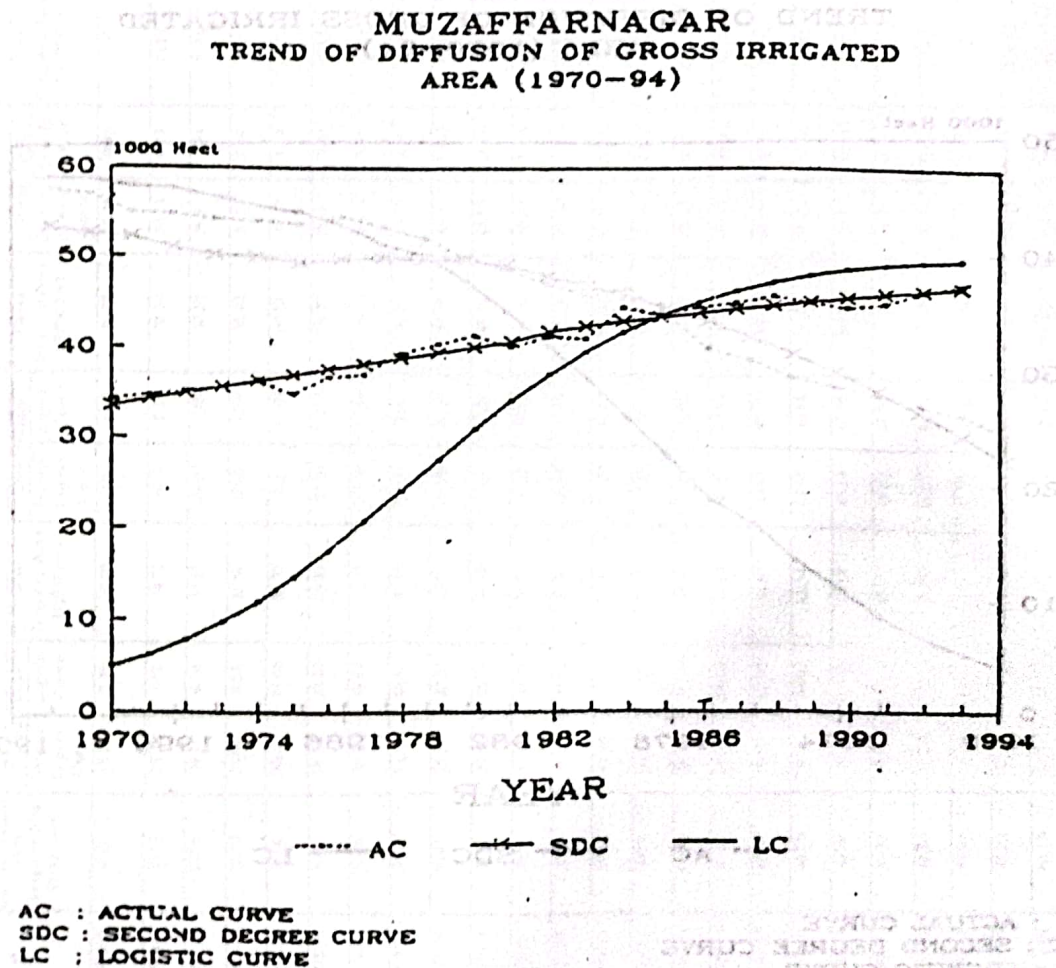
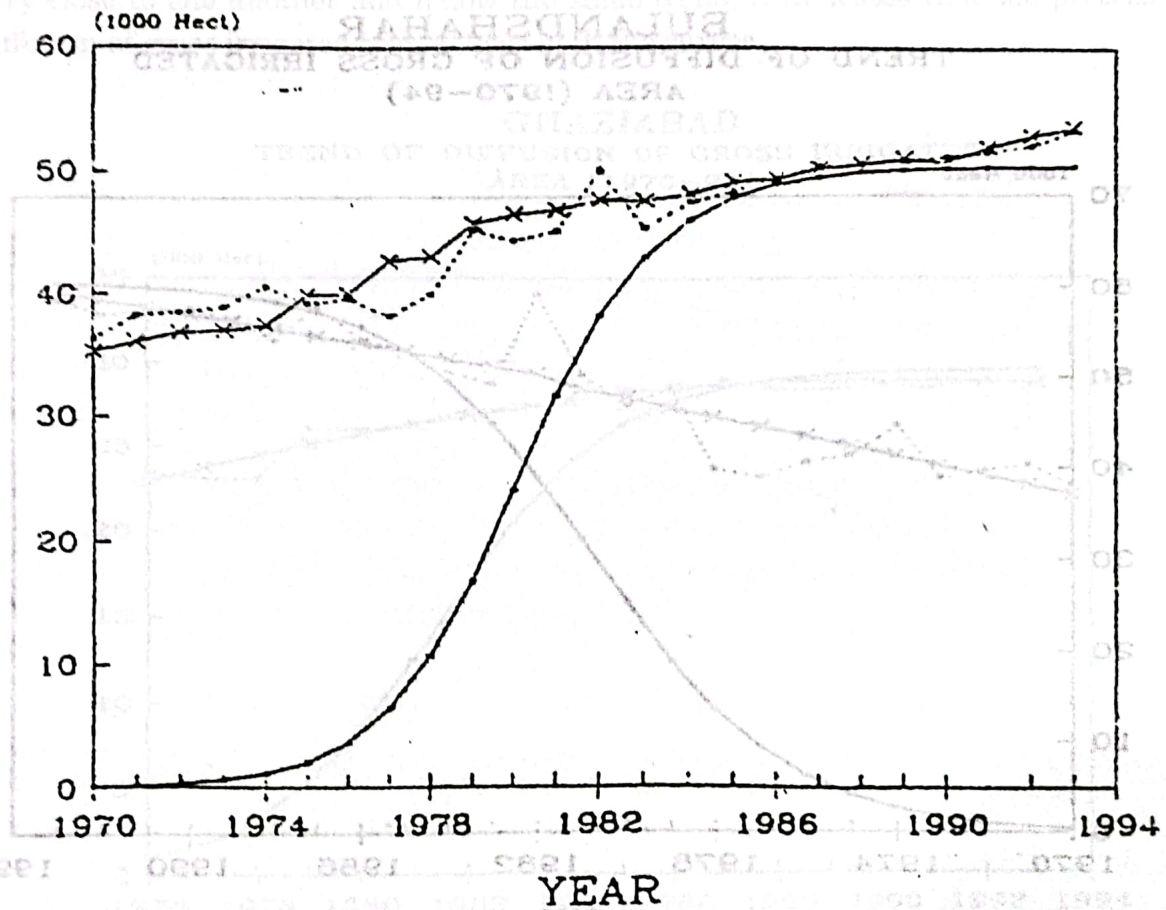


Figure 3. Trend of Diffusion of Gross Irrigated Area (1970-94), Muzaffarnagar.

Meerut

Table 3 indicates the values of gross irrigated area and the trend value of second degree and logistic curve, during more than two decades of the study area. There has been gradual increase in gross irrigated area with minor fluctuation. Figure 4 shows the curves of actual gross irrigated area, second degree and logistic curves which reveal that both the actual and second degree curves run in close proximity with each other while the logistic curve follows the same pattern after 1980 and onwards. The closer view of the trends of these lines shows that the line of actual gross irrigated area mostly follows the pattern of the line of second degree curve.

MEERUT
TREND OF DIFFUSION OF GROSS IRRIGATED
AREA (1970-94)



AC : ACTUAL CURVE
 SDC : SECOND DEGREE CURVE
 LC : LOGISTIC CURVE

Figure 4. Trend of Diffusion of Gross Irrigated Area (1970-94), Meerut.

Bulandshahr

Table 4 indicates the value of gross irrigated area and value of second degree and logistic curve. During the course of the study, the rate of irrigated area is continuously increasing but in a slow pace. Figure 5 shows the curves plotted with the help of actual gross irrigated area and computed values of second degree and logistic curves. The two trend values of actual and second degree curves run close to each other but with minor fluctuations, whereas the logistic curves show the upward trend and become very close to both the curves and run almost very closely to one another after 1983. However, actual curves move much closer to the second degree curve as compared to the logistic curve since 1970 to 1983 and thereafter all the curves follow the same patterns and run close to one another. Therefore, it indicates that the diffusion of gross irrigated area has followed the trend of second degree curves.

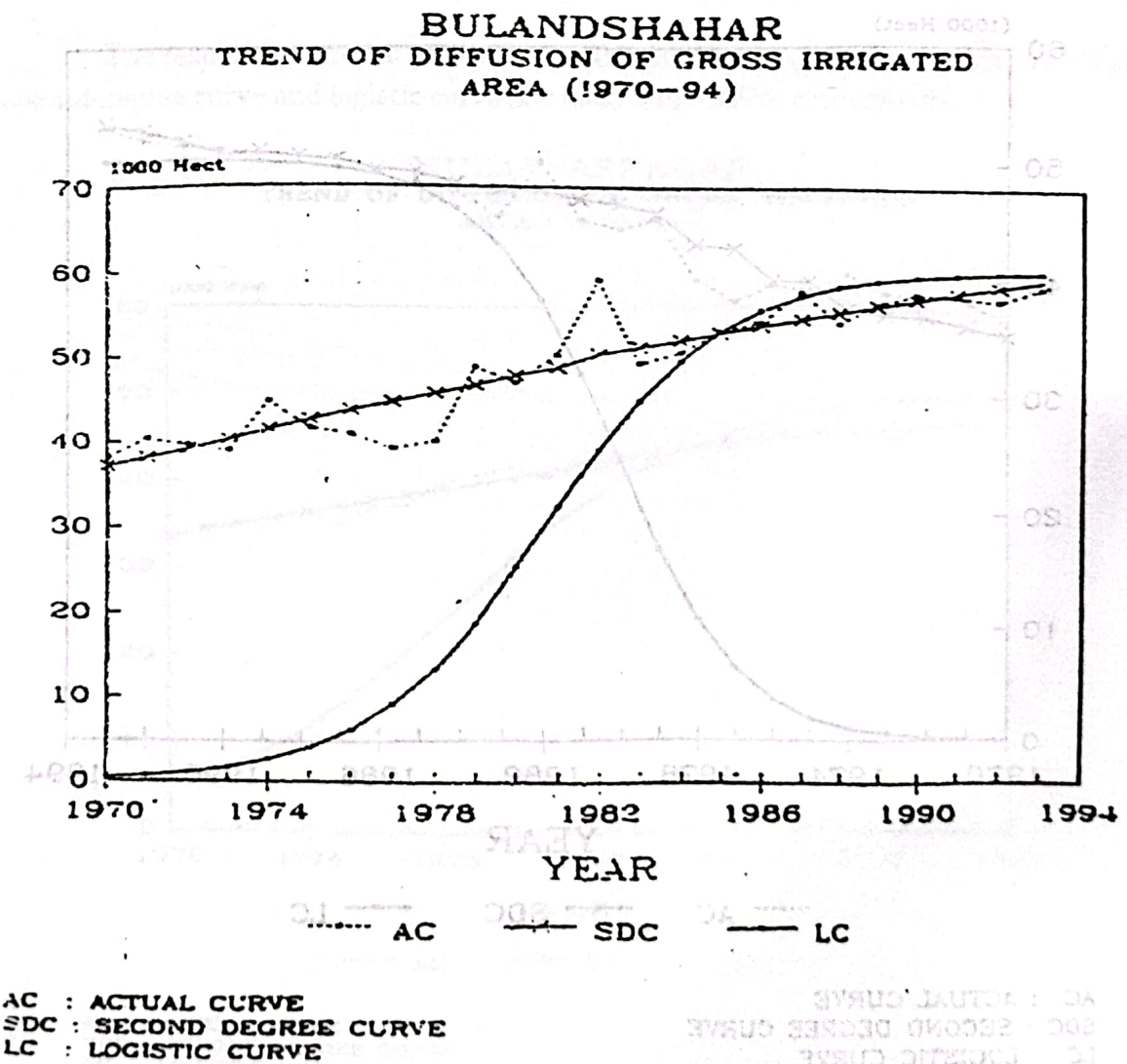


Figure 5. Trend of Diffusion of Gross Irrigated Area (1970-94), Meerut.

Ghaziabad

Table 5 shows the value of actual gross irrigated area and the values of second degree and logistic curves. During almost two decades of the study of the district, the data indicate the steady growth of gross irrigated area up to 1984-85 and thereafter the irrigation becomes almost constant. This is attributed to the fact that due to speculation most of the unirrigated area lying close to the urban fringe is brought under urban land use and industrial development. Therefore, the irrigation is almost limited to the irrigated area and has no prospects for expansion to unirrigated areas for agricultural development because of non-remunerative considerations as compared to land speculation. Figure 6 shows the curve of actual gross irrigated area and the second degree and logistic curve. Both the curves, second degree and actual, show the same pattern and run very close to each other, whereas the logistic curve also follows the same pattern after 1985 and onwards. Since all the three curves – actual, second degree and logistic – run very close to one another and follow the same trend, it indicates that the process of diffusion of gross irrigated area follows both the curves.

GHAZIABAD
TREND OF DIFFUSION OF GROSS IRRIGATED
AREA (1976-94)

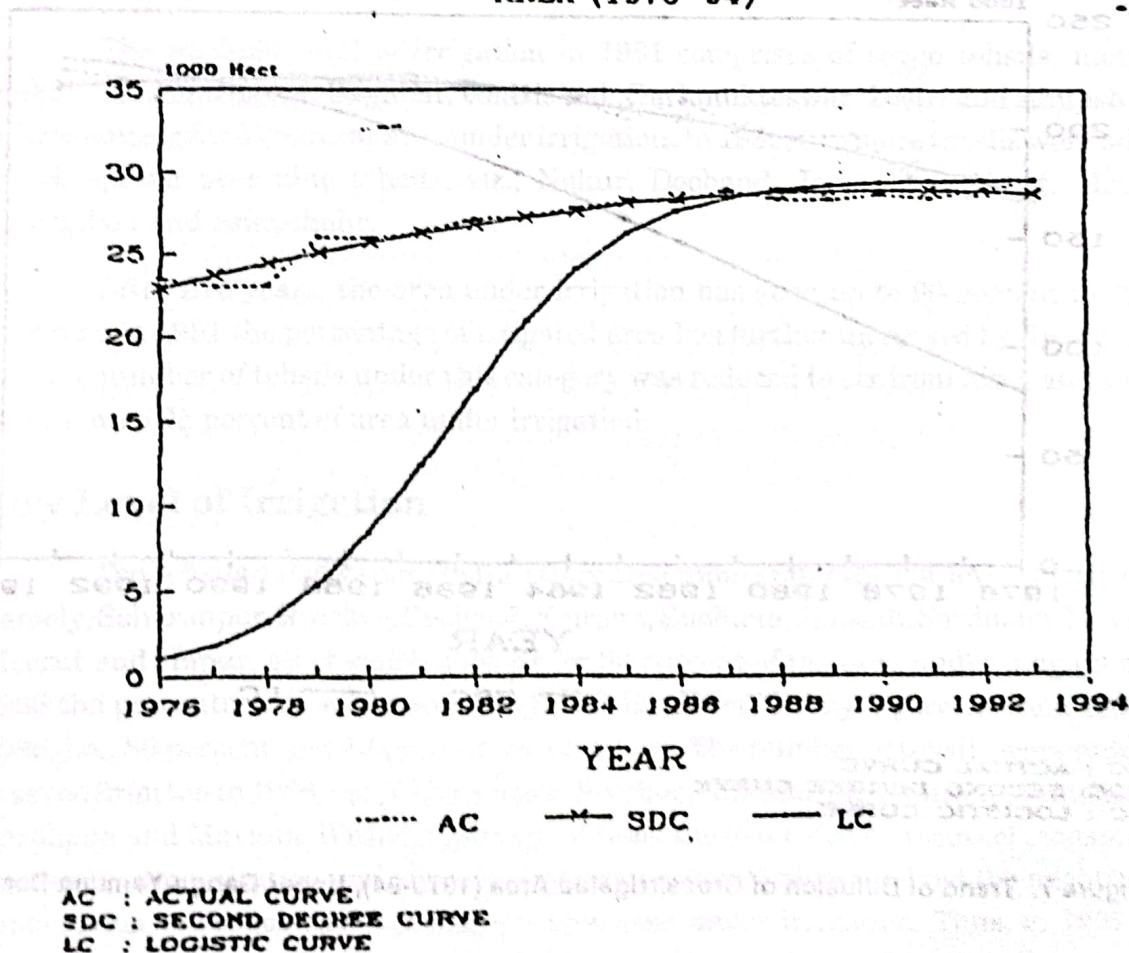
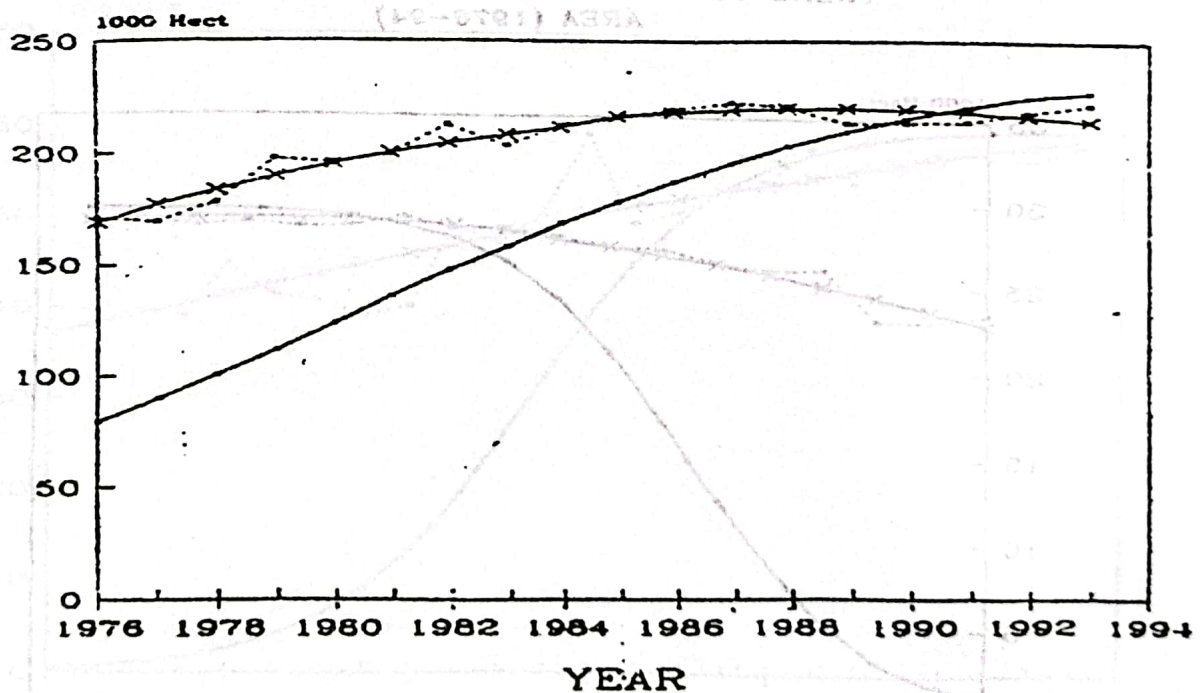


Figure 6. Trend of Diffusion of Gross Irrigated Area (1976-94), Ghaziabad.

Upper Ganga-Yamuna Doab

After the analysis of diffusion of innovations of gross irrigated area in each district of study area, it is found that the process of diffusion of gross irrigated area follows the trend value of the second-degree curve. Table 6 shows that there is overall increase in gross irrigated area from 1976-77 to 1993-94. Figure 7 exhibits the trend line of actual gross irrigated area and computed values of second and logistic curves. The trend lines of actual and second degree curves run very close to each other since the beginning to an end whereas the logistic curve shows the upward trend and becomes very close to the curve after 1988 and further follows the same trend line. Therefore, it may be concluded that diffusion of gross irrigated area in Upper Ganga-Yamuna Doab as a whole follows the second-degree curve, which is in accordance with the findings of individual districts.

**UPPER GANGA YAMUNA DOAB
TREND OF DIFFUSION OF GROSS IRRIGATED
AREA (1976-94)**



AC : ACTUAL CURVE
SDC : SECOND DEGREE CURVE
LC : LOGISTIC CURVE

Figure 7. Trend of Diffusion of Gross Irrigated Area (1970-94), Upper Ganga-Yamuna Doab.

LEVEL OF DIFFUSION OF IRRIGATION

On the basis of Z scores, the whole region has been categorised into three major groups, i.e., high, medium and low irrigation which are as follows:

High Level of Irrigation

The high level of irrigation consists of three tehsils, Sikandrabad, Bulandshahr and Khurja (1981) which accounts for 95 percent of the area under irrigation, having indices varying from +0.5 to -0.5 of Z scores. In 1986, new tehsil is added under high irrigation such as Dadri and now the area has come under 99 percent irrigated of the net sown area. Thus, the number of tehsils became four instead of three. In 1991, the picture is different, though the number of the tehsils remains the same but two new tehsils took over the place of Khurja and Dadri, such as Ghaziabad and Anupshahr, and Dadri and Khurja occupied the second place, i.e., medium level of irrigation. Besides the changing position of different tehsils from medium to high and vice-versa, the magnitude of irrigation has also changed from 94 percent in 1981 to 100 percent in 1991.

Medium Level of Irrigation

The medium level of irrigation in 1981 comprises of seven tehsils, namely, Nakur, Muzaffarnagar, Baghpat, Ghaziabad, Garhmukteswar, Dadri and Anupshahr—all accounting for 87 percent area under irrigation. In 1986, two more tehsils were added which spread over nine tehsils, viz., Nakur, Deoband, Jansath, Baghpat, Meerut, Ghaziabad and Anupshahr.

After five years, the area under irrigation has gone up to 90 percent in 1986. Whereas in 1991 the percentage of irrigated area has further increased by five percent and the number of tehsils under this category was reduced to six from nine, and which experiences 95 percent of area under irrigation.

Low Level of Irrigation

Ten tehsils out of twenty in the study area come under the low level of irrigation namely, Saharanpur, Roorkee, Deoband, Kairana, Budhana, Jansath, Sardhana, Mavana, Meerut and Hapur, all of which account for 80 percent of the area under irrigation. In 1986 the percentage of area under irrigation has increased by 3 percent from 1981 to 1986, i.e., 80 percent and 83 percent, respectively. The number of tehsils were reduced to seven from ten in 1986; viz., Saharanpur, Roorkee, Kairana, Muzaffarnagar, Budhana, Sardhana and Mavana. With the passage of time, the extension of means of transportation and communication and other infrastructure and facilities helped the adoption of innovations, subsequently bringing the new area under irrigation. Thus, in 1991 the area under irrigation has gone up to 85 percent, comprising of ten tehsils, namely, Saharanpur, Nakur, Roorkee, Deoband, Kairana, Muzaffarnagar, Budhana, Jansath, Sardhana and Mvana (Table 7 and Figures 8 A, B and C).

IRRIGATION VS. ADOPTION OF AGRICULTURAL INNOVATIONS

Almost all the studies conducted to find out the impact of irrigation facilities on the adoption of agricultural innovations have revealed the positive correlation between the two variables, viz., that farmers with adequate and assured irrigation facilities adopt improved agricultural practices much earlier as compared to others. However, in the present study an attempt has been made to test this relationship further. Therefore, the following hypothesis has been formulated in this connection:

The farmers having adequate and assured irrigation facilities are more adoptive of agricultural innovations as compared to others.

For the assessment of the individual standing of the farmers with respect to irrigation facilities, a scoring scheme is evolved. For each crop the farmer having adequate, average, poor and very poor irrigation facilities is given the score of 4, 3, 2, and 1, respectively. His total score is worked out by adding his scores in respect of all the crops grown by him and this figure is divided by the number of crops cultivated by him in order to get his average scores. The average adoption score varies from 0 to 4. Finally, on the basis of their average scores the farmers are classified into following four groups:

Group A	Adequate irrigation facilities	> 3.0 scores
Group B	Average irrigation facilities	30.20 scores
Group C	Poor irrigation facilities	21.10 scores
Group D	Very poor irrigation facilities	< 1.0 score

Table 8 and Figure 9 show that only 10.4 percent of the total farmers have adequate irrigation facilities and their average adoption index is highest (4.6872). The farmers having average irrigation facilities account for 29.92 percent of the sample and their average adoption index is 2.9235. The farmers having poor and very poor irrigation facilities account for about 59.68 percent of the respondents and their average adoption indices are poor, i.e., 1.6482 and 0.8763, respectively. The above analysis is very much in conformity with the earlier studies and it proves that there is positive correlation between these two variables.

CONCLUSION

After the foregoing discussion regarding the trend and level of diffusion of irrigation and its impact on the adoption of agricultural innovations in Upper Ganga-Yamuna Doab, it may be concluded that the trend lines of actual and second degree curves run very close to each other from the beginning to the end whereas the logistic curve shows the upward trend and becomes very close to the curve after 1988 and further follows the same trend line. Therefore, it may be concluded that the diffusion of gross

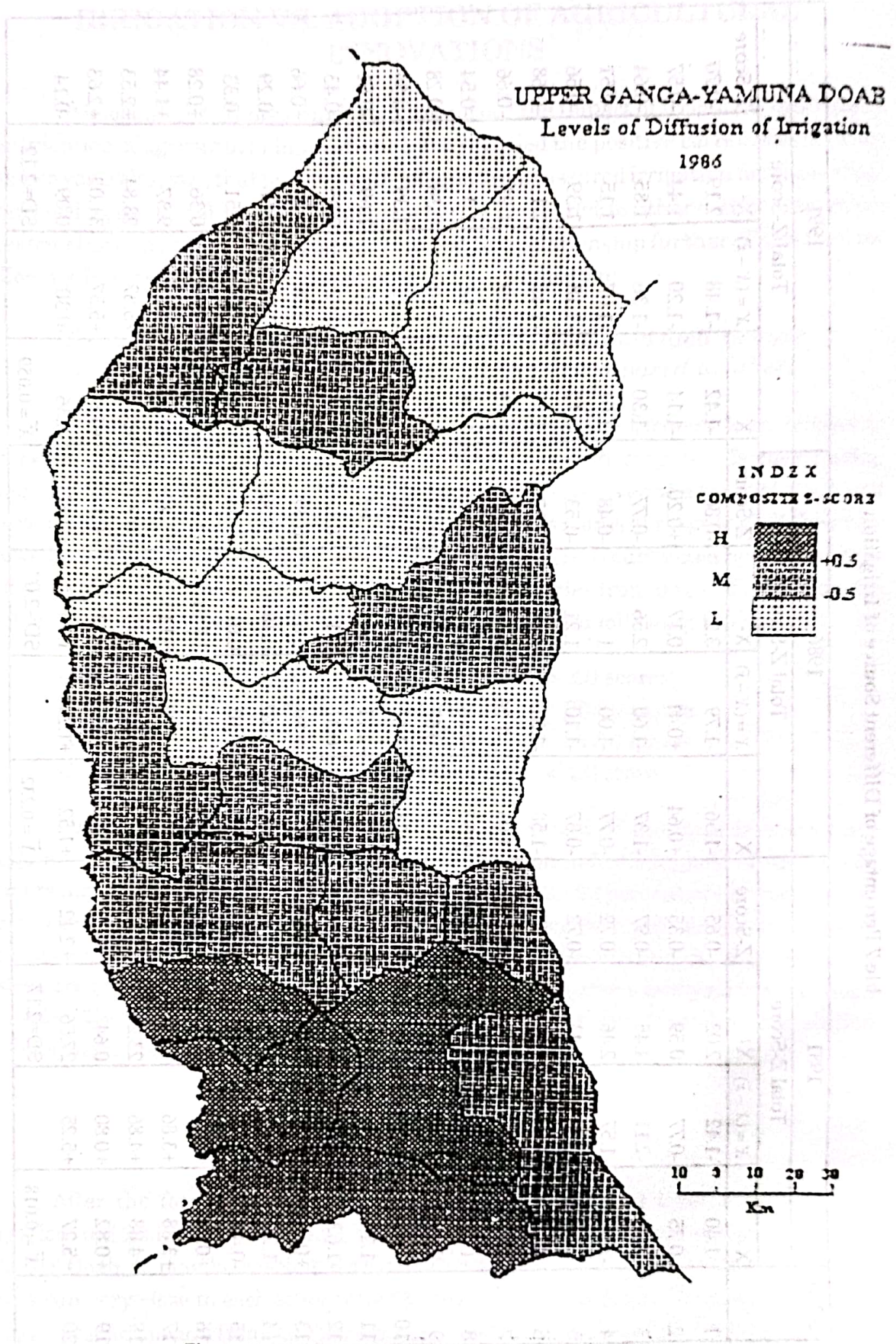


Figure 8a. Levels of Diffusion of Irrigation, 1981.

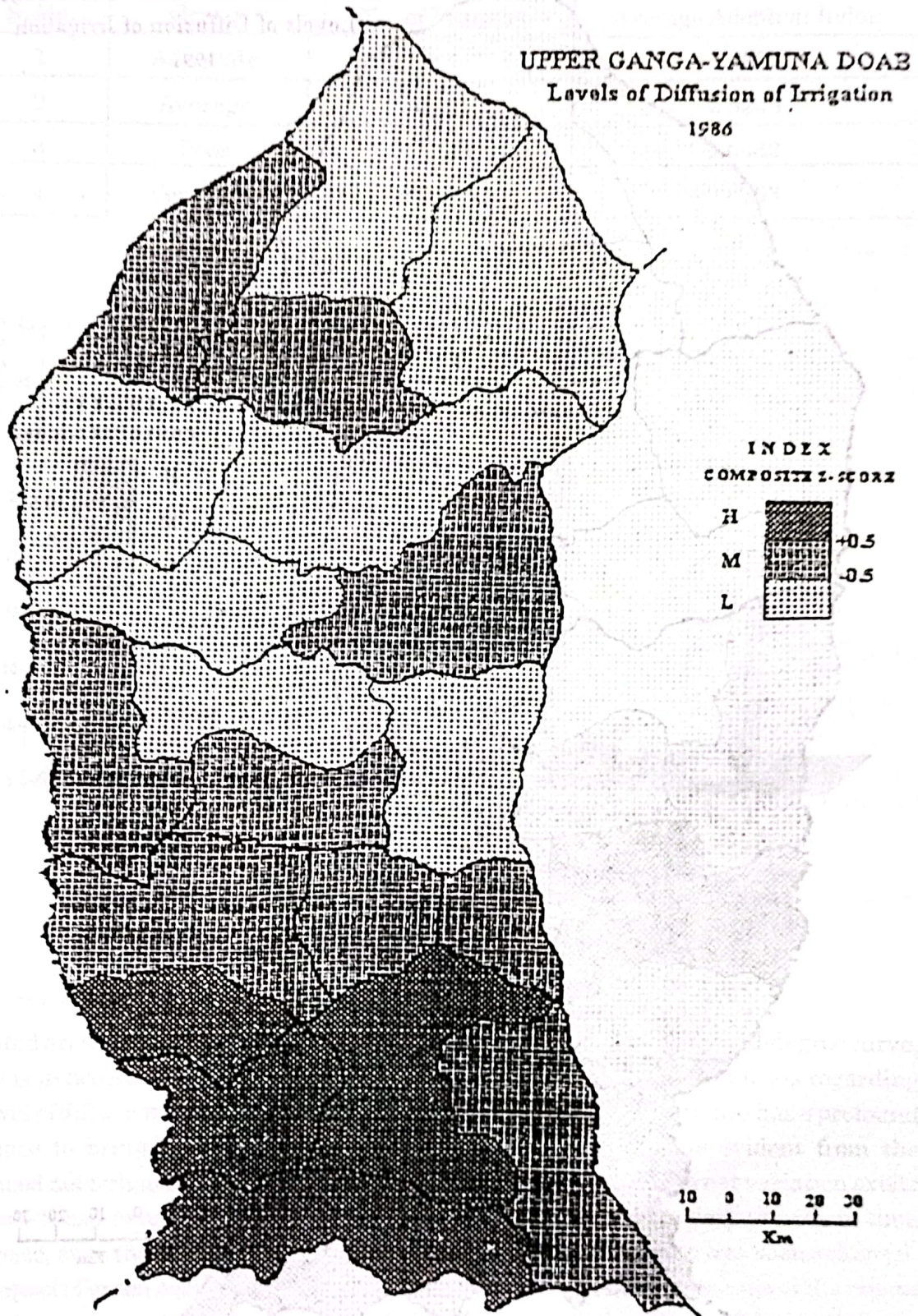


Figure 8b. Levels of Diffusion of Irrigation, 1986.

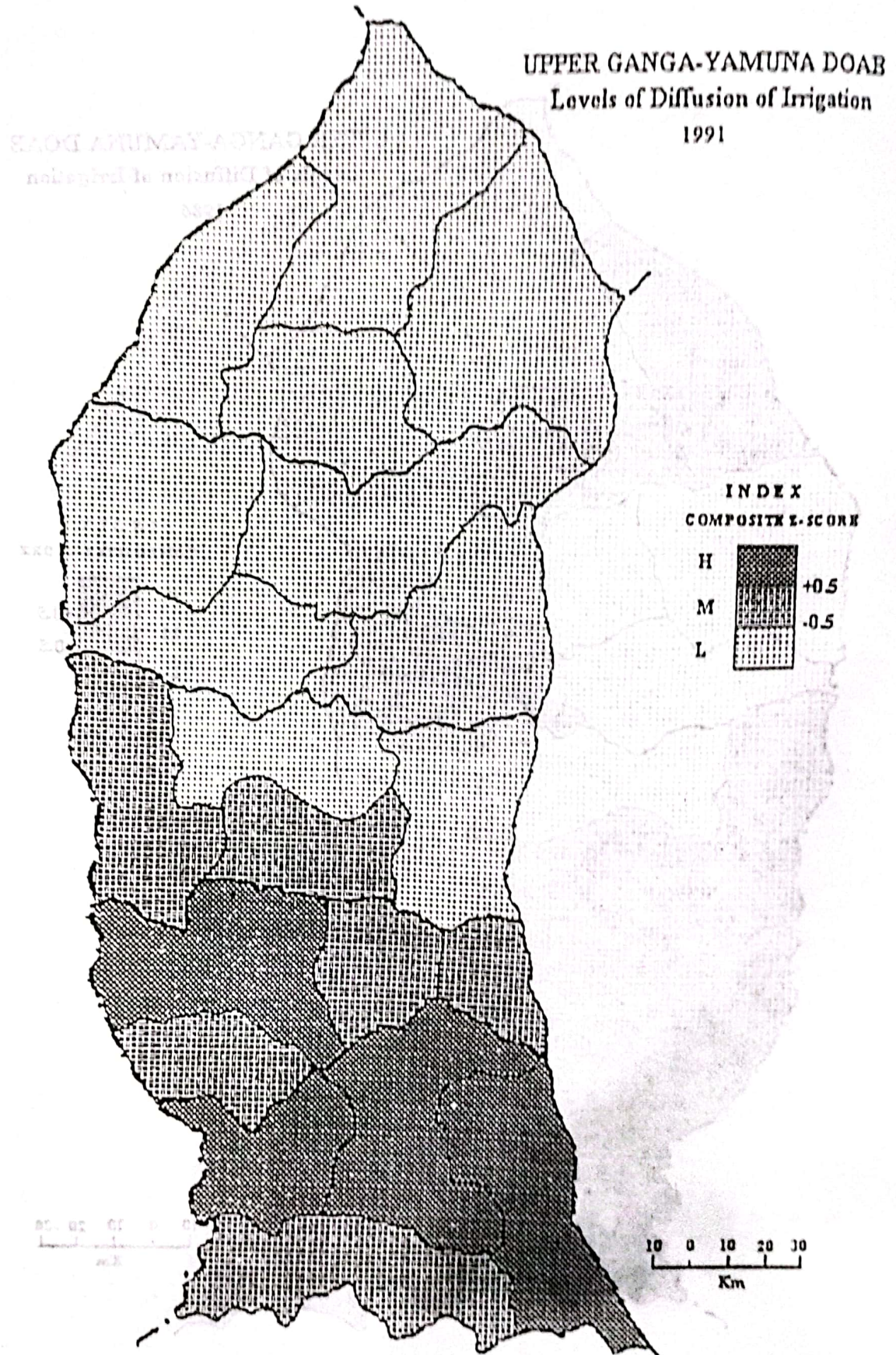


Figure 8c. Levels of Diffusion of Irrigation, 1991

Table 8. Irrigation vs. Average Adoption Index

S. No.	Group	No. of Farmers	Average Adoption Index
1	Adequate	65	4.6872
2	Average	187	2.9235
3	Poor	256	1.6482
4	Very Poor	117	0.8763

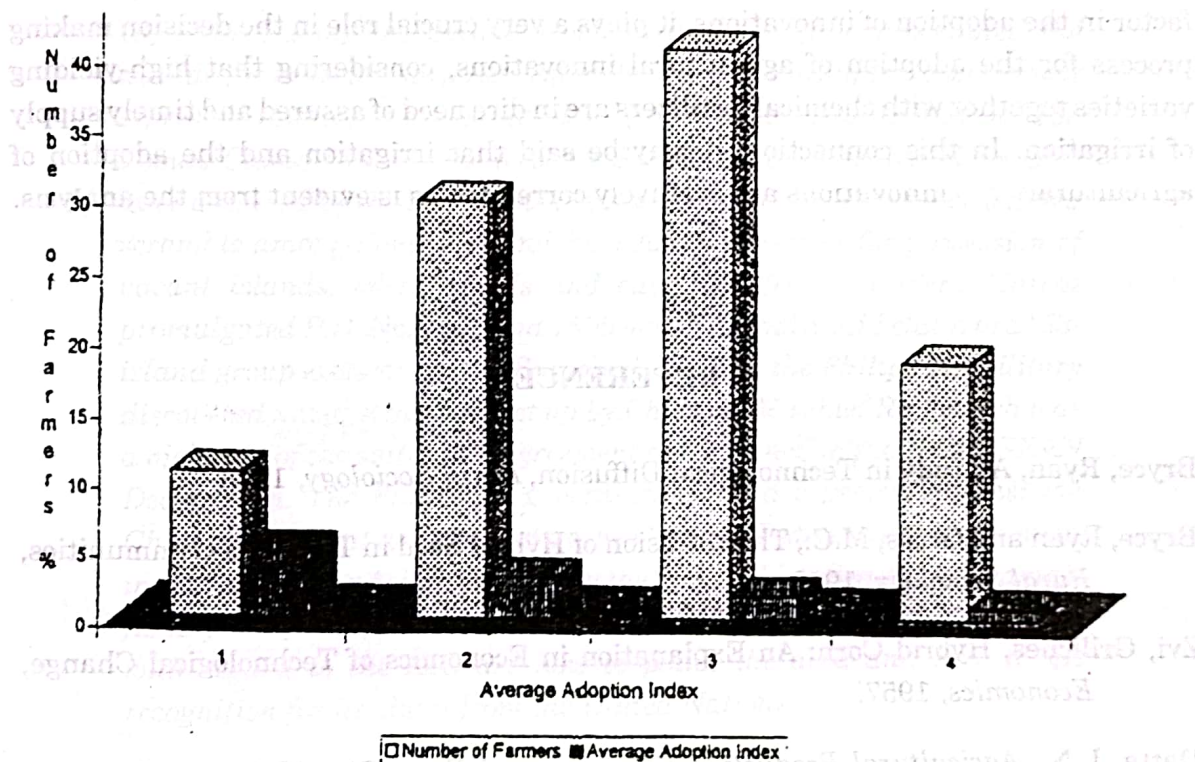


Figure 9. Irrigation vs. Average Adoption Index.

irrigated area in Upper Ganga-Yamuna Doab as a whole follows the second-degree curve, which is in accordance with the findings of individual districts. The analysis regarding the level of diffusion of irrigation reveals that a new package programmes has a profound influence to bring more and more area under irrigation. This is evident from the increased net irrigated area, i.e., 90.7 percent in current year, yet a great variation exists from one tehsil to another. The pattern of diffusion of irrigation is very uneven in time and space, even though overall improvement in the field of irrigation has been achieved. The impact of green revolution has been intensively realised in three tehsils of the region that enjoyed almost the same position in 1991. However, all the tehsils of the region have improved the percentage of area under irrigation and have realised the impact of green revolution to maximise the agricultural production. It is clear from the analysis that the

diffusion of irrigation has played a very significant role in the adoption of agricultural innovations. The farmers who have adequate irrigation facilities have the highest adoption index of innovations and vice versa. The hypothesis is accepted. However, the present analysis based on a single variable regarding the impact of irrigation on the adoption of innovations is too brief to make any generalization either at global or at national level, but prediction could be made fairly at a high degree of certainty in this connection for all the geographical regions with similar physico-cultural and socio-economic conditions. The analysis would be very fruitful if other factors are taken together along with irrigation, such as size of land holding, tenurial status, socio-economic status, government schemes, etc. Although irrigation is not the only decisive factor in the adoption of innovations, it plays a very crucial role in the decision making process for the adoption of agricultural innovations, considering that high-yielding varieties together with chemical fertilizers are in dire need of assured and timely supply of irrigation. In this connection, it may be said that irrigation and the adoption of agricultural innovations are positively correlated as is evident from the analysis.

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OVERVIEW OF THE PHILIPPINE CLAIM TO THE KALAYAAN ISLAND GROUP*

JAY L. BATONGBACAL**

ABSTRACT. *The Kalayaan Island Group (KIG) claimed by the Philippines off the coast of Palawan was originally not included in the International Treaty Limits drawn up by the Treaty of Paris on December 10, 1898. During the Second World War, the Japanese occupied the islands for military purposes. After the war the Philippine government expressed interest in the occupation of the Spratly Islands but in 1956 Tomas Cloma claimed the western Spratly Islands, which claim was later assumed by the Philippine government in 1970. This move led to a scramble among Southeast and East Asian countries for possession of vacant islands, islets, shoals and cays. In 1979, President Marcos promulgated P.D. No. 1596 and 1599 which formally laid claim to a "53-island group exclusive of the Spratlys". In 1995, the Philippine military discovered naval structures set up by China on Mischief Reef which was a violation of the status quo agreement as contained in the 1992 ASEAN Declaration. The Philippine government lodged a protest against the Chinese move, but was ignored by the Chinese. Today, there are competing claims among Asian countries in the South China Sea due to its ample fishery and fossil fuel resources. For the Philippines, its major problems with regard to the KIG are how to police the area and how to get recognition for its claim from the United Nations.*

INTRODUCTION

In October 1998, public attention focused on the developments in the South China Sea, particularly on the expansion of Chinese artificial structures on Panganiban Reef, otherwise known on international maps as Mischief Reef. Within the fledgling Estrada Administration, reactions of the heads of government departments varied from the caution on the part of the Department of Foreign Affairs, detachment for the Department of Justice, to the great agitation of the Department of National Defense.

* Briefing delivered for the members of the Philippine Geographical Society on March 5, 1999 at the Philippine Social Science Center.

** Executive Director, Philippine Center for Marine Affairs, Inc.

Other would-be players from the legislative department also sought to project either alarmist or grim images for the public. While officials of government jockeyed for their place in the front pages, however, it appears that the public has not been properly apprised of the nature of the Philippines' claim and interests in the far-off patches of rocks and shoals west of Palawan.

The aim of this paper is to present a brief overview of the Philippine claim to the Kalayaan Island Group (KIG), and the main issues surrounding this claim, that have now placed the Philippines in a rather unenviable position in international relations vis-a-vis the Peoples' Republic of China, and a problematic position with respect to the international community. The country has found itself at another crossroad in its foreign policy, without its own deliberate decision and again in reaction to another country's actions; but it is likewise an opportunity for retrospection and re-evaluation. Hopefully, for some Filipinos this discussion will shed some more light on this continuously brewing friction with China and the others of our ASEAN neighbors and work towards the formation of an intelligent and sober discussion and deliberate national consensus on the issue of the KIG claim.

THE KIG IN PHILIPPINE HISTORY

The American Period

Based on the standards of Philippine legislators during the Commonwealth Era and after our independence in 1946, the KIG was not an inherent portion of the Philippine Archipelago. This standard was the line drawn by the Americans and the Spaniards in the Treaty of Paris (1898), forming the shape of a modified rectangle separating the Philippine archipelago from the Malaysian and Indonesian territories to the south and the Chinese territory to the north. Simply perusing the lines formed by the Treaty of Paris clearly shows that the southwestern portion of the archipelago was hewn closely to the island of Palawan. Prior to the American period, references in the historical record to the KIG were rather erratic; some showed unnamed islands and shoals and others did not. Official interest in the KIG was not manifested in government records until the Second World War. The then-unoccupied islands of the KIG were not factored into the consideration of the national territory.

The Second World War

The Japanese conquest of the Philippines brought attention to the islands in the South China Sea because those islands were used by the Imperial Japanese Navy as naval bases for their submarines and as supply points for their ships. It was in 1939 when the Japanese formally declared their occupation of the Prata, Paracel, and Spratly island

groups, and created the *Shinnan Gunto* or New South Islands administrative region under the jurisdiction of Japanese-occupied Taiwan.¹ The *Shinnan Gunto* comprised a group of islands enclosed in a polygonal structure off the western coast of Palawan. During the war, Itu Aba, the largest island in the *Shinnan Gunto*, was used to mount naval attacks in the area.²

Post-War Official Awareness

In 1946, the Philippine Foreign Affairs Secretary stated that the Philippines intended to include the Spratly Islands in its national defense perimeters, and this was reiterated the following year in an assertion that the victorious allies should award the Spratly Islands to the Philippines.³ In May 1950, then-President Quirino was quoted as saying that the occupation of the Spratly Islands “by an enemy” would be detrimental to Philippine national security, apparently in fear of the possibility that they would be taken over by Communist China, since he also stated that same year that it would not be so if the occupation was by the Nationalist Chinese of Taiwan.⁴

The Tomas Cloma Discovery Claim

On May 15, 1956, Tomas Cloma, a Filipino businessman who owned a fishing fleet and operated a private maritime school, sent a note to the Vice President and Foreign Affairs Secretary Carlos Garcia, claiming that he and his crew had discovered in 1947, and since 1950 had taken possession, of what he called the “Freedomland Archipelago” which was purportedly not within the jurisdiction of any other state. The map accompanying the note encompassed the main islands of the western Spratly islands including Itu Aba, Spratly, Nam Yit, and Thi Tu Islands. On May 26, he sent another note, asserting that the claim was made in his own private capacity and not on behalf of the Philippine Government, but nevertheless alleging that the archipelago had become Philippine territory because it was occupied by the Filipinos. He further cautioned the Philippine Government against espousing his claim in an international forum like the United Nations in order to prevent opposition.⁵

Taiwan and Vietnam took the Cloma claim seriously and immediately reacted. Taiwan stationed naval forces on Itu Aba the following month, and Vietnam sent a destroyer to patrol the Spratly area and subsequently issued a declaration annexing the archipelago to one of its provinces. Cloma thereafter reversed his original position and tried to convince the Philippine Government to espouse his claim before the United Nations. When this failed, on July 6, 1956 he caused the publication in the newspapers of a “Declaration” establishing a separate government for the “Free Territory of Freedomland” with himself as the head of the Supreme Council of State, and a capital on Flat Island.⁶

In December 1956, Vice President Garcia issued an equivocal declaration which argued that the Cloma claim encompassed islands, cays, reefs, shoals, and rocks that were *terra nullius* and not included in the Spratly Islands; the Spratly Islands under the *Shinnan Gunto* to which Japan had renounced all rights under the San Francisco Peace Treaty were placed under Allied trusteeship de facto; and that the unoccupied and uninhabited islands of the Spratly area were subject to legitimate exploitation and settlement by Filipinos. This was likewise protested by the People's Republic of China, Taiwan, Vietnam, and even France; but thereafter the Philippine Government assured its counterparts that it was not making a formal claim to sovereignty over the islands.⁷

Filipino Garrisons in the 1970s

In 1970, the Philippines placed troops on Thitu, Nanshan, and Flat Islands, and a year later in June 1971 announced that it was making an official claim to the Kalayaan Islands, defined as a "53 island group exclusive of the Spratly s" which Tomas Cloma explored and occupied from 1947 to 1959. In 1972 the KIG was incorporated into the Palawan Province to be administered as a municipality. Two more islands were occupied in 1974, another two in 1978, and one more in 1980. Military installations, including an airstrip, were built on Thitu, now renamed Pag-asa Island.

Prior to 1970, the only occupied island was Itu Aba, manned by the Taiwanese. The Philippine occupation triggered a scramble for islands and reefs over the following decade, with the Vietnamese taking nine reefs and cays between 1973 and 1978, and Malaysia occupying two reefs in 1977.

Presidential Decree No. 1596 and 1599

In 1979, then-President Marcos promulgated Presidential Decree No. 1596 which proclaimed Philippine sovereignty over the area encompassed in a parallelogram extending from the Palawan side of the Treaty of Paris limits, and officially called it the Kalayaan Island Group, constituted as a municipality of Palawan Province. The decree declared absolute sovereignty over the islands, waters, seabed, and subsoil of the area within the described boundaries.

However, PD 1596 was followed on the same day by Presidential Decree No. 1599, which declared an Exclusive Economic Zone corresponding to the concept of an EEZ which had developed in the course of negotiations for the United Nations Convention on the Law of the Sea. The EEZ extended 200 nautical miles from the baselines of the territorial sea, which were laid down in Republic Act No. 3046 as amended by RA 5446, and overlapped with about 2/3 of the KIG area described in PD 1596.

Renewed Occupations in the 1980s

In 1988, the Chinese dislodged the Vietnamese from the Paracels (a separate group of islands in the South China Sea), leading to another round of occupation by Vietnamese forces of another ten features, while China took six. Vietnam continued to take over new, smaller features from 1989 to 1991. This round of new occupations caused such concern that the 1992 ASEAN Declaration came to be issued, seeking to affirm that the claimants would use peaceful means to settle the dispute and exhorting all claimants to restrain themselves from taking action that would increase tensions or destabilize the region.⁸ The issuance of the declaration positively contributed to regional stability by allowing the claimant countries to freeze the *status quo* on occupation of the islands pending further diplomatic discussions.

The Mischief Reef Incidents

The *status quo*, however, was short-lived. In January 1995, Philippine reconnaissance flights recorded the existence of several small structures on Mischief Reef, located roughly in the center of the KIG and about 130 nautical miles from the nearest point on Palawan. The Chinese occupation of the reef was the first major move by any claimant since the collapse of the Soviet Union and the end of the Cold War; it also heralded a relatively new mode of occupation through the construction of installations that were practically artificial islands where no other features used to be above water. Mischief Reef was an entirely submerged feature, and no portion of the reef could even be regarded as an islet above water at any time and subject to occupation. It was also seen as a direct violation of the 1992 ASEAN Declaration, particularly the provision on the exercise of self-restraint.⁹ After the Philippines filed a strong protest against China, bilateral dialogues on the issue were held which resulted in a Joint Statement on Consultations on the South China Sea And On Other Areas of Cooperation in August 1995. This helped to reduce tensions, but did not produce any clear resolution as Philippine demands for Chinese withdrawal from the reef were ignored.

Mischief Reef passed into obscurity for the Filipino public, until sometime in October 1998. On the 15th of that month, China informed the Philippine ambassador in Beijing that repairs will be undertaken on the existing structures, as well as a proposal for joint use of the renovated structures. However, this information was not promptly relayed to the Department of Foreign Affairs. Between October and November 1998, continuous reconnaissance by the Armed Forces of the Philippines revealed that the activities on Mischief Reef were not merely repairs of existing structures, but rather expansion and construction of new facilities. Malacañang sent another strong protest to Beijing, believing that the new structures were a renewed violation of the *status quo* as indicated in the agreements between China and the Philippines. The Chinese ambassador, however, responded that only repairs of certain structures were being done on the reef.

ISSUES AND PROBLEMS

Competing Claims for Islands in the South China Sea

The KIG is only a part of the Spratly Island group, one of three major island groups in the South China Sea. The "Spratly Islands" generally refer to the group of islands, islets, and assorted features located in the portion of the South China Sea between Vietnam and the Philippines. China, Taiwan, and Vietnam claim all of the islands in the Spratlys. The Philippines claims essentially only the eastern section of the group which is closest to Palawan Island, but also contains most of the major islands in the group. Malaysia claims only three islands and one cay. Brunei has also staked a claim to one underwater reef. Except for Brunei, all the claimants have militarily occupied islands or reefs.

The conflicting claims to sovereignty by the above-mentioned countries makes the dispute over the Spratly Islands much more complicated due to the sheer number of parties and divergent interests in the area. The most powerful claimant, China, has thus far refused to discuss multi-lateral approaches to resolving the dispute, preferring bilateral negotiations instead. The other claimants, on the other hand, have been reluctant to antagonize China, and have limited the extent of multi-lateral discussions about the dispute.

Resource-use in the Western Palawan Region

Statistics from the Bureau of Fisheries and Aquatic Resources will show that nearly twenty percent (20%) of the total marine fisheries production of the Philippines comes from the sea west of Palawan. The western Palawan region is also where the country's major oil and gas interests are currently located; the Malampaya Sound Gas Development Project is adjacent to the Reed Bank area of the KIG, where much of the oil and gas exploration and development is taking place. A lot of international shipping also passes between Palawan and the KIG over what is known as the Palawan Passage; this is part of several traditional shipping routes astride the Philippines connecting the Indian Ocean with the Pacific Ocean.

It is clear that resource-use is a major interest for the Philippines. However, there is no clear policy or program on precisely how the Philippines intends to protect and pursue these interests in the KIG Area as well as the South China Sea. As usual, policy implementation has been a major stumbling block; for example, PD 1596 clearly provides for the establishment of a Municipality of Kalayaan, which despite the passage of 20 years has not been fully realized. The extent of fisheries activities in the KIG, whether Filipino or otherwise, is largely unmonitored. Marine scientific research has been taking

place, but the support which the government has provided this has been relatively meager. Oil and gas exploration contracts have been entered into, and some have been implemented, but lack of really commercially viable finds has until recently provided no good incentive for policy development.

Security Issues

National security is a major concern with respect to the KIG. As stated, in the last war the KIG was a staging ground for attacks on the Philippines and surrounding waters. The KIG serves as a "buffer zone" for southwestern approaches to the country. In particular, the KIG lies between the high seas and areas considered as prospective oil and gas fields. Control over the KIG also allows closer monitoring and surveillance of international vessel traffic in the South China Sea and along the Palawan Passage.

The Philippine Navy has the main responsibility of monitoring and surveillance of the KIG. However, with the suspension of the AFP Modernization Program, it is not clear how the Philippine Navy can be expected to discharge its functions. Even with a modernized armed forces, securing the KIG is a mammoth task, especially for a navy lacking in ships and manpower.

National Law

PD 1596 purports to place the KIG area under the full sovereignty of the Philippines. However, PD 1599 actually converts nearly 2/3 of the KIG into an Exclusive Economic Zone, which is not under the full sovereignty of the state but rather is subject only to certain rights of exploration and exploitation of natural resources. Within the EEZ, foreign states exercise the freedom of navigation and overflight, and the laying of submarine cables and pipelines. As such, the Philippines cannot lawfully prevent entry and travel of foreign vessels and aircraft through the zone, which it can if it were the area under full sovereignty. This has major impacts on the security arrangements and strategies available for the Armed Forces, as well as the management of resource-use activities in the KIG area.

International Law

The KIG Claim is not recognized under international law because of its political ramifications, and because it purports to subject to national sovereignty an area which was considered by the international community has part of the high seas. The Philippines is a party to the United Nations Convention on the Law of the Sea, which a system for allocation of state rights, duties, and responsibilities in the sea; this includes, however, a prohibition against subjecting the high seas to sovereignty. The KIG claim does not correspond with the accepted rules for delineation of the Territorial Sea,

Contiguous Zone, and Exclusive Economic Zone. The Philippines has not yet addressed the issue of how to implement the Convention, and the KIG Claim introduces a complicating element since the inclusion or non-inclusion of the islands in the KIG would have an impact on delineation of the country's maritime zones. Non-compliance with the Convention also prevents the Philippines from effectively invoking international law in support of its claims to certain rights and jurisdictions in the area.

ENDNOTES

¹ Chiu, H. and C. Park, "Legal Status of the Paracels and Spratly Islands," in *Ocean Development and International Law Journal*, Vol. 3, No. 1 (1975), cited in Lu Ning, Flashpoint Spratlys, Dolphin Books, Singapore, 1995 at p. 25

² *Ibid.*

³ *Id.*, p. 50

⁴ *Ibid.*

⁵ Valero, G.M.C., Spratly Archipelago: Is the Question of Sovereignty Still Relevant? Institute of International Legal Studies, Quezon City, 1993, p. 63

⁶ *Id.*, p. 64

⁷ *Id.*, p. 64-66

⁸ See Baviera, A. "Turning Predicament into Promise: A Prospective on Philippine-China Relations" in *China Currents*, Vol. 8, No. 4, October to December 1997, pp. 5-10.

⁹ *Ibid.*

HUMAN USE AND DEVELOPMENT OF THE CARBONATE KARST TERRAINS OF SOUTHEAST ASIA *

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ABSTRACT. *Humid tropical karstlands such as those found in Southeast Asia are viewed as either inhospitable, fragile and resource-poor environments, on one hand, or auspicious environments for human habitation, on the other. The article reviews this dichotomy in order to provide a framework for determining, 1) a critical minimum area needed for the creation of a distinctive karst-based culture, 2) the role of karst landscapes as population growth centres since prehistoric times, and 3) if karst landscapes can be classified based on cultural, rather than physical, criteria. It may be observed that karstlands that have supported long-term occupation generally cover an area of at least 1000 km². As to the second objective, it has been observed that many karstlands have served as cultural hearths on account of sustainable resources they contain. Thirdly, karstlands may be classified in terms of land use. In tropical karstlands, the "upland-dry-poor" and "lowland-wet-affluent" karsts have a dynamic interrelationship, with a need to maintain the sustainability of the former such that it becomes an auspicious environment particularly in relation to the lowland karst ecosystem.*

INTRODUCTION

Humid tropical karst was first described in modern times by Czech geographer Danes (1910). Lehmann (1936) was the first to publish a detailed study of the origins and evolution of a tropical karst landscape (Sweeting, 1974). Lehmann's landmark study prefaced modern tropical karstland evolutionary theory by introducing climate as an important variable in landscape evolution. This fostered a global survey of karst terrains from the equator to the Arctic in search of comparative examples. In the intervening period, tropical karst studies grew out from the Dutch East Indies to mainland Southeast Asia, the West Indian Islands, Central America and scattered portions of Africa and South America.

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For the purpose of this paper, Southeast Asia ranges from Myanmar (Burma) in the west to Papua New Guinea in the east, Indonesia to the south, and southern China to the north (see Figure).

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While the number of geomorphologic and stratigraphic studies of tropical karst exploded in the 20th century, the study of cultures exploiting karstlands languished. Perceived infertility, erosivity, and droughtiness of tropical karst soils resulted in them being unjustly categorized as ill suited to sustained exploitation and hence, occupation (Wemstedt and Spencer, 1967: 72; Nordholt, 1971: 27). This bias continues today. Gillieson presumes that the karstlands of New Guinea will follow those of other tropical karst areas, and will be "the last terrain to be intensively settled and cultivated" (Gillieson, 1988:198).

Archaeologists, prehistorians and increasingly geographers provide a different interpretation. Karst terrain and associated landforms like caves and grottos provided protection from warring parties and shelter from the elements, while silicified karsts may have provided the necessary materials for stone axes and other tools (Verstappen, 1960). Furthermore, abundant evidence of early sedentary agriculture comes from karst landscapes in both mainland and insular Southeast Asia (Chang, 1989; Glover, 1985; Gorman, 1977). Important regional trade entrepots have developed in karst areas (Solheim, 1964). Finally, associations between early population growth, limestone terrain and malaria free areas warrant investigation (Vandemeer, 1967). Clearly, currently exploited tropical karst landscapes may have supported long and sustained cultivation (Nooy-Palm, 1976; Urich, 1993).

Consequently, a theoretical paradox exists between those who envision humid tropical karstlands as inhospitable, fragile and resource-poor environments, and those who empower them with an early and important status. The purpose of this review is to explore this dichotomy in the Southeast Asian context. Prior to doing so I provide an overview of the karst areas in Southeast Asia, the nature of karst systems, and the growth of thought pertaining to humankind's exploitation of karstlands. I then introduce and order a complex suite of variables associated with the human occupation of Southeast Asian karstlands including: the continuous extent and physical characteristics of the karstlands, lithology, landforms, and climate, plus analogous patterns of culture, demography, and landuse.

It is hoped that such a review will provide a framework for determining, 1) a critical minimum area necessary for the creation of a distinctive karst based culture, 2) the role of karst landscapes as population growth centres through prehistoric and historic times, and 3) if karst landscapes can be classified using cultural rather than physical criteria. In conclusion I examine the role tropical karstlands could play in the study of land degradation in Southeast Asia.

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THE DISTRIBUTION OF KARST LANDSCAPES

Carbonate rocks on which karst landscapes can develop cover from 12 to 15 percent of the Earth's dry, ice-free land (Ford and Williams, 1989; Gunn, 1986). Between seven and ten percent of this area has developed either distinctive karst topography or significant groundwater circulation patterns affiliated with karst development. These karst landscapes provide the water supply for at least 25 percent of the global community and their landforms are being increasingly exploited for agriculture and industry.

Karst topography can be found on every continent and in every climatic zone. However, karst is not distributed evenly over continents. The majority of karst topography is associated with plate margins and in the Gondwana continents, karst topography is concentrated on the margins of cratons rather than the interiors. Generally, carbonates do not cover vast continuous areas with the exception of southern China where over 15 million km² can be found (Sweeting, 1990). In insular Southeast Asia, the larger continuous karst regions comprise 2 - 3,000 km² such as in the Goenung Sewu or southern mountains of Java, and the karsts of Sulawesi Selatan and the central Philippine island of Bohol. Small, discontinuous karsts are found scattered throughout both mainland and insular Southeast Asia (Figure 1).

Insular Southeast Asia

On a regional basis Indonesia's karst is principally associated with the uplift of marine sediments on the outer arc of the volcanic belt stretching from Sumatra through Java and the Lesser Sunda islands to Halmehera (Figure 1). Portions of western Sumatra and southern Java along with the limestone islands of Nias, Timor, Sumba,

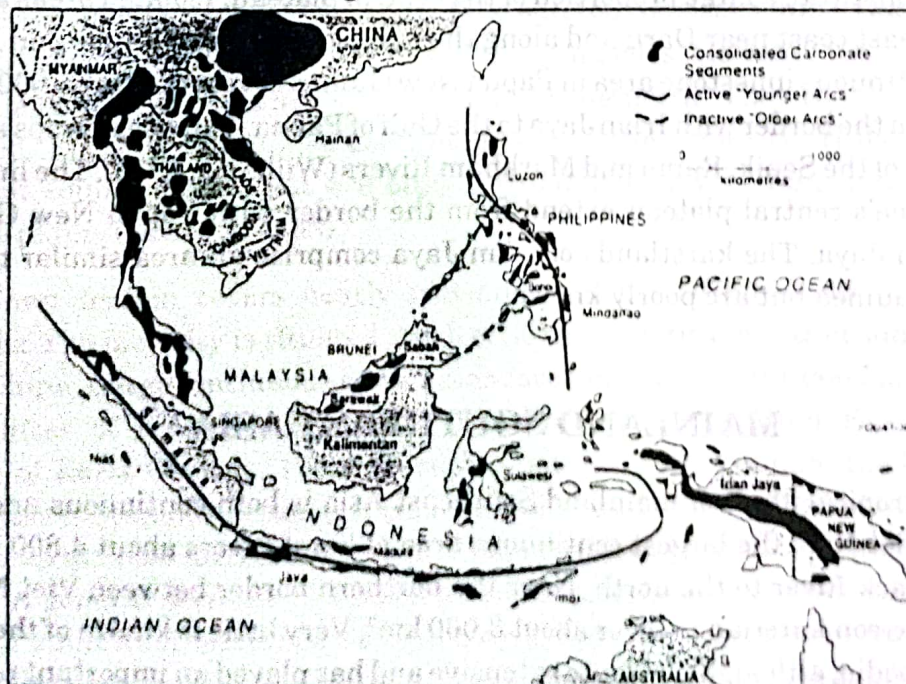


Figure 1. Karst Distribution in Southeast Asia

Seram, Savu, Roti, Tanibar, Am, Ambon, Bum and Misool are most prominent to the south of the volcanic arc. To the north of the arc Madura, northeast Java, portions of southern Sulawesi, and isolated pockets on Halmehera are examples.

As in Indonesia, volcanic arcs influence the lithology of the Philippines. Two distinct series of arcs are of importance (Figure 1). An inactive or "older" pair of arcs stretch from southwest to northeast. The southernmost of the two passes along the Sulu archipelago, the Zamboanga Peninsula, bisects the Visayas where it terminates at an active or 'younger' arc in Leyte. A northern arc conterminous with the southern arc extends from northwest Borneo through Palawan and Mindoro to southern Luzon where it intersects with the younger arc. A second active arc extends from southeast to northwest passing through eastern Mindanao along the west coast of Samar and southern Luzon bisecting northern Luzon.

The fragmented nature of the archipelago has mitigated against the development of numerous large carbonate outcrops, but several small and discontinuous karsts occur. Burial caves and rice terraces are associated with a localised carbonate outcrop at the village of Sagada, northern Luzon, as are important archaeological sites in a larger outcrop within the region's Cagayan Valley (Thiel, 1990). In the Visayan Basin, and between the two 'older' arcs, a block and graben bedrock sequence has developed. It is on an uplifted block that the Philippine's most extensive carbonates are found. Included are the comprehensive karstlands of Bohol, Cebu, Leyte, Samar and northern and eastern Mindanao. Limestones outcrop on Palawan and in the Sulu archipelago stretching from southwest Mindanao to northeast Borneo (Longman and Brownlee, 1980).

Karst landscapes of Papua New Guinea are found at heights from 450 to 3,100 metres and constitute a large proportion of the central plateau. Isolated areas are found on the southeast coast near Daru and along the north coast near Vanimo and Madang. The most continuous limestone area in Papua New Guinea covers nearly 45,000 km² and stretches from the border with Irian Jaya to the Gulf of Papua. Patchy outcrops are found in the valleys of the Sepik, Ramu and Markham Rivers (Williams, 1972). The limestones of New Guinea's central plateau extend from the border with Papua New Guinea to western Irian Jaya. The karstlands of Irian Jaya comprise an area similar to that of Papua New Guinea but are poorly known.

MAINLAND SOUTHEAST ASIA

The tropical karst of mainland Southeast Asia is both continuous and discontinuous. In Viet Nam the largest continuous area of karst covers about 4,800 km² and flanks the Black River to the north. Near the northern border between Viet Nam and China the Bac-son karstlands cover about 3,000 km². Very little is known of the karst of Laos or Cambodia, although it is quite extensive and has played an important role in the

cultural and political fabric of these countries. For example, the caves of northern Laos have protected political dissidents and the general population for extended periods during regional conflicts (Sesser, 1990).

Fifteen to twenty percent of Thailand is underlain by carbonates. The broadest areas are along the eastern side of the mountains dividing Thailand and Myanmar (Dunkley, 1985). In Thailand, the Rat Buri limestones are most apt to develop karst topography. Rat Buri is also common in northern Laos and Viet Nam (Pitakpaivan, 1966). It is often underlain by an intensely folded shale and sandstone sequence which can have a strong influence on hydrology and hence, landuse. Large continuous areas are rare; rather more common are discontinuous areas reaching up to 1,000 km. In southwest Thailand karst towers covering several km are interspersed among alluvial plains (Anderson, 1990). To the north and west of the Chao Phraya basin, dolines, uvalas, poljes and blind valleys are common where limestones reach reliefs of over 1,000 metres (Dunkley, 1985).

Myanmar is also well endowed with limestone bedrock although exploration of karstlands has been severely restricted by political conditions. The limestone in the east is continuous with that of the Tenasserim Range in Thailand. Further north, karst topography occurs more sporadically through the Karen, Kayan, and Shan states (De Terra, 1943; Dunkley, et al., 1989).

Peninsular and island Malaysia each possess numerous dramatic karst landscapes, but their individual areal extent rarely exceeds 200 km-. In Sarawak and Sabah there are at least 25 outcrops, yet they cover less than 500 of the territory's nearly 200,000 km-. The largest outcrop is the Melinau Formation, 39 kilometres long and eight wide. The other prominent formation is the Bau which is 64 kilometres long but rarely exceeds three kilometres in width. Half of the outcrop consists of hills; the remainder is overlain by swampy alluvium or forms striking pinnacles (Gobbett, 1965:13). In peninsular Malaysia, limestones are found mainly in the north. They consist of dense, re-crystallized, massive limestones containing very little impurity. Hills are typically grouped in small massifs, but are often surrounded by very flat, alluvium covered limestone plains (Gobbett, 1965).

Karst terrain covers nearly two million km- of China's 15 million km- of carbonates. The majority is situated south of 30° north latitude within sub-tropical and tropical China. Large continuous karst areas covering more than 1,000 km² are found in the Provinces of Kwangsi, Kweichow, Guizhou, Kwantung and Eastern Yunnan (Institute of Karst Geology, 1985). In central and western Yunnan, the karst terrain becomes less continuous because of smaller blocks and folding. Limestones in eastern China are up to 2,600 metres thick, one of the deepest deposits in the world (Sweeting, 1990:48). A general decrease in limestone depth correlates with increasing rates and distance of uplift from eastern to western China. Karst landforms vary from immature, relatively flat plateaus with nascent karst development to landscapes exhibiting mature karst landforms such as the karst towers of Guilin.

THE KARST ENVIRONMENTAL SYSTEM

Karst areas can express dramatic changes in resource quality and availability in very small areas. These variations are evidenced most clearly in the distribution of soils and the position of water in the environment. In pristine conditions limestone derived soils are some of the most fertile of the tropics. Similarly vast reserves of water are often associated with limestone lithologies. It is however, the configuration of the two along with the bedrock lithology which dictates landscape geomorphology, agricultural potential and human settlement.

Soils

Humid tropical Asia is well supplied with limestone derived soils. They cover about seven million hectares and are dominated by Mollisols, also known as Chemozmes, Rendzinas and Grumusols. Although often associated with steep slopes, they are excellent agricultural soils when located on slightly rolling or flat topography (Sanchez, 1985; Kawaguchi and Kyuma, 1977). Nearly a third of humid tropical Asia's soils are either Mollisols or other soils derived from sedimentary rock, three and four times those found in humid tropical Africa and America, respectively (Sanchez, 1985). This reflects the dominance of plate margins versus plate centres as discussed earlier, and more specifically the difference between active plate margins of the Pacific and inactive plate margins of the Atlantic (Drake and Burk, 1974). Thus humid tropical Asia has the highest percentage of good to excellent soils in relation to other humid tropical regions of the world.

Soils mantling tropical carbonate rocks can be derived from three sources, 1) residual soils composed of insoluble fractions of the carbonate rock, 2) colluvial soils which have been deposited on carbonate terrain from noncalcareous areas on higher slopes, or 3) alluvial soils transported to a carbonate terrain by paleofluvial or contemporary surface streams. The majority of soils in larger, continuous carbonate rock areas are derived from carbonate parent material. These residual soils are calcium rich and soluble.

In carbonate rocks of China and Malaysia and many other areas, soluble minerals of calcite and dolomite may be as high as 90-99%. Insoluble constituents ranging from 1-10% can lead to soils rich in aluminium, iron or zinc. If the insoluble content in a limestone is 2.5%, one metre of soil would require the dissolution of about 25 metres of limestone which in a warm, humid climate such as southern China would take between 250 and 750 thousand years to develop (Daixin, 1989). However, varying quantities of insoluble material have been found in tropical carbonates; for example 45 metres of Tikal limestone of eastern Guatemala would be expected to yield one metre of clay (Deevey et al., 1979). Clearly, there exists a wide variability in soil forming

capabilities in carbonate rocks. Unfortunately, the literature fails to consider the influence of outside inputs on karst soil formation such as mass movements, variation within geologic structures, and other externalities such as inputs of loess in China and volcanic ash in Indonesia, Papua New Guinea or the Philippines.

Soils also play an important role in landform evolution. Trudgill (1985) reports that soils are in general more alkaline at the base of karst slopes. This is due to the accumulation of karst rubble on the toeslope. The majority of the rain water moves down through the soil and into the underlying bedrock. Water which moves laterally reinforces the process of downslope accumulation. At the top of the karst landform where slopes are shallow, more water moves vertically culminating in accelerated leaching. As soils are translocated to the toeslope they mix with the more alkaline soils of the lower slope. Carbonates are re-introduced and the soils regain their alkalinity. Biologic agents such as moles and earthworms also assist by mixing subsurface and surface soils. This results in soils becoming increasingly acidic as one moves upslope, leading to increased chemical weathering on the upslope and reduced weathering on the toeslope.

The Hydrological System

The hydrologic condition of the underlying bedrock presumably weighs heavily in their long term stability or instability of mantling soils (Trudgill, 1976). Under dry conditions resulting from free and open drainage it is hypothesized that a positive feedback mechanism develops. This encourages the removal of carbonates and accelerates the opening of solutional joints which hastens free drainage, resulting in the loss of soil and vegetative material into grikes and joints. Thus areas of acid soils and *Calleuna* vegetation resting on carbonates will be unstable in the long term. Conversely, poor drainage presumably operates a negative feedback system which keeps calcium in the system; soils are inherently more stable as joints and grikes fail to develop. Trudgill notes that the model remains to be tested under conditions of contrasting solutional regimes, especially those associated with changing landuse patterns which alter drainage and soil pH (Trudgill, 1976:39).

Clearly the hydrological system is the most dynamic element of the karst environmental system. It is responsible to a large degree for the transport of materials (energy) in and out, and within the karst system. It is conspicuously different from non-karst landscapes as karst landscapes generally have a developed subterranean drainage network. The spatial form of the network can vary from linear to dendritic, but in most cases is closely allied with surface drainage especially when relating to discrete entrance points such as swallets. A strong inter-relationship results between seemingly dissimilar surface features and the subterranean hydrologic regime. Usually the rapid movement of surface and groundwater out of a karst area is through well developed subterranean pathways.

ATTITUDES TOWARD KARSTLANDS

Historically, karst studies have fallen within the realm of geology and geomorphology. The ecology of karst terrains and their complexity has only developed with cursory examples in the early 1960s. However, the acknowledgement of humankind's occupation of tropical karstlands came earlier (Helbig in Uhlig 1980; Lehmann, 1936). However, it was not until the 'ecological explosion' of the late 1960s and early 1970s that karst terrains were viewed as ecosystems which could either repel or attract human settlement.

The human occupation and consequent impact on karstlands has a long and controversial history. The following discussion outlines the evidence for and against humankind's early and sustained occupation of karstlands. In conclusion, an example of humankind's long term occupation of a Southeast Asian tropical karstlands is reviewed.

Prehistoric Hominids and Karst in Southeast Asia

It is now thought that Asian hominids are less than 1 million years old (Pope, 1983). Pope asserts a "bamboo-karst" model for hominid paleocultural evolution within the complex environments of Southeast Asia. He associates a predominance of bamboo with karstlands; bamboo is a highly versatile cane grass which can be manufactured into a variety of artifacts, with the exception of chopping tools. Thus, these criteria in accordance with fairly uniform features of karst terrain: caves, springs, fauna and bamboo, hypothetically provided 'known' landscapes as hominids spread through Southeast Asia and China and into insular Southeast Asia.

Pope further argues that a rather sophisticated culture developed in association with these non-lithic technologies, in contrast to commonly held beliefs that Southeast Asia represented a "cultural backwater". Nevertheless he postulates that the development of Southeast Asian hominids in a forest environment played a major role in the growth of a culture dependent on non-lithic technologies.

Hutterer (1985) provides a brief retort to Pope's claims in his survey of Pleistocene archaeology in Southeast Asia. He restrains Pope's enthusiasm by noting that the "bamboo karst" model is not applicable to "all subrecent hominids throughout Southeast Asia" (Hutterer, 1985:7). While failing to offer a counter hypothesis, Hutterer awaits more substantial proof given the breadth of ecological variability in Southeast Asia.

The study of Kopper and Young (1976) also espouses a strong correlation between prehistoric settlements and karst terrain. Their analysis using hominid archaeological sites dating to around 30,000 B.P. moves us closer to the invention of agriculture than Pope's study. In fact it postulates an even stronger connection between people and karst by the birth of agriculture around 12,000 B.P.

Through an analysis of early hominid archaeological sites they conclude that hominids had a penchant for carbonate rock landscapes. In their survey 95% of African, American, Asian and European hominid fossils (~ 30,000 B.P.) were found in karst or soluble rock terrains. Given that only a small percentage of the earth's surface is composed of carbonates and other soluble bedrocks they felt it necessary to test the anomaly. They explored preferential preservation, sampling bias and coincidence with potentially beneficial climatic regimes. These variables failed to refute their findings (Kopper and Young, 1976).

They concluded their paper with a question: Did karstlands offer a special ecosystem for hominids and later occupants of karstlands? They postulate that further "tantalizing" evidence exists, such as the global pattern of surviving primates which correlates closely with the distribution of terra rossa and bauxite soils. They also note that our closest primate relatives, the greater and lesser apes, are confined to heavily karstified portions of Southeast Asia. Interestingly, they link early hunter and gatherer activities in karst terrain to later agricultural development in karstlands like northern Thailand (12,000 B.P.).

Two critics of Kopper and Young's theory, Teaford (1977) and Kempe (1977) fail to adequately discredit it. Kempe's concern involved Kopper and Young's overestimation of karst terrain in Germany. Teaford's challenge was more pointed. He asserted that the data from Africa was incomplete. Yet when the data set and mapping area were clarified the paper's findings were not diminished. Following his corrective comments Teaford (1977:36) noted that the hypothesis was "extremely interesting".

As an aside, there is an interesting paper by Oilier (1985) which reviews the geologic development of Southeast Asia in association with its prehistory. This paper is not compelling for what it says, but rather for what it fails to say in light of the two papers reviewed above. Oilier properly asserts that the geologic development of Southeast Asia had a strong effect on humankind's evolution in the region; it is intimately related to the molding of topography, the formation of soils, and the existence of physical hazards such as volcanism, flooding, or drought.

Following Oilier's lengthy introduction to plate tectonics and the geologic evolution of Southeast Asia he shifts the focus to particular 'dominant' landforms. Volcanoes and their lava and ash hold a pre-eminent position; they are discussed as to their spatial extent but further emphasized are their positive impacts on agricultural development. In contrast to the previous statement. Oilier notes that most of the volcanoes in Southeast Asia are andesitic rather than basaltic, and andesitic lava forms much poorer soils than basaltic lavas.

According to Oilier, alluvial plains were the only other landform attractive to early hominids. River valley and coastal alluvium derived from the weathering and erosion of the volcanic cores presumably providing rich, flat fertile soils. The suitability of marshy lowland environments for agriculture did not develop until the recent advent of drainage technologies. Moreover, malaria may have been restrictive. The conspicuous absence of carbonate landscapes in the review is disturbing given the attention received above.

Contemporary Attitudes to Karstlands

As knowledge of geologic, geomorphologic and hydrologic attributes of karstlands and their resources expanded in the 1960s and 1970s the idea that they may be important in explaining agricultural evolution waned. Le Grand's (1973) paper probably stifled any notion that karstlands had redeeming qualities. The paper's title, Hydrological and Ecological "Problems" of Karst Regions, predisposes us to his bias (my emphasis added). Le Grand, trained as a hydrologist, remarks that in karst terrains; "There are complex insidious problems that develop as man disturbs the natural balance of geologic and hydrologic conditions in carbonate terrains" (Le Grand, 1973:859). He prejudices humankind's adaptive abilities when he notes that a scarcity of soils, surface streams and rugged topography are "problems". Are such 'problems' unique to carbonates? In fact rugged topography, when associated with the maintenance of village autonomy, may be viewed as an advantage. Subsurface drainage can also lead to focused watering points at sinkholes. Springs can also be used as sources of domestic water or may be incorporated in irrigation. The scarcity of soils may only be problematic when they erode, but even when eroded they do not always leave the karst system. They may be simply translocated to valley floors or depressions.

With proper technologies equilibrium can return to any disturbed environment, even one as 'dangerous' as karst. Furthermore, as will be noted below, these perceived resource scarcities do not necessarily mitigate against the development of "flourishing and expansive environments" as postulated by Le Grand (1973:863). For example, Nibbering's (1991) study of the Goenong Sewu karst of Java attests to the fact that over time karst landscapes can not only be stabilized after destructive occupation but can be improved in quality without experiencing a decline in population.

A Contemporary Example

The central Visayan basin of the Philippine archipelago, defined by the two predominantly limestone islands, Cebu and Bohol, has a rich and continuous culture history based on the occupation and exploitation of the island's distinctive and rich karst resources. Their manipulation having distinguished the Cebuano culture from that of the other islands of the region (Figure 2). This karst based culture has been dated to at

minimum 9000 B.P. based on a site located on the southeastern shore of Bohol. The earliest known occupation site on Cebu is dated to 5000 B.P. (Vandemeer, 1963). The region's significance as an important Southeast Asian trading entrepot prior to western written history has been described by Guthe (1927), Solheim (1964) and most recently and elaborately by Junker (1993). Local archaeological work is supported by Chinese chronicles dating from between 627 and 649 A.D. which describe the region as an important regional trade and political power (Chen, 1966:259). Prior to Iberian contact the Dapitan culture, then centred on an area on the southwest coast of Bohol, influenced all of southern Cebu and the north of Mindanao while maintaining trade links with the Chinese, Khmers, Thais and Vietnamese. A peak in pre-historic economic activity occurred in the 12th and 13th centuries (Henson, 1983).

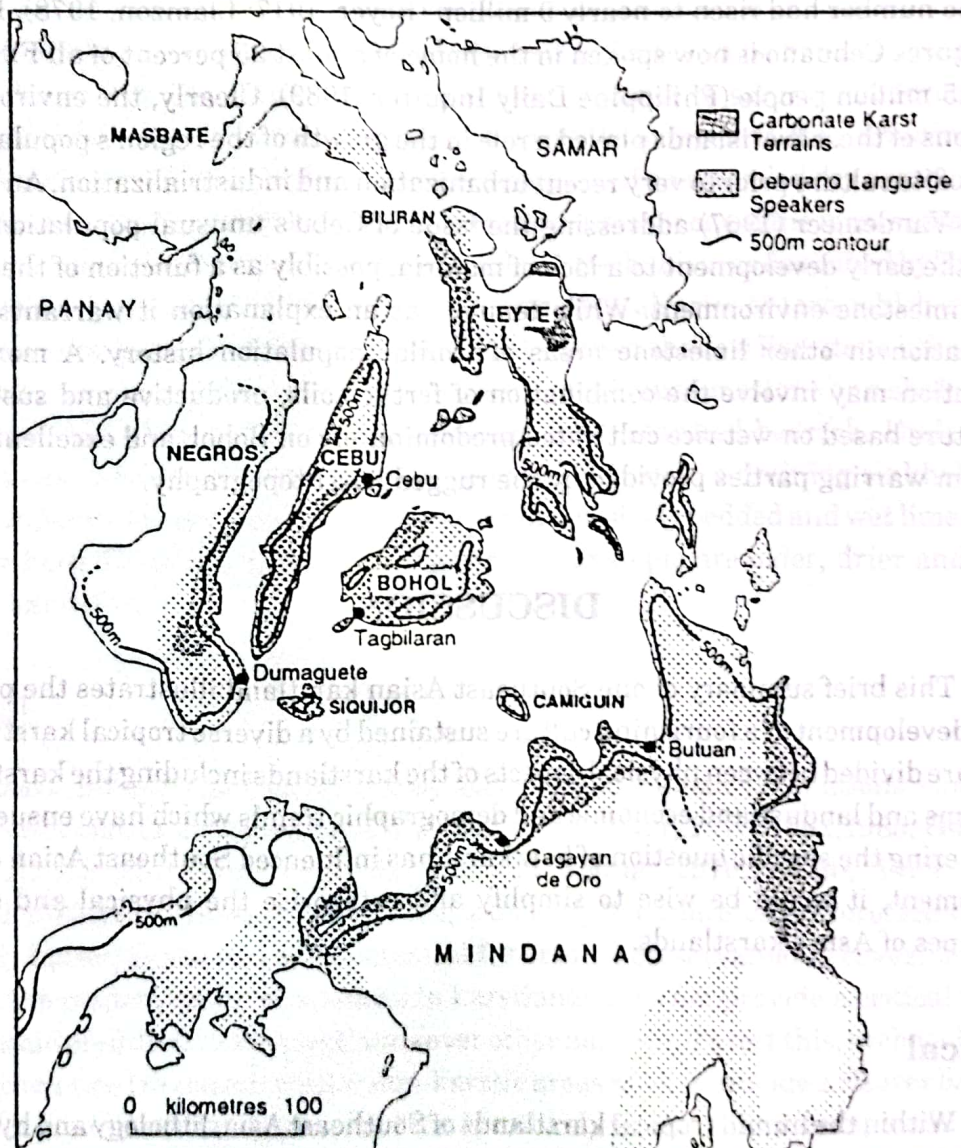


Figure 2. Contemporary extent of the diffusion of Cebuano culture from the historical settlement core of Bohol and southern Cebu.

The local economy was centred around agriculture and trade, with emissaries having been sent to China as early as the 7th century A.D. The culture flourished into the 14th century supported by its production of cotton and rice which it traded for Chinese porcelains. Cotton was an important trade commodity as China was not to begin the development of its domestic cotton production and processing industry until the Southern Sung dynasty (1126-1279 A.D.). This pattern of trade began to diminish in the 15th and 16th centuries as slave raiding and piracy forced coastal residents into the island's interiors for protection.

Throughout the colonial period Cebu and Bohol are represented in government records as areas of relatively high population density. By 1916 the number of Cebuano speakers, the language group of Bohol and Cebu, stood at over 1.8 million people and by 1970 the number had risen to nearly 9 million (Beyer, 1917; Llamzon, 1978). Based on 1984 figures Cebuano is now spoken in the home of almost 25 percent of all Filipinos or about 15 million people (Philippine Daily Inquirer, 1989). Clearly, the environmental conditions of these two islands played a role in the growth of the region's population and spread of its culture prior to very recent urbanization and industrialization. An essay by Canute Vandemeer (1967) addressing the issue of Cebu's unusual population growth linked the early development to a lack of malaria, possibly as a function of the dryness of the limestone environment. While tenuous as an explanation it warrants further examination in other limestone areas of similar population history. A more likely explanation may involve the combination of fertile soils, productive and sustainable agriculture based on wet rice cultivated predominately on Bohol, and excellent protection from warring parties provided by the rugged karst topography.

DISCUSSION

This brief summary of one Southeast Asian karstland illustrates the potential for the development of a flourishing culture sustained by a diverse tropical karst terrain. Issues are divided between physical aspects of the karstlands including the karst extent, landforms and landuse and economic and demographic trends which have ensued. Prior to answering the specific question of how karst has influenced Southeast Asian cultural development, it would be wise to simplify and categorise the physical and cultural landscapes of Asia's karstlands.

Physical

Within the humid tropical karstlands of Southeast Asia, lithology and hydrology of a particular karst terrain plays a dominant role in determining the type and sustainability of landuse practice. Lithology and hydrology can be differentiated into two broad categories. Although they are addressed independently, process-wise they are interdependent.

Lithologies vary from generally young, poorly consolidated, massively bedded, but poorly jointed limestones to those which are older, metamorphically altered, well bedded and jointed. The latter are more prone to intensive karstification identified by free draining karst depressions, grikes, runnels, and large cave systems. Humankind's incursions into these landscapes and subsequent disturbance of the soil resource often leads to widespread degradation. Soils erode via the many limestone fissures and are transported out of the system by extensive cave systems. In contrast, relatively young, poorly jointed and massively bedded limestones generally exhibit a different surface morphology. They typically lack free draining closed depressions, and extensive cave systems. Thus, upon human occupation and ecosystem disturbance degradation is rarely as severe, as eroded soils infrequently leave the system. Rather, they are translocated and stabilize in depressions or poljes.

Lithology also infringes on hydrology. Asia's karsts can be broadly categorized as either dry or wet. Dry karst exhibits a greater distance to saturated bedrock, and surface water is rare. Ephemeral streams frequently sump into free draining cave systems. Landuse is usually limited to dry cropping and if an extended dry season occurs this cropping can be severely restricted. Wet karsts represent one of the most sustainable landscapes in the humid tropics. A positive feedback mechanism as described by Trudgill (1976) appears to enhance the agricultural system, typically rice or taro, which exploits the wet field conditions. Wet karsts usually exist where a shallow limestone lithology is underlain by a more resistant lithology such as a less porous limestone or a shale lense. Water is perched close to the surface resulting in a saturated bedrock. Under such conditions cave and other negative karst features such as free draining sinkholes are rare. Bohol, Sulawesi and Nias karsts are based on massively bedded and wet limestones while Northern Thailand, Madura and Sumba for example are older, drier and more intensely karstified.

Cultural

Asia's tropical karstlands clearly have hosted human populations since the evolution of hominids in the region (De Terra, 1943; Glover, 1976, 1981, 1985; Gorman, 1970, 1971, 1977; Harrison, 1965; Kopper and Young, 1976; Lamb, 1965; Pope, 1978, 1982, 1983, 1989). However, the evidence for early hominid occupation of karstlands is probably biased due to a greater potential for artifact preservation in caves. If this is accepted, the predominance of artifacts in karstlands does not provide a critical test of early hominid predilection for karstlands over other habitats. To test this, archaeological investigations need to consider other non-karstic areas so as to provide a clearer balance suitable for a comparative approach. This is unlikely in the near future; a paucity of personnel and lack of field methods capable of assessing humankind's activities in open sites are but two limiting factors. Studies to date do however, permit the development of a minimum hypothesis; early hominids were clearly not repelled by the prospect of occupying or exploiting karstlands.

I have examined only one region for this paper, several others merit greater attention. In Indonesia: Nias, Madura, Sumba and Timor islands exemplify areas of long-term occupation of karst terrain and cultural development. In mainland Southeast Asia, the Bac-son karst on the border between Viet Nam and China is of particular interest. In contrast to these examples are the karsts of Goenung Sewu, Java and the vast karsts of Papua New Guinea, the former being only recently intensively settled and the latter supporting only light occupation.

It is possible that the settlement of particular karsts is a reflection of prehistoric trade patterns, many of which have long since shifted due to local or regional political and economic change. Examples of historic trade entrepot developed in accordance with karstlands are Timor and Sumba. Today Madurese traders of the karstland of Madura are regionally recognized as excellent traders (Koentjaraningrat, 1976). These cursory examples signify an emerging pattern which remains to be explained.

Demographically, the study areas support population densities in excess of regional averages. While few if any examples of high population densities and out-migration patterns exist in mainland karsts, several examples are to be found in insular Southeast Asia. Madurese emigrants now occupy a large portion of northeast Java (Koentjaraningrat, 1976) and Cebuano speaking migrants of the Philippine's Central Visayas have settled large areas bordering the Bohol Sea (Adem, 1982).

Given the examples cited it is possible to tentatively answer three of the four questions posed in the introduction: 1) Is there a physical minimum area necessary for the creation of a distinctive karst based culture?, 2) Have karstlands been points of population growth or culture hearths through prehistoric and historic times?, and 3) Can karst landscapes be classified using cultural rather than physical criteria?

It appears that the major karstlands which have supported long term occupation generally cover over 1,000 km² or indirectly influence an even greater area through hydrological or pedological means. Certainly some karstland populations expanded to occupy adjacent lands, or in the case of insular Southeast Asia adjacent islands. For lack of a better term these sites could be called classic culture hearths. Boholanos have a long history of emigration to adjacent islands as do the Madurese with their incursion into northeast Java. On the mainland the Bac-son karst of North Viet Nam may have provided the population responsible for the colonisation of the Red River Valley as sea-levels retreated from the area 5-6,000 years ago (Jamieson, 1981).

In the future as more and more karstlands are occupied by agricultural societies it may become beneficial to classify them by landuse. By examining the interaction of culture and karstland, a framework for predicting and evaluating humankind's exploitation of karstlands will emerge, thus permitting their classification by cultural landscape rather than geomorphology such as cockpit or cone, tower, doline or dry valley, or crevice karst (Sweeting, 1974).

TROPICAL KARSTLANDS AND CONTEMPORARY SOCIETIES

Tropical karst environments are distinct from other environments in that they offer a wide range of resources of varying quality over a relatively small area. As a result, when exploited for agriculture a complex system evolves which reflects this varying potential. Furthermore, the intimate mixture of wet and dry environments especially in densely settled Kegel and Tower karst areas can lead to divergent yet interrelated agricultural and social systems.

In karstlands with high population densities, divergent social and agricultural systems evolve in relation to the type and distribution of karst resources, with water and its position in the landscape being the dominant factor. For example, a lowland wet and often rice based, agricultural system with abundant and sustainable resources controlled by an elite social class may often adjoin marginal dry uplands occupied by an impoverished portion of society exploiting resources in an unsustainable fashion. Socio-ecological patterns of this type are not unusual in other densely settled areas of tropical Southeast Asia (Poffenberger, 1990). However, in karstlands exhibiting variable forms of environmental health, the intimacy of entwined landuses and social structures pose an important question when examining the causes and consequences of land degradation (Blaikie, 1985; Blaikie and Brookfield, 1987; Emel and Peet, 1990; Rees, 1990; Redclift 1984,1987). As Blaikie (1985) noted, conservation strategies may be initiated in rapidly degrading uplands only when their destabilisation threatens the dominant lowland economy and society. While a critical concept in all landscapes, it may be most clearly defined in tropical karstlands, especially where wet karsts and economies are hydrologically dependent on the ecologic and hydrologic stability of the upland.

In karstlands, exploitive patterns can be evaluated in terms of the 'health' and/or 'sickness' of a particular karstland. As mentioned above the dichotomy between upland - dry - poor and lowland - wet - affluent karsts is often very evident at the local, micro-level, but it is their hydrological marriage which is critical to agro-ecosytem development and maintenance. In karstlands groundwater is usually focused along particular subterranean routes referred to as "karst plumbing", analogous to the human circulatory system (Ford and Williams, 1989:374). Where blood testing exposes the basic health of a mammal, groundwater testing exposes the health of a karstland. Furthermore, groundwater contained in focused conduits can be continually monitored and its economic value frequently assessed (Pitty, 1966; Sencu, 1986). This oversimplified analogy provides the basis for correlating critical changes in landuse with changing hydrology.

Several important questions emerge from such an intimate arrangement of society, land quality and hydrology. For instance: How do the two systems (lowland - wet - affluent and upland - dry - poor) interact? How will changes in the lowland economy influence changes in the upland economy and vice versa? And how will these changes influence society and remedial action strategies in the environment as a whole? These are but a few of the important questions which may be effectively answered by studying karstland agro-ecology and hydrology.

In order to answer these questions one must first explore the nature and history of landuse change in the marginal uplands. This can then be compared with any hydrological transition which potentially threatens the dominant lowland - wet - affluent economy. It is hoped that an integrated socio-environmental monitoring strategy will test critical assumptions, for instance, hypothesized changes in attitudes among lowland occupants to upland landuse activities. And furthermore, by monitoring these intricate shifts in the environment in unison with those of society, social thresholds and environmental trigger(s) may be identified.

CONCLUSIONS

This discussion has spanned a vast time period, from the beginnings of human-kind's incursion into karst terrains to present conditions and the opportunities they represent. Clearly, cultures have a long history of interaction with and manipulation of karst terrains and have in certain instances developed workable and, until very recently, sustainable systems (Urich, 1993). But like any environment the karst, environment has limits and it is the reaching of the limits and the nature of the subsequent cultural response which is critical, especially as the stable supply of groundwater often relies on the ecological stability of a karst environment. Even more critical is a greater understanding of cultures reliant on the exploitation of karst resources and their developed technologies and adaptive strategies which they have amassed through centuries of interaction with the limestone environments they choose to inhabit.

In effect this paper is a call for more and better research on the cultural aspects of human interaction with tropical karst environments. I hope that like in the wake of Lehmann's study of 1936 a new wave of tropical karst research will emerge based on local culture's adaptation to diverse and rapidly changing environments, economies, and societies.

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ENVIRONMENTAL SENSITIVITY INDEX (ESI) MAPPING FOR OIL SPILL IN SOUTHEAST ASIA: THE CASE OF BATANGAS BAY, PHILIPPINES

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ABSTRACT. *Oil spill concerns are among the major marine issues of various SEA countries due to the probable extent of damage it can bring to the marine and coastal environments.*

In 1997, the Environment Agency of Japan developed a set of guidelines on Environmental Sensitivity Index (ESI) Mapping for Oil Spill in Southeast Asian Seas. These guidelines were distributed to Asian countries to determine its applicability and provide assistance in the preparation of ESI maps aimed at developing an expeditious and responsive oil spill contingency plan.

Last year, WWF-Philippines was chosen to conduct this project for the Philippines using Geographic Information System and Remote Sensing technology as major tools in producing the final ESI maps. The project systematically identified, classified, mapped and evaluated existing sensitive ecosystems throughout the coastal lowland. The maps depicted ecologically important habitats; economic related support infrastructures including areas utilized for industrial use; human-use resources; designated natural resource management areas; resource extraction areas, and subsistence fisheries. The biological resources identified include major groupings of marine mammals, birds, and fish. The shoreline of Batangas Bay, the pilot site, was identified and classified according to its sensitivity to oil contamination, the natural persistence of oil and ease of clean up. These information among many others were reflected in the final ESI maps which was distributed to the various agencies and industries surrounding the bay.

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INTRODUCTION

“Coastal Sensitivity... refers not to the risk of an oil pollution incident occurring, but to the extent of damage or effects likely to be suffered by a given coastal area in the event of an oil spill....”

Oil spill concerns are among the major marine issues of various Southeast Asian countries due to the probable extent of damage it can bring to the marine and coastal environments as well as being a major source of marine pollution at sea. Major transportation routes of large oil tankers characterize Southeast Asia, a region strategically located at a navigational crossroad of maritime trade and whose marine environment is constantly threatened due to the high risk of oil spill occurrence in the area.

Oil spill pollution refers to the alteration of the physical, chemical and biological properties of any body of water as a result of discharges of hydrocarbon or petroleum in any form, including crude oil, fuel oil, sludge, oil refuse and refined products except petrochemicals that will likely create or render such water harmful, detrimental or injurious to public health, marine life, sea birds, safety and welfare as well as to domestic, commercial, industrial, agricultural, recreational or other legitimate uses. (*Excerpt from the keynote speech of Captain Elpidio Padama, Jr., Commander, Marine Environmental Protection Command, Philippine Coast Guard, at the ESI Mapping Workshop held at the Bay View Park Hotel, Manila, 12 December 2000.*)

During an oil spill accident, various ecosystems are at risk, ranging from coral reefs to mangrove forests, to fishpond areas as well as various marine and terrestrial mammals living along the coastal areas. The need to determine the kind of shoreline is as important as knowing the behavior of oil once it reaches the coasts and the necessary steps needed to counter the effects or determine the best cleanup procedure by the response team.

As specified by the set of principles promoted by the International Petroleum Industry Environmental Conservation Association (IPIECA) which states that “the response to spill should always seek to minimize the severity of the environmental damage and hasten the recovery of any damaged ecosystem”, the importance of defining ecologically important habitats such as coral reefs, seagrass and mangroves, economic-related support infrastructure, recreation areas and other cultural and historical amenities will ensure a low level of impact due to a decisive response to control or at least mitigate any adverse effects of oil spills on these environmentally sensitive areas. Furthermore, as the sensitiveness of the different environments are known, emergency oil spill response teams can easily prioritize areas for preventive action as well as cleanup operations.

With these principles in mind and taking into account the importance of technical cooperation, the Environmental Agency of Japan has promoted the “International Cooperation Programme for the Measures to Oil Pollution” in 1996 and developed a set of guidelines on Environmental Sensitivity Index Mapping for Oil Spill in Southeast Asian Seas with the goal of improving the capabilities of Southeast Asian countries to address oil spill incidents quickly and accurately from the perspective of protecting the environment.

The guidelines which were then distributed to these countries, identifies the composition of a sensitivity mapping indexing, describes procedures, and outlines techniques on data compilation, configuration, analyses and synthesis in establishing database structures using Geographic Information Systems technology.

This year, the Environmental Agency (EA) of Japan through the Japan Wildlife Research Center (JWRC) has sought the assistance of World Wildlife Fund-Philippines (WWF-Phils.) in validating the applicability of the guidelines in the Philippines, with Batangas Bay as pilot site. Various mapping tools and techniques have been applied in the preparation of the ESI maps for the area with inputs from the various national and local government agencies, industries, non-government organizations and the local government unit of the area.

OBJECTIVES

“... The response to spills should always seek to minimize the severity of the environmental damage and hasten the recovery of any damaged ecosystem....”

General

Apply the Guidelines for Environmental Sensitivity Index Mapping for Oil Spill in Batangas Bay;

Assess the applicability of the Guidelines under Philippine setting;

Recommend measures to improve and/or enhance the applicability of the Guidelines to Philippine setting.

Specific

Classify shoreline characteristics, habitat types according to NOAA established Environmental Sensitivity Index;

Identify biological resources such as coral reefs, fisheries, mangrove areas and other sub-tidal and supra-tidal communities;

Assess bio-physical and human-use resources such as industries, land-use and protected areas using primary and secondary sources;

Undertake primary data gathering using digital aerial videography, shoreline classification survey, ground-truth verification and fishery and marine mammal survey.

PROJECT SITE

“Batangas Bay harbors a distinct uniqueness which offers a perfect blend of industrial stability and ecological soundness, despite its engagement in capital-intensive activities....”

The project site covers the entire Batangas Bay, including the Maricaban Passage. The project site has a total coastline of 72 kilometers, extending from Matoco Point on the eastern tip of the bay to Bagalangit, on the western coast of Mabini, Batangas including the northern coastline of Tingloy Island.

The absolute location of the project site lies at 13° 33' to 13° 50' N latitude and from 120° 48' to 121° 05' E longitude. By political subdivision, the project site falls within the jurisdiction of the Province of Batangas. It encompasses four municipalities and one city. It is bounded by the municipalities of Bauan and Sta Clara on the north; by Batangas City and Verde Island Passage on the east; by the municipality of Mabini and Balayan Bay on the west; and Municipality of Tingloy on the south.

An Overview of its Resource Base

Batangas Bay's coastal land area and the adjacent Maricaban Island comprise an ecological region, which is fairly intact despite the fast growing rate of industrialization. Coral reefs are relatively abundant, especially around the island of Maricaban, where a high percentage of live coral cover flourish in the area. Reef fishes are abundant in community managed fish sanctuaries that were established by the Municipality of Mabini along Maricaban Strait. Patches of seagrasses are sparsely distributed along the moderate to steep slopes of the narrow intertidal zone in the central portion of the bay. Based on estimates from digital data and ground truth surveys, at least 25 percent of the remaining mangrove forests are located along the riverbanks leading to the exposed tidal flats of large deltas. Roughly 30 percent of fishponds are still operating today culturing mainly bangus and prawns (estimated from aerial and ground truth survey information). The rest are not operational and are due for conversion into port facility soon (personal communication with Sargeant Ponciano delos Angeles, PCG, Batangas City). Fishery is one of the bay's most important natural resources and provide for more than half of the livelihood and subsistence of the coastal communities surrounding the bay. More often, various species of marine mammals such as whales and dolphins enter the bay area and are often sighted during the seasons of anchovies and other pelagic juvenile fish species.

Resource-Use Conflict

Leading in the industrialization and urban expansion of the CALABARZON development areas, the Batangas Bay region is establishing itself as a first class industrialized area with a 12 billion-peso investment plan for an international port (Investment Information Portfolio of Batangas Province, undated). The coastal area of the bay supports various uses including ports/piers, fishpond areas, industries, quarries, residential and commercial establishments and agriculture. There are about 22 private and government-owned ports, which are intensively used to ferry cargoes and passengers as well as for trans-shipment of raw materials and finished products. A focal point of industrialization in the area is the government-owned Batangas Port, which is the subject of major expansion in the next few years. Among the various industries located there, twelve large industrial firms are engaged in oil refinery, chemical, textile manufacturing and food processing. The refineries have an estimated daily production of about 30,000 to 125,000 barrels, which are transported by sea to various destinations around the region. Underwater structures associated with piers, jetties and mooring devices are present. Gas pipelines are currently being laid from the Malampaya region of western Palawan province. Twice to thrice a month, very large crude carriers (VLCCs) belonging to these refineries enter the bay, carrying about 2.2 to 2.4 million barrels of oil equivalent to about 320,000 metric tons (*personal communications with Mr. Elvir Sta. Catalina and Mr. Warren Galarce, September, 2000*).

Due to the relative size of the bay, coupled with the fast growing industrialization and development of the international port, problems related to maritime traffic congestion, resource use conflicts, occurrence of oil and chemical spills, navigational safety and coastal and marine pollution are likely to increase significantly. Intense development pressures throughout the bay continue to pose threats to the marine environment, to its resources and to the quality of life of the coastal communities along the bay.

Potential for Oil Spill

As an industrial center and with the presence of large industries, there is clear potential for accidental oil spill in the bay. The relatively high potential for oil spill in the bay is based on the convergence of the following factors:

Occurrence of oil spill in the past

The presence of two refineries and other industries in the bay

High vessel traffic (> 200 a month)

Relatively high volume of oil and oil products transported through the bay

Highly industrial character of the bay

Table 1 shows the major spill incidents recorded by the Philippine Coast Guard in the Batangas Bay Region from 1983 to 1994. Table 2, on the other hand, shows oil spill incidents that occurred from 1998 to 2000.

Table 1. Oil Spill Incidents in Batangas Bay Region, 1983 – 1994 (after GEF / UNDP/ IMO, 1997)

Date	Spiller	Place	Approx. Qty.	Products
30 May 1986	Pilipinas Shell	Batangas	6,000 bbls	Bunker Oil
19 August 1989	NPC Tank No 2	San Pascual	15,000 ltrs	Bunker Oil
16 July 1990	Pilipinas Shell	Tabangao	150 ltrs	Fuel Oil
10 March 1991	Pilipinas Shell	Batangas	2,100 ltrs	Bunker Oil
20 March 1991	Caltex Refinery	Batangas	200 bbls	Crude Oil
10 Sept. 1992	M/T Andhika Ariadne	Batangas	30 bbls	Diesel Oil
17 Dec. 1992	Pilipinas Shell	Batangas	30 bbls	Diesel Oil
24 April 1993	Batangas Power Plant	Pinamucan	25 ltrs	Used Oil
01 May 1993	Pilipinas Shell	Mapul, Taysan, Batangas	20,000 ltrs	Bunker Oil
09 Jul 1993	Batangas Power Plant	Pinamucan	25 ltrs	Used Oil
29 Sept. 1993	Caltex Refinery	San Pascual	420 ltrs	Bunker Oil

Source: Philippine Coast Guard

Table 2. Pollution Case/Incident in Batangas Bay Region for the year 1998-2000

Date	Spiller	Approx. Quantity	Pol / Chem Products
13 Feb 1998	M/V Maria Pamela	3 drums	Lubricating Oil/Fuel Oil
02 March 1998	Pilipinas Shell	10 drums	Fuel Oil
13 May 1998	Petron Bulk Depot	315 ltrs.	Bunker Oil
02 Sept 1998	M/T DSC – 8	10 ltrs.	Fuel Oil
13 Feb. 1999	M/T Abalon	20 ltrs.	Fuel Oil
04 March 1999	LPG/C Bisugo	1.9 ltrs.	Fuel Oil
20 Aug. 1999	M/T Core Diamond	400 ltrs.	Bunker Oil
07 Jan. 2000	M/T JoyJoy.	2 ltrs.	Fuel Oil
15 March 2000	Keppel Shipyard	1 drum	Used Oil
29 March 2000	M/T Maria Erika	2 ltrs.	ADO

Source: Philippine Coast Guard – Batangas Station

THE PROJECT

“Mapping of sensitive ecosystems is a first step in bringing about a deeper understanding of the coastal processes that work together to bring forth a unique marine environment....”

The ESI Mapping for Oil Spill Project systematically identified, classified, mapped and evaluated existing sensitive ecosystems throughout the coastal lowland. The maps depicted the following: ecologically important habitats such as coral reefs, seagrasses and mangrove areas; economic-related support infrastructures including areas utilized for industrial use; human-use resources such as dive sites, recreation areas and amenities; designated natural resource management areas such as fish sanctuaries; resource extraction areas such as quarries, aquaculture, and subsistence fisheries. The biological resources include major groupings of marine mammals, birds, and fish. The shoreline of Batangas Bay was identified and classified according to its sensitivity to oil contamination, the natural persistence of oil and ease of clean up.

Data on the biophysical components of the area, which were also looked into and projected on the map, include ocean currents and bathymetry, hydrology and land topography as well as information on navigational regulations such as ferry routes, navigation lanes, and anchorage areas.

Additional information were gathered to aid in management of oil spill incidences such as inventory of both public and private spill response companies and agencies, equipment, supplies, personnel and other resources; various memorandum circulars from the Philippine Coast Guard on the Prevention, Containment, Abatement and Control of Marine Pollution; and the existing national and local Oil Spill Contingency Plans developed for the area.

Geographic Information System (GIS) Approach

The data generated for each layer of information was captured, analyzed, stored and displayed using GIS as the main tool in developing the ESI maps. The initial phase of the project involves the compilation of existing digital data contained in the Environmental Management Atlas of the Batangas Bay Region. It is a spatial database produced by the GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas, and various data in the form of printed maps, publications, and Environmental Impact Statement (EIA) reports from various agencies and industries located within the bay. Data quality assessment was performed for each layer of information in order to identify data that needs to be simplified, reclassified and updated. Data conversion and digitization procedures were then followed to develop the base map and the various thematic layers needed for the project. Data standards were set based on the guidelines for mapping in the Philippines

and the format stated in the guidelines. Moreover, to augment all the available secondary data, existing information on various coastal features were updated using digital aerial videography. This technique provided updated information on the existing land cover, e.g., built-up areas, mangrove stands and aquaculture areas; coastal and marine infrastructure, e.g., industries, ports and piers; areal extent of various intertidal communities, e.g., coral reefs and sea grasses; road network, and other existing human-use resources situated along the bay.

PROJECT INPUT

“An effective project management lies not only on conservation science tools but with the power that technology can bring forth when put into action....”

Primary Sources

Aerial Videography

Airborne video data capture system coupled with Differential Global Positioning System (DGPS) and supplemented with ground-truth survey procedures, provide a cost- and time-effective method for obtaining data and updating information on land use and various coastal features over fairly large geographic areas. It is a process of capturing images, either still or moving video, at a constant altitude. Given the purpose of the application as well as the relative size of the study area, the team flew on October 14, 2000.

The final mosaic provided us with an aerial view of the study area at a resolution of 5 meters on the ground.

Shoreline Videography

In order to accurately identify and classify the shoreline type, video footage of the coastline was captured using a digital video camcorder. Again, the camcorder clock was synchronized with the GPS unit. The camera was held by hand and set to progressive scan mode to minimize manifestation of camera shake. The video was taken from a banca, which is running at an average speed of 5 knots per hour. Coastal features and shoreline types were then identified and marked on the base map with their corresponding geographic positions. Important near-shore habitats were also noted, e.g., mangrove stands, seagrass beds and existing fishpond areas near the coast. The video was then analyzed simultaneously with the aerial mosaic to guide in the interpretation and classification that was described in the guidelines, e.g., its relative exposure to wave and tidal energy; the slope of shoreline; substrate type such as grain size, mobility, penetration, and trafficability; and finally, the biological productivity and sensitivity. The boundaries of the shoreline types were then marked and defined on the base map and on the digital coastline coverage of the study area.

The shoreline types identified for the Batangas Bay region ranked according to sensitivity include Exposed Rocky Shores, Exposed Solid Man-made Structure, Wave Cut, Coarse-Grained Sand Beaches, Mixed Sand and Gravel Beaches, Sand and Coral Rubbles, Gravel Beaches, Riprap, Exposed Tidal Flats, Sheltered Solid Man-made Structure and finally, mangrove and aroma. Exposed rocky shores are among the least sensitive to oil spill while mangrove and aroma stands constitute the type of habitat most sensitive to oil and other types of marine and coastal pollution. Another shoreline type present in the study area that was absent in the types of shoreline described in the guidelines was coral reefs, a highly sensitive coastal environment. The final output included the shoreline types that are present in the study area, type descriptions, predicted behavior to oil spill and response considerations. The surveys were conducted 17-18 October 2000.

Ground-Truth and Global Positioning System Survey

Ground truth surveys were conducted from October to November 2000 to validate the condition of any discernible coastal features and ecosystems of interest. It is projected on the map and may be viewed in the aerial mosaic that was prepared. In addition to this, GPS positions were acquired for the various industries along the coast, the existing road network, resorts, dive sites, fishpond areas, the various coastal ecosystems such as coral reefs, seagrass communities, and the remaining mangrove and aroma stands in the area as well as coastal activities which may have direct impact on the marine resources of the bay. GPS is the acquisition of location information from a constellation of 24 satellites roving around the earth. The GPS positions were then plotted on the base map and also used to aid in georeferencing the digital aerial mosaic, and the various digitized and scanned maps gathered from agencies and local government units in the area. Additional information was also gathered for each particular coastal feature and habitat to provide attribute data that would link it to the GIS database coverage for further analysis and interpretation.

Fishery and Marine Mammal Survey

The state of fishery resources of Batangas Bay, which emanate from its coral reefs may have been reduced substantially as coral reefs become degraded or even completely lost due to massive coastal conversion/developments. Despite the poor condition of the remaining coral reefs of Batangas Bay, its near shore and offshore fishery areas continue to be relatively productive because of the rich coral reefs in the adjacent Maricaban Island and western section of the Calumpan Peninsula and the presence of other natural nursery grounds that supply its near shore areas like rivers, mangroves and seagrass communities. Juvenile shrimps, milkfish, mackerels, tunas and anchovies remain to be harvested in viable quantities along near shore areas while mature pelagic species are caught in deeper portions of the bay. There are two types of fisheries that thrive in the bay, pelagic and coral reef fisheries. Additionally, significant population of

marine mammals; e.g., whales and dolphins, are still present in the bay and its adjacent waters. Sources of information contained herein were taken from secondary data and administered interviews of selected fisherfolks around the project site. The information that was gathered from the 18-20 October 2000 aims to provide input on the general status of fishery and marine mammal resources in the bay and its adjacent waters.

Additional data were gathered through administered interviews conducted by the Bantay Dagat of Mabini. Interviews were done in selected barangays, which are adjacent to known fishing grounds. Information that was gathered includes fishing grounds. In order to get this information, respondents were shown a map of the area, given a brief orientation on their relative location in the bay and asked to draw the approximate fishing areas for mature and juvenile fishes. The estimated fishing months as well as the type of fish that were caught in certain seasons of the year were also gathered. Identification of fishes to the species level was done by showing colored fish field guidebooks to respondents. Additional information on coral reef associated fish species were supplemented from information gathered from underwater observations in various dive spots in Mabini and Tingloy as well as observations in the fish market in Anilao, Mabini. Poster and identification manuals for cetaceans were used to determine the cetacean species that are found entering the study area. The interviewers also tried to establish the species of cetaceans commonly sighted in the bay, peak sighting months and usual time of day that the animals are sighted.

ESI COMPONENTS

“The existing social and environmental characteristics of Batangas Bay remain undaunted despite the potentially dangerous threat of oil spill accidents that VLCCs lay upon it...”

Classification of Shoreline

The shoreline of Batangas Bay can be classified into the following characteristic coastal habitats as classified by NOAA:

- Exposed rocky shores
- Exposed solid man-made structures
- Wave cut
- Coarse-grained sand beaches
- Mixed sand and gravel beaches
- Sand and coral rubbles
- Gravel beaches

Riprap
Exposed tidal flats
Sheltered solid man-made structures
Mangrove and aroma

The exposed rocky shorelines of Batangas Bay are commonly located at the outer parts of the bay, near the headlands of Cazador Point and Matoco Point as well as portions of the northern coastline of Maricaban Island. Moving to the central portion of the bay, the beach deposits grade to gravel and mixed gravel and sand. At the central section of the bay, sandy beaches make up the coastline of the alluvial plain of Batangas City. Mangrove is also present in this part of the bay.

Solid man-made structures are very common in the large coastal settlements and the industrial and other built-up areas along the coastline. These are located in Pinamucaan, Santa Clara, San Pascual and the industrialized barangays of Bauan. Short solid structures are also present in the coastal settlements of Maricaban.

Biological Resources

Coastal Resources

The coastline of Batangas Bay is now dominated by industrial development, settlements and agriculture. Industries line up the coastline from Pinamucaan, Batangas City to Bauan and eastern coastline of Mabini facing Batangas Bay. Approximately 10 percent of the total length of the shoreline of Batangas Bay was converted to industrial facilities. Interspersed among the industries are settlements. The largest aggregation of this is found in Sta. Clara, Batangas City and adjoining barangays. Typical of the coastal regions of the country, the common agricultural crop in the area is coconut. Small orchards and farm lots can also be found along the slopes facing Batangas Bay.

The natural vegetation communities observed along the coastline of the study area include limited strands of aroma (*Acacia farnesiana*) noted at some parts of the coastline of Batangas City. Test Consult (1996) reported the presence of "aroma" in the backshore of Sta. Rita Karsada and Bgy. Sta. Rita Aplaya, Batangas City. It also reported the presence of some "nipa" (*Nypa fruticans*) along the river banks in Sta. Rita. Despite the widespread conversion to fishponds, mangrove stands are still present in Sta. Rita, Santa Clara and Wawa, Batangas City. In areas where very steep slopes abut the sea, vegetation cover is commonly brush.

The beach formation is generally not vulnerable to oil spill since these are located above the high tide level and these are generally found at the backshore region. The mangrove is considered to be highly vulnerable to oil spill for the following reasons: (after NOAA, undated)

Oil can wash through mangroves if oil comes ashore at high tide;

If there is a berm or shoreline present, oil tends to concentrate and penetrate into the berm sediments or accumulated wrack / litter;

Heavy emulsified oil can be trapped in thickets or mangrove prop roots;

Oil readily adheres to prop roots, tree trunks, and pneumatophores; Re-

oiling from re-suspended or released oil residues may cause additional injury over time;

Oiled trees start to show evidence of effects (leaf yellowing) weeks after oiling; tree mortality may take months, especially for heavy oils.

Marine Resources

Coral Reefs

Coral reefs are present in limited locations in Batangas Bay. There are very few coral reefs at the eastern side of the bay. Reefs in this part of the bay are present in Matoco Point, Barangay Tabangao and Pinamucaan. Ground truth survey conducted October, 2000 revealed that the few remaining coral areas on the eastern section of the bay still has an estimated 15-20 percent live coral cover. This estimate is similar to the result of survey of Aliño, et al. in 1997 where Matoco Point was described as an area with an estimated 20 percent cover. The highest coral cover in the bay (cited in UNDP, 1999). In the same report, it was noted that coral cover is generally low on the western side with less than 15 percent hard coral cover. However, recent rapid verification survey of coral cover up to Cazador Point shows an estimated coral cover higher than in Matoco Point. In fact, there are still two dive sites located in barangay Mainit, near Cazador Point. It was also observed that coral cover diminishes towards the central section of the bay and that large portions have been extirpated of corals possibly due to heavy sediment loads particularly along the intertidal zone. Corals are present from Mainaga Point and Dilaw Point and percentage of live coral cover increases towards Cazador Point.

Similar to the result of the recent ground truth survey, results of marine surveys conducted by BHP Engineering (1994) in Pinamucan, Batangas City and GAIA South (2000) in San Roque, Bauan are consistent with the findings of Aliño (1997). Coral covers in these areas of the bay are classified as poor to fair condition with 22% to about 27% live coral cover.

As reported by UNDP (1999), the best coral reefs in the entire study area are found along the coastline of Maricaban Strait, particularly along the shoreline of Maricaban Island and southwestern shoreline of the Calumpan Peninsula within Barangays Bagalangit and San Teodoro. The municipal fish sanctuaries – Cathedral Rock, Arthur's Rock and Twin Rocks – are found respectively in these barangays. These coral reefs are considered to be among the best diving spots in the area. However, no quantitative data are available at the moment to support this claim.

According to NOAA, predicted oil behavior in coral reefs are as follows:

Coral reefs vary widely in sensitivity to spilled oil, depending on water depth, oil type, and duration of exposure;

There are three primary exposure pathways; direct contact with floating oil; exposure to dissolved and dispersed oil in the water column; and contamination of the substrate by oil deposited on the seafloor;

Reef-associated community of fish, crustaceans, sea urchins, etc. can experience significant mortality.

Seagrass and Seaweeds

There is a dearth of information on seagrass and seaweeds in Batangas Bay. BHP (1994) reported the presence of 36 taxa of seaweeds and seagrass in the survey site in Pinamucan, 35 taxa of seaweeds and 1 seagrass.

Predicted oil behavior in seagrass beds according to NOAA are:

Oil will usually pass over sub-tidal seagrass beds, resulting in no direct contamination;

Oil that is heavier than sea water can become trapped in beds, coating the leaves and sediments;

Oil readily adheres to the vegetation, and the oiled blades are quickly defoliated when inter-tidal beds are oiled.;

Floating oil stranded on adjacent beaches can pick up sediment and then get eroded and deposited in adjacent beds.

Demersal and Pelagic Fishes

Results of survey from secondary sources show very limited information about the fishery resources of the bay and probably an understatement of its true potential value in terms of production and diversity. However, the list of fish species were supplemented by a list prepared from underwater and fish market observations by the author of this report. As observed, at least 160 demersal and pelagic species are known to occur within the study area. More than 90 percent of these are demersal and most of which are found in coral reefs and coral areas. The most common reef fish in the area are the damselfishes followed by the wrasses. These families are not only abundant in the Batangas Bay Region but are commonly the most speciose family in most parts of the Philippines. While it can be gleaned from the list that the diversity of coral reef fish species is high, its economic value is low because the species with high economic value, i.e., groupers and snappers, were over-fished. This is indicated by the dominance of small sizes of these species. Abundance of juvenile fish species was identified along the inter-tidal areas on the central to eastern section of the bay and on the northeastern coast of Tingloy. Reef fishery is active in areas where coral reefs are in good condition and these fishing grounds are identified on all coasts of the project site.

A majority of butterflyfishes and a few damselfishes are known as indicator species because they feed on coral polyps and its presence could indicate the general health of the reef. A good number of these fishes are still found particularly in the coral reefs of Mabini and Tingloy. But notable population sizes are found in fish sanctuaries like Cathedral Rock and Twin Rocks.

Pelagic species are those species that are found offshore. They come in large schools from the month of September through May. During this season, even fishers from neighboring towns come to fish in Batangas Bay and its adjacent waters. There are no available data, however, that could support claim that the pelagic fishery of the area is still productive, but only the verbal reports of local fishers and the presence of a number of medium-large commercial fishing vessels encroaching the municipal waters of Batangas Bay. The commonly caught pelagic species in the bay are skipjack, yellowfin tuna, frigate tuna, and common scad, round scad, long-jawed mackerel, moonfish and herring. Fishers identified the pelagic fishing areas and these are located at the mouth of the bay and along the Maricaban Strait.

Marine Mammals

Batangas Bay including Maricaban Strait is a feeding ground to a number of dolphins and whales. The most common of the dolphins in the bay is the spinner dolphin. These marine mammals are sighted during early morning and late afternoon. Fishers associate increased frequency of sightings of dolphins with the abundance of young pelagic fishes, e.g., anchovies and herrings. Reports indicate that sightings are usually in pods of at least 15-20 individuals. The sizes of dolphins and whales are somewhat small and were reported by respondents as ranging from 1-2 meters. Some respondents even reported sightings of less than a meter. Recently, there were incidents of stranding and one of the animals that were stranded was positively identified by specialist as dwarf sperm whale. Ever since the coastal law enforcers of Mabini and Tingloy were trained on marine mammal identification and rescue, reports of marine mammal stranding and slaughter begun to surface, an indication that there are still significant population of marine mammals in the area. The arrest of dynamite fishing practices in the bay likewise contributed to the increased frequency of sightings of these animals even within 500 meters from the shoreline of the central section of the bay and the western coast of Calumpan Peninsula. Test Consult (1996) reported sighting of a school of dolphins about 100 meters offshore of Sta. Rita. Table 3 is a list of whales and dolphins species that are present in the bay. These marine mammals are distributed through the entire bay including Maricaban Strait and Verde Island Passage. Sighting is year-round.

Table 3. Species of Marine Mammals Found in the Project Site.

Common Name	Scientific Name
Bottle nose dolphin	<i>Tursiops truncatus</i>
Pantropical dolphin	<i>Stenella attenuata</i>
Striped dolphin	<i>Stenella coeruleoalba</i>
Spinner dolphin	<i>Stenella longirostris</i>
Rough-toothed dolphin	<i>Steno bredanensis</i>
Dwarf sperm whale	<i>Kogia sima</i>
Sperm whale	<i>Physeter macrocephalus</i>

Human Resource Use

Coastal Land Use

Industrial

Approximately 10 percent of the coastline of Batangas Bay is occupied by industries. Shorelines fronting the industries are commonly lined by shore protection such as walls and ripraps in addition to pier and other docking facilities. These industries range from fossil fuel to coconut oil refineries, power generation plants, processing of food and chemical products, storage facilities and services.

Infrastructures

Port Facilities

Paw, et al. (1997) cited a 1993 inventory list, which indicates that there are 17 private and two public port facilities in the bay. The public port facilities are the Port of Batangas and the Terminal of Bauan. No data is currently on hand to indicate the annual volume of vessels that call on the various ports around Batangas Bay. However, it was estimated by Paw et al. (1997) that 1,323 ships docked in Batangas in February, 1995. Of the total vessels that docked, 94 percent were domestic vessels. Most of the vessels (81%) docked in the Port of Batangas City and Bauan. The remaining (19%) docked in private ports.

Settlements

Settlement is one of the major uses of the coastal area of Batangas Bay. But it seems that settlements are losing ground to industrial development. The most populous coastal barangays of Batangas City are Santa Clara and adjoining barangays of Cuta, Libjo and Wawa. The coastal barangays of Bauan with the largest population are Barangay Aplaya followed by San Andres 1 and San Andres Proper and Santa Maria. In Mabini, the largest settlements are those of Barangays Talaga and Saguang.

Tourism and Recreation

Tourism is not well developed in Batangas Bay. This is probably due to the fact that heavy industries are slowly dominating the shoreline in addition to pollution of the bay due to shipping operations of private ports (UNDP, 1999). Only small resorts and picnic areas have been noted along the coastline of Batangas City and Bauan during the survey conducted last September 2000.

Areas within the study site with high tourism and recreational potential are the coastlines of Tingloy and Mabini. Popular dive sites along the southwestern coastline of Mabini are Cazador Point, Twin Rocks and Arthur's Rocks. While along the northern coastline of Tingloy are Sombrero Island, Layag-layag, Caban Cove, Pulang Buli, Culebra (aka Bonito Island) and Balahibong Manok.

Talaga, along the eastern coastline of Mabini is an alternative training dive site during the height of the southwest monsoon. Dive spots along the northern shoreline of Tingloy are accessible even during the southwest monsoon.

Diving in Mabini and Tingloy is whole year round but peaks during the summer months and holidays.

Agriculture

Agriculture in the coastal region of Batangas Bay is quite limited based on the data presented by Paw, et al. (1997). This is validated by the aerial video photography of WWF. As presented by Paw, et al. (1997) rice cultivation along the coastline of Batangas Bay is confined to selected areas of Batangas City, Bauan and San Pascual. Crops include rice (non-irrigated), sugarcane and coconut. Table 4 shows the distribution of the cultivated areas along the coastline of Batangas Bay.

Aquaculture

Aquaculture in the project site is limited to Santa Clara Aplaya, Cuta, Wawa and Santa Rita, Batangas City where mangroves have been converted to fishponds. Aquaculture products include bangus and prawns. Scale of aquaculture industry is classified as small scale (UNDP, 1999).

With planned expansion of the Batangas City Port, fishponds and remaining mangroves in Santa Rita will soon be converted.

Table 4. Distribution of area (hectares) by agricultural land-use, Batangas Bay Region, 1985.

Town/City	NIRP	UR	Co	Ba	At	Su	Comocr	Comucr	CoSh	FP	Total Agri area
Batangas	138	2,215	138	111	-	6,368	28	28	1,689	498	11,213
Bauan	345	329	52	26	9	2,324	-	250	65	-	3,400
Sn Pascual	42	285	7	16	-	2,505	-	-	-	-	2,905
Mabini	32	66	-	-	227	-	194	68	1,697	-	2,284
Tingloy	-	234	-	72	-	-	-	-	1,075	-	1,381
TOTAL	557	3,129	247	225	236	12,197	222	346	4,526	498	21,183

Note: Area was computed using a dot grid, based on 1:50,000 Present Land-use Map from BSWM. Legend: NIRP – non-irrigated rice paddy; UR – upland rice; Co – corn; Ba – banana; At – atis; Su – sugarcane; Comocr – coconut (monocrop); Comucr – coconut (multicrop); Cosh – coconut shrubs; FP – fishpond

Marine Water

Navigation

The use of Batangas Bay for navigation is quintessential, being a highly industrialized area. A corridor along the eastern part of the Bay has been designated as a navigational route for inbound and outbound vessels. Under the Batangas Bay Vessel Traffic Separation Scheme (BBVTSS), inbound vessels are confined to the easternmost (near the coastline) corridor, while the outbound vessels should take the outer corridor (western corridor). In addition, the Verde Island Passage Traffic Separation Scheme (VPTSS) is implemented. The scheme separates the northbound and southbound vessels that sail through the Verde Island Passage. Southbound vessels are to pass through the western side of Verde Island, while the northbound vessels are to pass through the eastern side of the island. Local ferry boats serving the island municipality of Maricaban/Tingloy navigates the western part of the bay from Mainaga/Talaga to Tingloy, while ferry boats plying the Tingloy-Anilao route pass through the eastern coastline of Balayan Bay.

Community Managed Protected Area

In May 1993, the municipality of Mabini issued Ordinance No. 06-93, amending Ordinance No. 11-91 which declares portions of Barangay San Teodoro and Bagalangit as marine sanctuary and reservation area. These barangays are situated along Maricaban Strait. The first provision declares waters 700 meters offshore of the two barangays as municipal marine reserve. The second provision declares three sites within the two barangays as fish sanctuaries. These are Cathedral Rock, Twin Rocks and Arthur's Rock.

The sanctuaries are very small with an approximate size of less than 2,000 square meters each. In these sanctuaries, it is prohibited to catch fish except for the gathering of shellfish in knee-deep waters from May to October only. The sanctuaries are enveloped by the municipal marine reserve which serves as the buffer where only traditional fishing methods such as hook and line and spear fishing without scuba or compressor, the catching of fish fry, and use of bamboo traps are allowed. Although the ordinance prohibits scuba diving inside the sanctuaries, enforcement is lax and recreational divers blatantly violate this provision every time they dive even for purposes of appreciation. Extractive activities, however, particularly fishing by resident fisherfolks and spear fishing by recreational divers are being enforced. Despite the absence of a prohibition on dropping of anchors in these areas, dive boats (bancas) recognize its potential threat and cooperate to always tie to mooring buoys installed by recreational divers and resort owners. The use of mooring buoys has dramatically improved the health of the fringing reef in the two barangays.

Capture Fishery

As described by the MTE (1996), two types of fishery sectors exist within the Batangas Bay region, the municipal and commercial fisheries. The municipal fishery refers to small-scale (less than three gross tons) fishing within a 15-kilometer distance from the shoreline. Most types of fishing gears used in municipal fishery are traditional, e.g., hook and line and gill net. Aliño (1997 cited in Paw, et al.) reported the commonly used fishing gears in the bay in terms of total number of fishers. These are:

Hook and line or kawil (40% of total fishers)

Gillnet or pante (32-36% of total fishers); and

Drag seine or salap / pukot (21% of total fishers)

Since the Batangas Bay falls under municipal water, it is closed to commercial fishing. Commercial fishery refers to operations that use boats greater than three gross tons. Despite the prohibition, commercial fishery persists within the bay. Commercial fishing boat owners are able to legitimize their operation in the bay by applying for municipal permit. In fact, it was reported by fishers during the fishery survey conducted by the Bantay Dagat that several fishing operations in the pelagic fishing ground near the mouth of the bay are commercial fishing operations. Major pelagic species landed by municipal fishing boats are shown in Table 5.

Municipal fishery production level of 1993 was reported at 3,634 metric tons with estimated value of 181.7 million pesos. Quantity of commercial fish landed in Batangas City appears to be declining as shown in Table 6, but is difficult to ascertain the reason for its decline. Moreover, landings in Batangas City include catches from other localities and do not truly represent the commercial fishery catch/production of the bay. Table 7 presents temporal characteristics of fishing seasons, which are derived from GEF/UNDP/IMO and EIA preparers.

Table 5. Local and Scientific Names of Fishes caught by fisherfolks in Batangas Bay.

English/Local Name	Scientific Name	Family
Scad/galunggong	<i>Decapterus sp.</i>	Carangidae
Anchovy / dilis	<i>Stolephorus sp.</i>	Engraulidae
Alumahan	<i>Rastrellger sp</i>	Scombridae
Yellowfin tuna	<i>Thunnus albacares</i>	Scombridae
Frigate tuna/tulingan	<i>Auxis sp.</i>	Scombridae
Skipjack	<i>Katsuwonus pelamis</i>	Scombridae
Spanish mackerel/ tanguigui	<i>Scomberomeros sp.</i>	Scombridae
Slipmouth/sapsap	<i>Leiognathus sp.</i>	Leiognathidae
Cavalla/talakitok	<i>Caranx sp.</i>	Carangidae
Fusilier/dalagang bukid	<i>Caesio sp.</i>	Caesionidae
Grouper/lapu-lapu	<i>Epinephelus sp.</i>	Serranidae
Barracuda	<i>Sphyraena sp.</i>	Sphyraenidae
Torsillo	<i>Barracuda sp.</i>	Sphyraenidae
Mullet	<i>Mugil sp.</i>	Mugilidae
Threadfin bream/bisugo	<i>Nemipterus sp.</i>	Nemipteridae
Moonfish	<i>Mene maculata</i>	Menidae
Sardine	<i>Sardinella sp.</i>	Clupeidae
Round herring	<i>Dussumieria sp.</i>	Dussumieriidae

Source: Office of the Provincial Agriculturist, Batangas Province, undated. (Scientific names and family entries corrected/updated by WWF-Phils.)

Common commercial fishing gears used in the bay are bag net and encircling gill net. Bag net operation is aided by high wattage lamps to shine the fish.

PROJECT OUTPUT

“Environmental Sensitivity Index Mapping using Geographic Information System is another boost to oil spill response capability of the Philippines...”

ESI Map

The final ESI map projects Batangas Bay in a 1:50,000 scale. It presents the existing status of the mangrove cover, coral reefs, seagrass beds, fishpond areas and coastal fishery wildlife resources. These various habitat types are delineated in the map by polygons with corresponding symbolization. The 72 kilometers total shoreline of the

study area were segmented and classified based on the ESI types represented by standardized color scheme following a general trend of having the least sensitive type as always black or dark color while the most sensitive type as red.

The distribution of biological resources is represented by polygons, which are color-coded accordingly with corresponding icons placed over the polygons. These resources include major groupings of marine mammals such as, whales and dolphins; birds; shrimp; fish nursery grounds; and, pelagic and demersal fishing areas.

Table 6. Quantity of Commercial Fish Landed in Batangas City

Year	Quantity (MT)
1993	184
1992	-
1991	625
1990	1,348
1989	-
1988	-
1987	1,112
1986	1,782
1985	1,687
1984	1,556
1983	1,565
1982	1,750
1981	7,589
1980	8,028
1979	8,231
1978	6,764
1977	7,270
1976	2,048

Sources: Fisheries Statistics of the Philippines, BFAR (1976-87) and the Bureau of Agricultural Statistics, Batangas City (1990-93).

Table 7 is a calendar of the temporal characteristics of fishing activities derived from various survey information conducted in the area.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Test (1996)				Good Fishing								
PCI (1991)			Good Fishing Season									
GEF/UNDP/IMO 1996	Peak Fishing Season					Lean fishing season			Peak Fishing			
Round scad (GEF/UNDP/IMO)												
Dilis												
Pugita												
Frigate Tuna(GEF/UNDP/IMO)												
Bangus and tiger shrimp Fry												

Similar with delineations of biological resources, identified human-use resources have designated codes with the corresponding feature type, which are represented as polygons and icons on the map. Resort areas, schools, industries, lighthouses, ports and piers, park, diving sites, fish landing sites and quarrying sites have been identified and plotted based on the GPS positions gathered during field works. Polygon areas of industries and coastal communities have been extracted from the aerial video mosaic produced for the area.

The various features projected on the map are supported with a database on the characteristics, qualitative and quantitative indicators, and other pertinent information in tabular form which provide for attribute information linked to these various map features in the form of points, lines and polygons.

Other features, which were deemed critical in identifying areas susceptible to oil, spill incidents and considered as sensitivity modifiers were also projected on the map. Among these features are the designated navigational lanes, ferry routes, anchorage areas, and underwater gas pipelines laid from the extraction source to particular storage and refinery plants. To provide as start-off point for response operations, access points were also indicated such as helicopter landing decks mostly found within industrial compounds, Coast Guard stations, port and harbor facilities as well as access roads and location of coastal communities surrounding the bay.

Based on what was presented in the final ESI map of the area, Batangas Bay has a fairly high sensitivity level to oil spill because of: its relatively abundant fishery resources in which coastal communities are heavily dependent on; the presence of rich, colorful coral reefs and fish sanctuaries which identify the area as world class diving sites; the presence of shoreline habitats among which are significant mangrove stands

and tidal flats which have high sensitivity rankings; the presence of economically sensitive areas which include ports and aquaculture areas; and most specially due to the intense development pressure throughout the region as it is developed into an international economic arena.

Geodatabase

Additional information has been incorporated in the database, which involves different mapping tools such as remote sensing and the GIS component on 3D modeling. Remote sensing deals with sensors attached to vessels or crafts deployed in space or the earth's atmosphere gathering data and information on the various earth processes and features. Data from these platforms come in the form of photographs, satellite images, aerial photos, and radar images. To augment the information extracted from the aerial video mosaic of the coastal areas, satellite images of the site have been processed to provide a backdrop. The same images were classified further to extract land cover and land use information, as well as the areal extent of the bottom cover. Given the various dates of satellite data acquisition, future processing would involve doing temporal analysis of the changes in land and bottom cover features of the region.

Digital elevation models and three-dimensional views of the site are also available, depicting the configuration of the area or the topography of both land and water. These would further aid in data analysis and interpretation as well as provide a different perspective in viewing the study area for better appreciation and understanding.

CONCLUSION

"The scenario of major tanker accident can never be discounted and the best thing to do is be prepared to combat a major oil spill..."

Assessment of Applicability

The susceptibility of a given coastal area to oil spill and to other forms of pollution is one of the most important aspects of environmental management and protection. In recognizing the need to define the sensitivity of resources to various forms of pollution, the availability of a set of guidelines to aid in implementing a sensitivity index mapping for the area is a critical step towards effective coastal resource management.

In the Philippine setting, the applicability of the guidelines is to augment or complement the implementation of the National Oil Spill Contingency Plan and further aid in reformulating the local contingency plan for any particular coastal areas in the country where it is applicable. With the rapid development in mapping technology in the

country, the implementation of the guidelines was generally successful and effective, although some difficulties related to data gathering were encountered. However, recommendations for its improvement were made to make it more adaptable to local setting.

Availability of data sources was one of the major obstacles in building the GIS database. To cope up with this problem, the project established networks and linkages with various industries and agencies of government, both local and national, in order to identify possible sources of data and information and to draw upon them a collaborative effort in the effective implementation of this project. Data gaps and updating of information were filled in with the use of primary data gathering tools such as field works and aerial surveys.

Recommendation

The guidelines provided efficient information in terms of identifying the composition of sensitivity map indexing, database development and establishing database structures using Geographic Information Systems (GIS) technology.

For applications in the Philippines, sensitivity modifiers, i.e., navigation or shipping lanes, anchorage areas, underwater structures and accessibility of coastal areas were introduced to further determine the susceptibility of a certain area or type of habitat to oil spill or other forms of pollution. Future development plans should also be considered particularly because of changes in land use, conversion plans, establishment of industries, or development of existing ports and facilities.

Additional shoreline types such as Coral Rubbles should also be stated and classified as having the same sensitivity ranking as with Mixed Sand and Gravel Beaches (5) or Gravel Beaches (6A). In addition, the various types of indigenous materials were used as solid man-made structures particularly for various coastal communities around the archipelago where certain types of vegetation or indigenous materials are unique and prevalent for that area.

Furthermore, susceptibility mapping should be considered as the next step in order to determine the level of risks each identified sensitive ecosystem or habitat has in relation to the occurrence of oil spill in the future.

OFF SHOOTS

"Living up to the visions that private and government sectors set forth in protecting and preserving the environment, where all of us depend on, is key to maintaining the integrity of ecological processes and striking equilibrium between man and nature..."

With the current efforts of the Philippine Coast Guard and the Norwegian Government through the Det Norske Veritas (DNV) to upgrade the current Philippine National Oil Spill Contingency Plan (NOSCP), the project's output was recognized as a vital input and a primary source of information to aid in establishing the necessary legislative framework, organizational structures, manpower skills, technical standards and operational procedures in the development of an effective and responsive NOSCP.

Memorandum of Understanding

Realizing further the relevance of the project as a vehicle towards establishing a collaborative effort in combating oil spill in the area as well as in preserving and managing the bay's resources, a Memorandum of Understanding (MOU) on Strengthening Inter-sectoral Cooperation on Pollution Prevention and Oil Spill Contingency Plan Execution was spearheaded by WWF-Philippines. The MOU is being formulated among the various signatories which include: the LGU sector which are represented by the mayors of the four municipalities and the City of Batangas, the Provincial Government of Batangas represented by the Provincial Government–Environment and Natural Resources Office (PG-ENRO); the national government agencies (NGAs) composed of the Philippine Coast Guard–Marine Environmental Protection Command (PCG–MEPCOM); the Philippine Ports Authority (PPA) and their local counterparts; the tourism sector headed by Friends of Balayan Bay (FOBB), an association of resort owners; the industry sector lead by Sea Transport Association, which is an association of oil tankers; the Domestic Ship Owners' Association; and the Batangas Coastal Resource Management Foundation, Inc. (BCRMF). The BCRMF is a non-profit, non-government organization with members from various industries and agencies surrounding Batangas Bay.

Oil Spill Contingency Plan (OSCP) Execution Training

Finally, in order to put policy into action, an Oil Spill Contingency Plan Execution Training shall be organized by WWF-Philippines, in coordination with the PCG-MEPCOM, and to be conducted with the assistance of Pilipinas Shell and Petroleum Corp. and Caltex Philippines, Inc. The training is being planned on the first quarter of the year 2001. It aims to increase the capacity of the local stakeholders in environmental protection and management of the area. Participants to the said training include the Bantay Dagat, representatives from the local government units, residents of various coastal communities and fisherfolks organizations.

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