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RESIDUAL EFFECTS OF LIME, CALCIUM SILICATE AND PHOSPHATE IN THE HUMID TROPICS: II. INFLUENCE OF CEC AND AVAILABLE NUTRIENTS[1]

by

B. C. MAHILUM[2]

ABSTRACT

Basic slag and lime-phosphate experiments were tried on a Hydrandept planted to sugarcane to determine their effects on CEC, exchangeable cations and extractable anions. Both basic slag and lime substantially increased CEC, exchangeable Ca, Mg and K and extractable P, Si and S. P applied simultaneously with lime significantly increased extractable P despite the fact that P fixation in this soil is very high. KH_2PO_4 was found a powerful extractant for Si and lime solubilized much of the soil S which moved down the profile, indicating that continuous liming may impoverish the soil of S.

INTRODUCTION

Tropical soils in humid areas required periodic liming for two main reasons: (1) continuous application of nitrogenous fertilizers which increase soil acidity and (2) natural high acidity as a consequence of accelerated weathering of primary and secondary minerals. Tisdale and Nelson (1968) calculated that the acidifying power of ammonium sulfate added to the soil at 100 kg/ha requires 107 kg/ha of pure lime to neutralize the acidity. Mohr and van Baren (1954) reported that weathering processes in the humid tropics are very intense, resulting in heavy loss of bases, increasing proportions of hydrogen and aluminum ions in the exchange sites and relative increase in the proportions of iron and titanium oxides. These conditions give rise to the formation of Oxisols (7th Approximation, 1960) which are highly acidic. Thus liming studies are needed for soils in high rainfall and high temperature areas.

This study was conducted on a Hydrandept using two kinds of liming materials in an area continuously planted to sugarcane since 1920.

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[1] Grateful acknowledgment is extended to Dr. R. L. Fox and Dr. J. A. Silva of the Dept. of Agron. & Soils, College of Agri., Univ. of Hawaii for their invaluable help in the conduct of this study.

[2] Assoc. Prof. V and Actg. Director, Regional Coconut Res. Center & OIC, Dept. of Agron. & Soils, ViSCA, Baybay, Leyte.

The objective was to evaluate the short- and long-term effects of lime on the CEC, exchangeable cations and extractable anions of a Hydrandept. An auxiliary purpose of the study was to determine the effects of fertilizer phosphorus on the exchangeable cations and extractable anions when applied simultaneously with lime.

MATERIAL AND METHODS

Two liming materials were used in this study. One was basic slag containing 50 percent CaO and 40 percent SiO_2 and ground to pass through a 200-mesh sieve. The other was crushed coral stone containing 92 percent $CaCO_3$ and passed through a 16-mesh screen. The soil is a Hydrandept at the windward side of Hawaii Island above the coast of Hilo with a mean annual rainfall of 4650 mm. The experiment was a randomized complete block with four replications. Each experimental unit plot was 0.01 ha on a terrain with 5 to 10 percent slope. In the coral stone trial, phosphorus in the form of underacidulated rock phosphate was included in a factorial arrangement with the lime.

The basic slag, lime and rock phosphate were rototilled into the soil after the last harrowing and immediately before planting sugarcane. One experiment (hereafter referred to as the slag experiment) consisted of 0, 5, 10, 15 and 20 T/ha of basic slag. The other trial (hereafter referred to as the lime-phosphate experiment) has 0, 5, 23.5 and 43 T/ha of coral stone and 0, 200 and 400 kg P_2O_5/ha from rock phosphate in factorial arrangement.

In the basic slag trial soil samples were taken 7 months after application of the slag while in the lime-phosphate experiment soil sampling was done 5 years after the coral stone and rock phosphate were applied. The slag plots received blanket applications of 200 kg N, 100 kg P_2O_5 and 150 kg K_20/ha. The lime-phosphate plots received uniform yearly applications of 200 kg N and 150 kg K_2O/ha. In this sugarcane plantation the plant crop was harvested at 24 months and the ratoon crop at 18 months.

Surface soil and profile samples down to 120 cm were taken from the lime-phosphate plots. All soil samples were kept field-moist in sealed polybags and were analyzed on field-moist basis since Hydrandept shows irreversible properties upon dehydration (Kanehiro and Sherman, 1956). This soil is composed mostly of amorphous allophane materials and exhibits thixotropy. Ayres, (1943) showed these general analysis of this on field-moist basis: CEC, 37 me/100 g; BS, 4 to 5 percent; and OM, 15 to 20 percent.

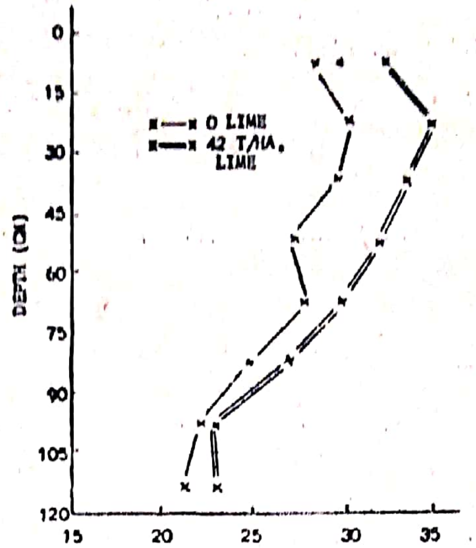


FIGURE 1. THE EFFECT OF ZERO- AND 42-TON/HA LIME APPLICATION ON THE CEC OF AKAKA SOIL PROFILE USING N NEUTRAL AMMONIUM ACETATE AND UNBUFFERED N NEUTRAL AMMONIUM CHLORIDE

CEC and exchangeable bases in the soil samples were determined using Jackson's (1948) methods of soil analysis. The dry matter content of the soil samples was 45 ± percent.

RESULTS AND DISCUSSION

CEC

CEC was determined in the lime-phosphate experiment in the 0 and 43 T/ha lime plots without phosphate. The samples from the plots were composited and triplicates from the composites were analyzed. Each depth in the profile had one composite sample. The CEC analysis of the two profiles are shown in Figure 1. It is evident in this figure that 5 years after application of 43 T/ha crushed coral stone CEC in the profile was substantially increased from the surface down to 90 cm deep, large increases occurring at the surface down to a depth of 60 cm. This increase in CEC with heavy lime application could be due to decrease in pH-dependent positive charges with increasing pH. This rate of liming increased the pH of the soil substantially from the surface down to 120 cm (Mahilum, 1971). Why CEC shows a substantial increase down to 60 cm only when pH increase was significant down to 120 cm is subject to interesting conjecture. Since this soil has unusually high OM content for a mineral soil, it is highly probable that the OM is intimately tied up with the mineral fraction to resist microbial decomposition. Otherwise, it could not equilibrate at such a high level (15 to 20 per cent). OM content is highest at the surface and decreases with depth. This probably explains why CEC at the limed plots increased substantially only at the top 60 cm even though pH increased significantly down to 120 cm.

Inasmuch as the roots of most seasonal crops are most bountiful at the upper 60 cm of the soil, the increase in CEC at this layer helps improve the retention of added cations coming from fertilizers as well as cations solubilized in the soil. Indirectly, this increased CEC helps improve plant nutrition.

EXCHANGEABLE CATIONS

Calcium. — In the slag experiment exchangeable Ca considerably increased with increasing application of basic slag (Table 1). The quantity of increase in exchangeable Ca in the treated plots, however, was much less than the amount of Ca contained in the slag. Two probable causes are advanced for this occurrence. One is that not all of the slag had been solubilized 7 months after application when soil sampling was made. The second is that if the slag were all solubilized, some of the Ca released was leached (Fox, et al., 1962 and Mahilum, et al., 1970).

TABLE 1. THE EFFECT OF TVA SLAG ON THE EXCHANGEABLE CALCIUM IN AKAKA SOIL[1]

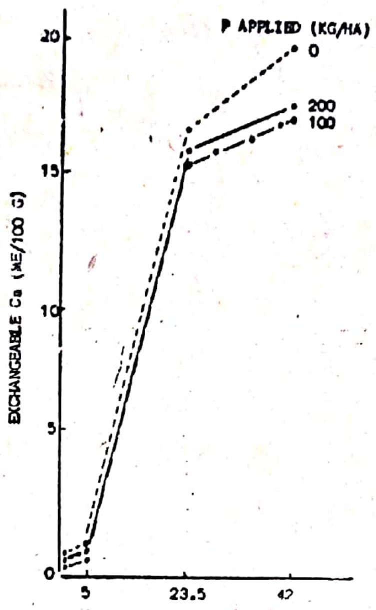
Silicate carrier	Si applied (T/ha)				
	0	0.86	1.72	2.58	3.44
	me/100 g				
TVA Slag	0.44	1.70	3.18	4.60	5.78

Analysis of Variance

SV	df	MS
Replications	3	0.2327*
Levels	4	18.4956**
Error	12	0.0640
Total	19	

[1] Values are means of 4 replications, moist basis.

In the lime-phosphate experiment increase in applied lime also substantially increased exchangeable Ca in the soil (Figure 2). Figure 2 also shows that with high lime rates the amount of exchangeable Ca decreased with increasing phosphate. What this probably implies is that simultaneous application of high rates of lime and phosphate caused the formation of calcium phosphate compounds of low solubility thus decreasing the amount of Ca solubilized as hypothesized by Scheffer and Schulz (1955).



LIME APPLIED (T/HA)

FIGURE 2. THE INFLUENCE OF LIME AND PHOSPHATE ON EXCHANGEABLE Ca IN AKAKA SOIL 5 YEARS AFTER APPLICATION

The data in Figure 2 indicate that in this soil 200 kg/ha P_2O_5 is sufficient to cause a decrease in the release of Ca from crushed coral stone when lime is increased from 23.5 to 42 T/ha. Clements (1962) reported that the Ca requirement for sugarcane in this soil was met when 5 T/ha of crushed coral stone was applied. He stated further that sugarcane gave substantial yield increases up to 25 T/ha. Evidently, sugarcane grown on this soil obtains benefits from liming other than from Ca derived from the lime. One other possible benefit is due to decrease in soluble Al resulting from addition of lime. Rixon and Sherman (1962) obtained a significant negative correlation between extractable Al and exchangeable Ca with increasing rates of lime applied to this soil. They also found that Al in the nodes of sugarcane decreased considerably in the limed plots.

The exchangeable Ca in the profile of the unlime plots and that of the plots limed with 42 T/ha crushed coral stone is shown in Figure 3. A very substantial increase in exchangeable Ca occurred from the surface down to 60 cm deep in the heavily lime plots. This trend in exchangeable Ca in the two profiles (0 and 42 T/ha coral stone) had a similar pattern as the pH of these profiles (Mahilum, 1971). The amount of exchangeable Ca from 60 to 120 cm deep showed a significant and steady increase along the depth increments in the profile of the heavily limed plots compared to that of the check plots. This trend indicates that Ca is loosely bound by this soil at this depth in the profile, hence it is readily leached.

TABLE 2. THE EFFECT OF TVA SLAG ON THE EXCHANGEABLE MAGNESIUM IN AKAKA SOIL[1]

Silicate carrier	Si applied (T/ha)				
	0	0.86	1.72	2.58	3.44
	me/100 g				
TVA Slag	0.09	0.18	0.56	0.92	1.06

Analysis of Variance

SV	df	MS
Replications	3	0.0063*
Levels	4	0.7524**
Error	12	0.0014
Total	19	

[1] Values are means of 4 replications, moist basis.

TABLE 3. THE EFFECT OF TVA SLAG ON THE EXCHANGEABLE POTASSIUM IN AKAKA SOIL[1]

Silicate carrier	Si applied (T/ha)				
	0	0.86	1.72	2.58	3.44
	me/100 g				
TVA Slag	0.06	0.08	0.12	0.11	0.14

Analysis of Variance

SV	df	MS
Replications	3	0.0000463
Levels	4	0.0038835**
Error	12	0.0000911
Total	19	

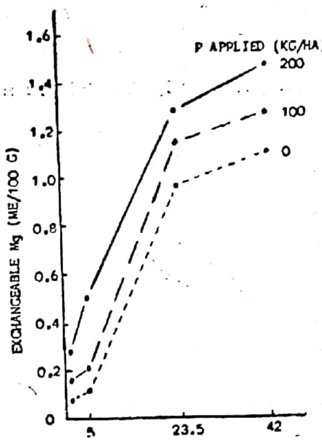
[1] Values are means of 4 replications, moist basis.

Magnesium. — Increasing rates of basic slag significantly increased exchangeable Mg in the soil (Table 2). Although the slag contained 0.4 per cent MgO equivalent, this quantity was not sufficient to account for the increase in exchangeable Mg in the treated soil. It is therefore evident that some of the soil Mg was solubilized by the slag.

The trends in exchangeable Mg in the lime-phosphate plots were substantially increasing with increasing lime at all levels of P and also tended to increase with increasing P at all levels of lime (Figure 3). Since in these plots exchangeable Ca was substantially decreased with increasing P especially at 0 and the next rate of lime, it may be deduced that ionic competition between Ca^{++} and Mg^{++} for exchange sites existed in this soil. Figure 3 also indicates that the increase in exchangeable Mg was highest at 23.5 T/ha lime.

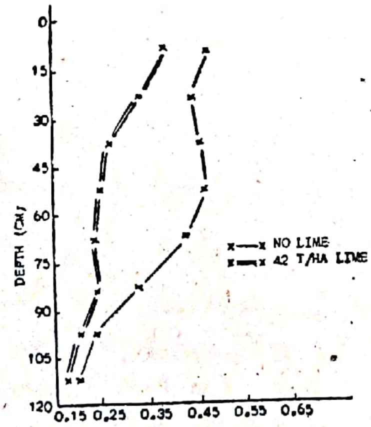
The exchangeable Mg in the profiles of the 0 and 42 T/ha lime rates of the lime plots without P are shown in Figure 4. Much more exchangeable Mg was obtained in the profile of the unlimed than in the heavily limed plots. What probably happened was that the lime solubilized the Mg in the soil and this Mg was either absorbed by the sugarcane plants or leached down the profile, or both.

Potassium. — Exchangeable K was significantly increased with increasing applications of basic slag (Table 3). In the lime-phosphate plots, lime up to 23.5 T/ha substantially increased exchangeable K while P did not (Table 4).



LIME APPLIED (T/HA)

FIGURE 3. THE EFFECT OF LIME AND PHOSPHATE ON THE EXCHANGEABLE Mg IN AKAKA SOIL 5 YEARS AFTER APPLICATION



EXCHANGEABLE Mg (ME/100 G)

FIGURE 4. THE EFFECT OF ZERO- AND 42-TON/HA LIME APPLICATION ON THE EXCHANGEABLE Mg IN AKAKA SOIL PROFILE

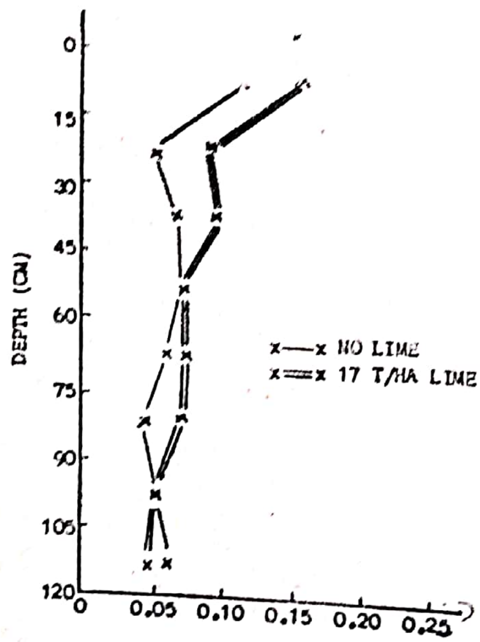
TABLE 4. THE EFFECT OF LIME AND PHOSPHATE ON THE EXCHANGEABLE POTASSIUM IN AKAKA SOIL[1]

P applied (kg/ha)	Lime applied (T/ha) 0	5	23.5	42
	me/100 g			
0	0.08	0.08	0.14	0.13
100	0 08	0 10	0.13	0.12
200	0.08	0.08	0.13	0.15

Analysis of Variance

SV	df	MS
Replications	3	0.000107
Phosphate (P)	2	0.000090 n.s.
Lime (L)	3	0.010573**
P x L	6	0.000404**
Error	33	0.000084

[1] Values are means of 4 replications, moist basis.



EXCHANGEABLE K (ME/100 G)

FIGURE 5. THE EFFECT OF ZERO- AND 42-TON/HA LIME APPLICATIONS ON THE EXCHANGEABLE K IN AKAKA SOIL PROFILE

The higher amounts of exchangeable K on the surface of both the limed and unlimed plots in the 0 and 43 T/ha lime of the limed plots without P (Figure 5 indicates that much of the regular dressing of K fertilizer was retained at the surface soil. The higher exchangeable K of the first 45 cm in the profile of the high-lime plots (Figure 5) shows that some of the soil K must have been solubilized by lime.

EXTRACTABLE ANIONS

Phosphate. — Increasing rates of basic slag up to 2.60 T/ha Si significantly increased extractable P in the soil (Table 5). Either the slag decreased P fixation or the SiO_2 in the slag released PO_4 into solution by exchange reaction, or both phenomena occurred. In the lime-phosphate plots the extractable P presented interesting patterns (Table 6). In the plots without P extractable P significantly decreased

TABLE 5. THE EFFECT OF TVA SLAG ON THE EXTRACTABLE PHOSPHORUS FROM AKAKA SOIL[1]

	Si applied (T/ha)				
Silicate carrier	0	0.86	1.72	2.58	3.44
TVA	3.8	4.3	5.3	7.8	6.3

Analysis of Variance

SV	df	MS
Replications	3	1.113 n.s.
Slag levels	4	10.080**
Error	12	0.482

[1] Values are means of 4 replications, moist basis.

TABLE 6. THE EFFECT OF LIME AND PHOSPHATE ON EXTRACTABLE PHOSPHORUS FROM AKAKA SOIL[1]

	Lime applied (T/ha)			
P applied (kg/ha)	0	5	23.5	42
	ppm			
0	3.7	3.7	2 5	2.4
100	2.9	3.7	4.0	3.9
200	3.2	4.2	5.4	6.2

Analysis of Variance

SV	df	MS
Replications	3	0.23
P levels (P)	2	11.44**
Lime rates (L)	3	1.97**
P x L	6	4.30**
Error	33	0.29

[1] Values are means of 4 replications, moist basis.

TABLE 7. THE EFFECT OF VARYING AMOUNTS OF TVA SLAG ON THE EXTRACTABLE Si IN AKAKA SOIL[1]

Rate (T/ha)	Si (ppm)
0	96
5	188
10	237
15	254
20	339

Analysis of Variance

SV	df	MS
Replications	3	180.5333
Levels	4	32230.1750**
Error	12	790.5750

Rp values for Duncan's Test

p	2	3	4	5
Rp: 5%	43.3	45.3	46.5	47.4
1%	60.8	63.3	65.0	66.3

[1] Values are means of 4 replications, moist basis.

with increasing lime. What probably occurred was that as lime increased the solubilized soil in these plots was absorbed by sugarcane. In the two higher levels of applied P extractable P substantially increased with increasing lime, indicating that P fixation by this soil was somewhat checked by liming. This was substantiated also by the fact that at the three levels of lime increasing P also significantly increased the extractable P. Evidently, some of this extractable P came from the fertilizer P.

Silicate. — Clements (1965) obtained dramatic response by sugarcane to the $CaSiO_3$ component of the basic slag. He then considered silicon necessary for sugarcane. In this experiment extractable Si was determined (Table 7). As expected in the slag plots extractable Si very significantly increased with increasing application of slag. This indicates that substantial amounts of the basic slag were solubilized 7 months after application.

In the lime plots without P small but significant increases in extractable Si were obtained from increasing lime applications (Table 8). The increase in extractable Si could be due to pH increase caused by the slag or to anion exchange of phosphate in the extracting solution with the silicate in the mineral fraction of the soil, or to both of these causes.

TABLE 8. THE EFFECT OF VARYING AMOUNTS OF LIME ON THE EXTRACTABLE Si IN AKAKA SOIL[1]

Rate	Si
(T/ha)	(ppm)
0	101
5	109
23.5	114
42	124

Analysis of Variance

SV	df	MS
Replications	3	8.25
Levels	3	394.40**
Error	9	5.67

Rp values for Duncan's Test

p	2	3	4
Rp: 5%	3.84	4.01	4.11
1%	5.52	5.75	5.89

[1] Values are means of 4 replications, moist basis.

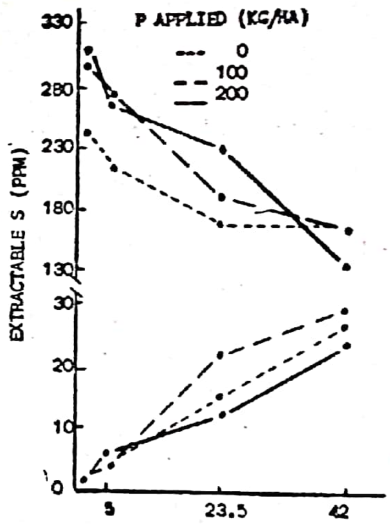
TABLE 9. THE EFFECT OF VARYING AMOUNTS OF TVA SLAG ON THE EXTRACTABLE S IN AKAKA SOIL[1]

Rate (T/ha)	Water-soluble S	KH_2PO_4-extractable S
	ppm	
0	6.5	242
5	13.6	243
10	28.1	245
15	31.8	269
20	39.0	261

[1] Replicates were composited; field-moist basis, 40± 3% dry matter.

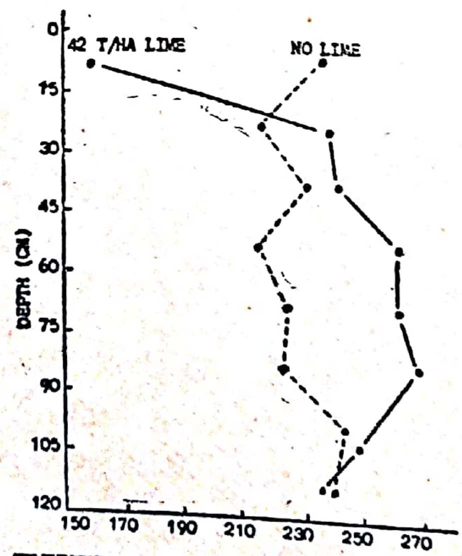
Sulfate sulfur. — Water-soluble sulfate sulfur substantially increased slag (Table 9). This must have been a pH effect where increasing pH caused by the basic slag also solubilized the soil sulfur. In these basic slag plots increase in KH_2PO_4-extractable S with increasing slag was not as dramatic as the water-soluble S although the total amount of S extracted by KH_2PO_4 was 7 to 37 times more than the H_2O-soluble S. What the data suggest is that KH_2PO_4 is a powerful extractant for sulfate sulfur and that this soil has high amounts of S, being of volcanic ash origin. The large amount of phosphate in the extractant must have masked the solubility effect of silicate in the basic slag.

In the lime-phosphate trial interesting trends in H_2O-soluble and KH_2PO_4-extractable sulfate sulfur were obtained (Figure 6). At all levels of PH_2O-soluble S was increasing substantially with increasing lime. On the other hand, the amount of KH_2PO_4-extractable S was clearly decreasing with increasing lime regardless of P levels. What these data indicate is that lime solubilized moved down the profile. This is substantiated by the profile distribution of S in the O and the 42 T/ha lime plots shown in Figure 7. The data also suggest that continuous liming may eventually impoverish the surface soil of S since it is leached down.



LIME APPLIED (T/HA)

FIGURE 6. THE EFFECT OF LIME AND PHOSPHATE ON H_2O-SOLUBLE AND P-EXTRACTABLE S FOUR YEARS AFTER APPLICATION ON AKAKA SOIL



P-EXTRACTABLE S (PPM)

FIGURE 7. THE EFFECT OF ZERO- AND 42-TON/HA LIME APPLICATION ON THE P-EXTRACTABLE S IN AKAKA SOIL PROFILE

SUMMARY AND CONCLUSION

Heavy lime application at 43 T/ha of crushed coral stone (92 percent $CaCO_3$) substantially increased CEC at 0 to 60 cm depth in the profile of a Hydrandept due presumably to decrease in pH-dependent positive charges with increasing pH. Both basic slag and lime significantly increased exchangeable Ca, Mg and K in the soil. It was evident that some of the Mg and K thus solubilized came from the soil.

Basic slag increased significantly the extractable P from the soil, indicating some degree of decreased P fixation by a Hydrandept due probably to pH effect as well as release of P through exchange reaction with silicate.

Both P and lime added to the soil simultaneously, significantly increased extractable P. The lime effect in increasing extractable P was distinct from that of P application and was attributed to a reduction in P fixation by lime.

As expected, Si increased significantly with increasing basic slag application. Lime also increased substantially the extractable Si due probably to pH effect as well as release of silicate from the soil due to exchange reactions with phosphate in the extracting solution.

Basic slag considerably increased water-soluble sulfate sulfur. Sulfate sulfur extracted by KH_2PO_4 was 7 to 37 times greater than that of H_2O, indicating that the KH_2PO_4 is a powerful extractant for S.

Lime substantially increased H_2O-soluble S but decreased KH_3PO_4-extractable S with increasing rates of application. It was evident that lime solubilized the soil S which then moved down the soil profile.

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ERRATA

CULTURAL DIVERSITY AND ECOLOGICAL STABILITY

by Meliton B. Juanico

Volume XIX, No. 4, 1975

Cover — *Geological* to read *Ecological*
p. 189, par. 2, line 4 — *temperorarily* to *temporarily*
p. 190, par. 4, line 3 — *year* to *years*
p. 191, par. 1, line 2 — *intially* to *initially*
p. 192, par. 2, line 11 — *way of life* to *ways of life*
p. 192, par. 2, line 18 — *as Ward and Dubos (1972:11-12)says* to *as Ward and Dubos (1972:1112) say*
p. 192, par. 2, line 19 — *equality* to *quality*
p. 193, par. 2, line 9 —.*guranteed* to *guaranteed*
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GEOGRAPHY AT THE UNIVERSITY OF THE WEST INDIES, JAMAICA

by

PATRICK W. NAUGHTON[1]
V. C. MULCHANSINGH[2]

The University of the West Indies is a unique institution. It serves and is governed by the various island-states in the Commonwealth West Indies. The three campuses of the U.W.I. are located in Jamaica, Barbados and Trinidad, the latter two of which already had institutions of higher education which could fit into a university for the West Indies. Codrington College in Barbados was originally affiliated with the University of Durham (England) and was by far the oldest of the three higher learning institutions in the British Caribbean. Trinidad was the site of the Imperial College of Tropical Agriculture which helped train many of the agricultural personnel who serviced the old British Empire. Jamaica had experimented unsuccessfully with higher learning establishments in the last century but it was not until shortly after the Second World War that the University of London was able to found affiliate college on the island — University College of the West Indies. When it was found desirable to expand the U.C.W.I. to Barbados and Trinidad the institutions named above were found to be useful cores or adjuncts.

Following World War II the British Government began to encourage the development of a regional political state of her colonies in the Caribbean. This led to the formation of the Federation of the West Indies in 1958. One aim of the Federation was the linking of various institutions on a regional scale. It was rightly argued that none of the islands individually was economically well enough off to develop and maintain a separate university, inter-island shipping concern, and the like; by amalgamating these programmes they would better serve the needs of the West Indies. The soundness of the scale arguments can account for the fact that the University of the West Indies still survives as a regional institution long after the dissolution of the Federation in 1962.

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The three campuses have kept their primary roles separate though the primate campus has become the one situated in Jamaica at Mona, a suburb of Kingston. The other two campuses have been renamed like Jamaica's to correspond to their sites: Trinidad's campus is known as St. Augustine whereas Barbados' is Cave Hill (hereafter the various campuses will be referred to by these locational names). Agriculture and Engineering are exclusively taught at St. Augustine, Medicine is likewise exclusive to Mona and Law (after the first year) to Cave Hill. The other subjects in Arts, General Studies, Natural Sciences, Social Sciences, Business Administration and Education are available to some degree at one or more of the three campuses. However, geography is only offered at Mona.

Geography at Mona. — The discipline of geography is taught in two separate but closely co-ordinated faculties at Mona. The Geography Department is responsible for undergraduate instruction as well as the supervision of post-graduate level work leading toward the degrees of M.Sc. and Ph.D. Within the School of Education geography is offered as a specialty in teaching methods only at a post-graduate level leading to the degree of Diploma in Education.

Teaching in geography at Mona began in 1965 within a combined Geology and Geography Department, while a separate Department of Geography was established in 1971. The subject is offered as a part of the General degree programme but a measure of honours specialization is possible through optional courses. A post-graduate programme in geography leading to the M.Sc., involving course work and a thesis based on field studies, was introduced in 1967. The Ph.D. programme was begun in 1970 with the first successful candidate completing the requirements — a thesis based on original research — in 1975.

The Geography Department is administratively within the Faculty of Natural Sciences although it has links, through the Faculty of Arts and General Studies, with the social sciences and arts. Students may therefore study geography in combination with such subjects as geology, mathematics, botany, zoology, and chemistry; or with economics, sociology, government, history, English, or modern languages.

Geography is taught in two sections of the School of Education at Mona. Both sections offer the same diploma and require course work and a thesis-like study for successful completion. The Pre-Service Diploma in Education is designed for university graduates who wish to pursue a career in teaching at the post-primary level. The course is patterned on similar programmes in the United Kingdom. It requires the students to remain at the Mona campus for one year though several months are devoted to practice teaching in Jamaican schools. The Pre-

Service course is the only one of its kind in the University and hence serves all the islands in the Commonwealth West Indies.

The In-Service Diploma in Education is, on the other hand, a new programme. All three campuses have In-Service Departments. The St. Augustine and Cave Hill programmes were begun in 1973 whereas Mona started its course one year later. Geography, however, was not offered at Mona during the first year. This in-service course is designed for those teachers presently in the educational system who wish to upgrade their instructional skills and their knowledge of (i) the philosophy of education, (ii) the psychology of education, and (iii) the role of education in national development. The In-Service programme fills the need of those teachers who for some reason (i.e. family responsibilities, financial needs, etc.) cannot stop working in order to obtain the diploma through the Pre-Service course. The In-Service course requires the teacher to attend classes during school holidays and on one day every two weeks during the school term for one academic year. The In-Service programme, unlike the Pre-Service course, relies on non-examinational assessment of the student-teacher. This is done through the assignment of written reports and a thesis on curriculum studies. Teaching assessment is made by the subject tutors in the student-teacher's actual job situation.

The Degree Programme in Geography. — The undergraduate teaching of geography at the University of the West Indies aims at giving, on a global scale, a broad and balanced view of the subject as a whole; at the same time, emphasis is placed upon the special environment and social conditions of the tropics, and particularly of the Caribbean area. Furthermore, some opportunity is provided for work at greater depth on selected topics in both the scientific and human branches of the discipline.

The methods used in teaching are designed to inculcate a thoughtful approach to the study of the geographical environment and its problems rather than to produce any massive inventory of facts about the surface of the earth. From the beginning, students are encouraged to use discretion in their selection of facts, to assess significance, and to exercise judgment in the weighing of evidence and opinion. Emphasis is on the nomothetic rather than on the idiographic.

Table 1 gives the titles of courses available in the Geography Department at the University of the West Indies. Students who are registered in the Faculty of Natural Sciences and wish to major in geography must attend all courses listed for the first two years. In the final year they must take four courses of which the "Geography of the Caribbean" is required. There are nine optional courses to choose from to complete the necessary requirements of the Department. In addition to the lecture and laboratory courses, all second year students are required to attend a week-long Field Studies Course during vacation-time (around Easter) as an integral part of the degree requirements.

Post-Graduate Programmes in Geography. — Eligible students who wish to undertake post-graduate work at the University of the West may be admitted to study for an M.Sc. or Ph.D. degree in geography or for a diploma in education. For the M.Sc., a candidate should have a creditable B.A.. or B.Sc. degree (honours) in geography or an allied

Table 1. COURSES AVAILABLE IN THE GEOGRAPHY DEPARTMENT, UWI, MONA.

Year	Course
1st	A. Introduction to Physical Geography B. Introduction to Human Geography C. Methods of Geographical Investigation (Lab)
2nd	A. Physical Geography B. Human Geography C. Advanced Methods of Geog. Investigation (Lab) D. Development of Geographical Thought E. Physical Planning
3rd	A. Geography of the Caribbean (Required) B. Advanced Studies in Phys. Geog. I: Climatology and Geomorphology C. Advanced Studies in Phys. Geog. II: Biogeography D. Advanced Studies in Econ. Geog.: Manufacturing and Industrialization E. Advanced Studies in Human Geog.: Urbanization in the Developing World F. Geography of Developing Areas: Tropical Asia G. Geog. of Developed Countries: Western Europe and USSR H. Political Geog. I. Quantitative Methods J. Research Paper — an original investigation, based on field studies, of a physical or cultural geographical problem within the Caribbean Area.

subject, either from UWI or an approved university. For the Ph.D. a candidate would normally have completed an M.A. or M.Sc. degree in geography. The Dip. Ed. requires that a candidate must have at least a pass degree (B.A. or B.Sc.) from any approved university. It is usually stipulated that the recipient of the Dip. Ed. will remain in teaching after completing the course. In addition, the In-Service Dip. Ed. has two further restrictions: (i) the candidate must be teaching at a secondary school during the period he is attending the course and (ii) he must be a Jamaican resident as the Mona Campus programme is supported solely by the Jamaican Government.

The M.Sc. and Ph.D. degrees must be on a topic of such a nature as to be able to be supervised by a member of Staff of the Geography

Table 2. TEACHING STAFF OF GEOGRAPHY DEPARTMENT, UWI, MONA, 1975-76.

1. Dr. Wilma R. Bailey, B.A. Hons. (Newcastle upon Tyne)), M.A. Soc. Sc. (Leicester), Ph.D. (UWI).
   Lecturer, Teaching and Research Interests: Caribbean Region, Biogeog., Urban Geog.
2. Dr. L. Alan Eyre, B.A. (London), M.Sc. (UWI), Dip. Ed. (Soton), Ph.D. (Maryland)
   Senior Lecturer, Teaching and Res Interests: Environmental Systems; Climatology, Population and Environmental Potential, Geog. Theory, Quantitative Methods, Regional Geog. of the Caribbean.
3. Dr. Brian J. Hudson, B.A., M.C.D. (Liverpool), Ph.D. (Hong Kong), A.M.T.P.I.
   Lecturer, Teach. and Res. Interests: Planning, Land Use, Reclamation, Conservation.
4. Mrs. Eleanor B. Jones, B.A. Hons. (City Univ. of New York), M.A. (Wisconsin)
   Lecturer, T and R. Interests: Geomorphology and Climatology.
5. Mrs. Anne Lyew-Ayee, B.A. Hons. (Singapore), M.A. (Pennsylvania).
   Lecturer, T & R Interests: Urbanization in the Third World, Quantitative Methods.
6. Dr. Vernon C. Mulchansingh, B.A. Hons, Ph.D. (Queens Univ., Belfast), Teach. Dip. (Trinidad).
   Lecturer and Head of Dept., T & R Interests: Model Approaches in Economic Geog., Geog. of Manufacturing and Petroleum Industries in the Caribbean, Economic Development in Space, Geography of Transport.

Department. Table 2 gives the names, qualifications, and interest areas of the members of staff of this Department. Table 3 gives the same information for the members of the staff teaching geography in the School of Education.

Table 3. TEACHING STAFF FOR GEOGRAPHY IN THE SCHOOL OF EDUCATION, UWI, MONA, 1975-76.

1. Mr. Michael P. Morrissey, B.A., Dip. Ed. (Wales)
   Part-Time Lecturer (Pre-Service Programme)
   Teaching and Research Interests: Geographical Teaching Methods, Educational Planning, Cartographic Design.
2. Mr. Patrick W. Naughton, B.A. (Hawaii), M.Sc. (Alberta, Canada), Ph.D. Candidate (UWI).
   Lecturer (In-Service Programme)
   Teaching and Research Interests: Geographical Teaching Methods, Natural Hazard Research, Geography of the Tropics, Military Geography.

Concluding Remarks. — Bearing in mind the unique regional, multi-state constituency served by the University of the West Indies, it is not surprising to find geography being offered and taught in such a manner as to relate to the political, cultural, and economic environment of the Commonwealth West Indies. The University has been the major supplier of teachers in the secondary schools during the past two decades, and the Geography Department has been at the forefront of this movement not only by programming its course content to best serve the continual education process begun in the first years of high school but also through its secondary and tertiary activities. The Geography Department works in close harmony with the School of Education's geography lecturers in order to insure that all possible support is given in providing geography teachers the best and most up to date academic background obtainable. Both divisions of the University actively encourage the work of the Jamaican Georaphical Society and the National Committee on Geography and, in fact, the Department has often provided the necessary personnel to guide these organizations' development. The former society has in the past few years been the leader in reform in geography at the secondary school level and has been encouraged in this role by the Geography Department and the School of Education's geography section.

Geography at the University of the West Indies is an academic and professionally dynamic subject. Its role is constantly changing as are conditions in the West Indian region. But geography will continue to serve the regional network by providing the vital link between society and the environment in which it is developing.

ENVIRONMENTAL CONTROLS OF MANGROVE DISTRIBUTION IN JAMAICA, WEST INDIES, AND WEST MALAYSIA, EAST INDIES

by

PETER A. WOOD[1]

INTRODUCTION

Mangroves are a type of tidal woodland consisting of halophytic trees, which occur in the tropical climatic zone. They appear to be most prolific in brackish water environments, but may grow in fresh to weakly hypersaline waters.

On a global scale, mangrove distribution is restricted to latitudes lower than 30°N and 30°S, due to a non-tolerance of cold conditions (Scholl 1968). They cannot survive temperatures below about —3°C, and well developed mangrove is restricted to areas where the average temperature for the coldest month exceeds 20°C and the seasonal range does not exceed 5°C. West (1956) plotted the world distribution of mangrove and two main provinces have been identified; the Occidental Province, centered on the West Indies, and the Oriental Province, centered on the East Indies.

Within the general climatic control of mangrove distribution, geologic factors favouring coastal mangrove development include a high tidal range, a large supply of detrital sediment, shallow coastal water, low coastal relief, low coastal wave energy and a fine grained substratum. The high tidal range and the low coastal relief co-operate to increase the width of the inter-tidal zone, while shallow water is necessary to encourage rapid progradation and as young mangrove trees cannot root in water depths greater than 60 cm at low tide. Low coastal wave energy is necessary as mangrove is vulnerable to high energy wave action, and asexually produced seedlings can root only if there is very limited water movement. A supply of detritus is necessary to permit progradation and accretion of the coast, and to enable a seaward extension of the growing mangrove.

Mangrove can vegetate on a variety of substratum types ranging from sand, clay or silt, or even coral-sand (Kudal, 1971), but they seem to favour fine grained, soft organic muds deposited in estuarine

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or deltaic locations. However, some modification of the substratum may result after colonization by mangrove, which would favour the development of the most suitable substratum.

It is the purpose of this paper to describe and discuss the controls of mangrove distribution from two areas; Jamaica from the Occidental Province, and West Malaysia from the Oriental Province.

MANGROVE FLORA

Scholl (1968) indicates that the mangrove flora of the two provinces differs, with the flora of the Occidental Province being restricted to four major genera (**Rhizophora, Avicennia, Laguncularia** and **Conocarpus**), while that of the Oriental Province has a more diverse assemblage with several more genera (**Avicennia, Bruguiera, Carapa, Ceriops, Rhizophora** and **Sonneratia**).

Rhizophora often forms the pioneer mangrove vegetation in both provinces, were it fringes the present coast. This gives way more inland, in the more brackish waters, to **Avicennia.**

MANGROVE DISTRIBUTION

West Malaysia. — Figure 1 shows the distribution of mangrove around the coastline of West Malaysia. It is evident that extensive mangrove spreads are confined to the western and southern coasts and are lacking from the eastern coast. Aerial reconnaissance along the west coast, by the author, indicates the presence of extensive tidal coastal plains crossed by meandering tidal channels showing the typical reticulate pattern where mangroves are able to colonize the intertidal zone. Sediments associated with the mangroves are maldorous, and dominantly fine grained (clays and silts) with a high organic content and occasional evidence of a brackish or marine fauna.

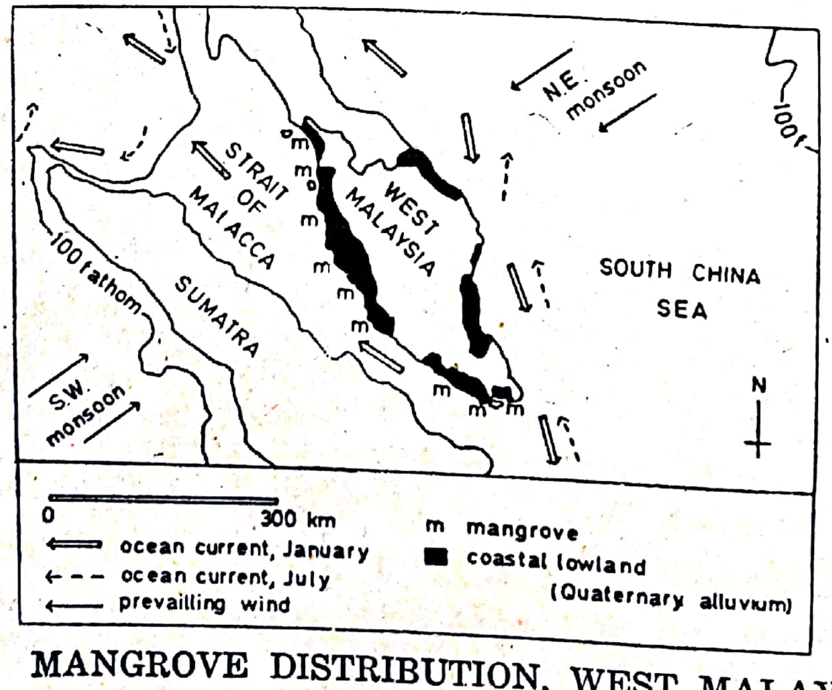

FIGURE 1. MANGROVE DISTRIBUTION, WEST MALAYSIA.

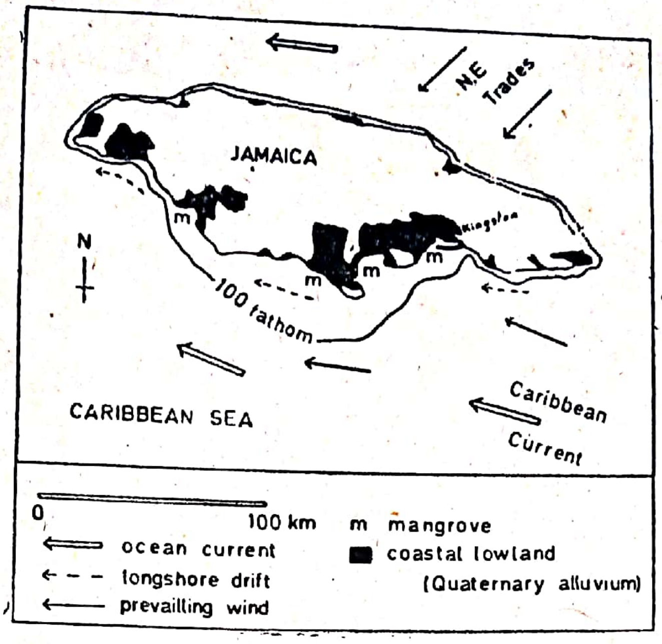

FIGURE 2. MANGROVE DISTRIBUTION, JAMAICA.

Jamaica. — Figure 2 shows the distribution of mangrove around the coastline of Jamaica. As indicated by Horsfield (1973) mangrove is much more extensive on the south coast and almost entirely absent from the north coast except for local developments. Much of the mangrove is associated with lagoons that have been cut off by prograding and accretionary bars, spits, and beach ridges that are abundant on the south coast (Wood, 1975). Still other areas of mangrove have colonized small coastal islands similar to the mangrove of the Everglades National Park, Florida, and some has colonized patch coral islands. There is litte development of the tidal reticulate pattern found in West Malaysia. Sediments associated with Jamaica's mangrove are again dominantly fine grained and malodorous, but with a varying proportion of carbonate material.

CONTROLS OF MANGROVE DISTRIBUTION

West Malaysia: —

(a) *Tidal range* — The tidal range of West Malaysia is slightly greater than that of Jamaica, although it is restricted, with tides generally less than 3m. The range is slightly greater in the south than in the north, and funelling of the tidal wave may locally increase the tidal range.

(b) *Detritus supply* — Much of West Malaysia is mountainous, and experiences monsoonal rains, with drainage flowing both to the east and west coast. Under these conditions much sediment would be expected to reach tide water, and Nossin (1965) reports that much mud, but little sand, is supplied to the coasts by rivers. Watson

(1928) also indicates that Malaysian mangroves receive an abundant supply of river-born terrigenous sediment.

(c) *Depth of water* — The continental shelf in the vicinity of West Malaysia extends for over 600 km east into the South China Sea before depths of over 100 fathoms are reached (Fig. 1). Similarly, water depths in the Strait of Malacca are shallow and less than 100 fathoms. Consequently, shallow waters persist around the entire coast of West Malaysia.

(d) *Coastal relief* — Much of the coastal areas of West Malaysia along both the east and west coasts, consist of a broad low-lying area of Quaternary, mainly Holocene, alluvium. Consequently, low coastal relief is widespread, with perhaps more on the west coast than the east (Fig. 1).

(e) *Wave energy* — West Malaysia fall under the influence of the Asiatic Monsoon, and so experiences a seasonal swing in the dominant wind direction. From November to April the N. E. monsoon prevails, while from May to October the S. W. monsoon prevails. Associated with this change in wind direction is a change in the ocean current movements in the South China Sea.

The N. E. monsoon generates wave trains along the east coast (Nossin, 1961) and their fetch extends for some distance over the South Sea. The east coast is thus a high energy coast, and consists mainly of linear sand beaches and rocky headlands (Stauffer, written communication, 1975), part of which is illustrated by Nossin (1965) and Davies (1972).

The S. W. monsoon is also a major wave generating event, especially on the coast of India, but the west coast of West Malaysia is sheltered from these by Sumatra and the narrow Strait of Malacca. The west coast is consequently one of lower energy, and has a relative lack of sandy deposits.

Jamaica: —

(a) *Tidal range* — The tidal range around Jamaica's coast is very restricted, with a diurnal range of less than 60 cm on both the north and south coasts.

(b) *Detritus supply* — The south coast has a potentially higher rate of terrigenous sediment supply, as during the Quaternary, crustal movements of the island block included a southerly tilt (Horsfield, 1975), which was associated with more, and larger, rivers draining south than north (WOOD, 1974).

(c) *Depth of water* — Associated with the Quaternary crustal tilting, there is an offshore island shelf that is much wider off the submergent south coast than off the emergent north coast (Fig. 2). This produces a more extensive shallow water zone off the south coast than off the north coast.

(d) *Coastal relief* — Similarly, the submergent south coast has extensive alluvial deposits producing low coastal relief while the north coast is often cliffed (Fig. 2).

(e) *Wave energy* — The prevailing winds over Jamaica are the N. E. Trades, which dominate the north coast. The south coast however, experiences a more variable wind direction, with a dominant wind direction of E. S. E. recorded at Kingston. Waves striking Jamaica's south coast may have a greater fetch than those striking the north coast, although some of their potential energy may be lost due to friction with the southern offshore island shelf and associated reefal structures.

Longshore drift directions along both the north and south coasts are dominantly east to west. This results from the dominant wind direction of the two coasts in combination with the westerly flowing Carribbean Current, a branch of the Atlantic North Equatorial Current.

It is this westerly longshore drift that is responsible for much reworking of elastic material derived from the land, and of carbonate material derived from the offshore island shelf, and thus constructing the numerous beach ridges, lagoons, spits and bars of the south coast (Wood, 1975). It is then, in the quiet waters of these lagoons, and in the lee of such structures as spits, that the mangrove vegetates.

DISCUSSION

Both Jamaica and West Malaysia have an unequal distribution of extensive mangrove spreads, with one coast almost devoid of extensive mangrove, and another with large areas of mangrove. A simplified summary of the controls of mangrove distribution on these coasts is provided by Table 1.

Jamaica's north coast has a low potential for extensive mangrove development, due primarily to its tendency for a cliffed coast, associated with steep coastal relief and deeper water. Wave energies are also reasonably high, resulting from wave generation by the N. E. Trades.

Jamaica's south coast has a medium potential for mangrove development, and this has occurred where lower energy environments occur, such as lagoons and bays associated with the construction of spits, bars, etc. constructed by east to west longshore drift. Conditions encouraging mangrove development include extensive low coastal relief and shallow water associated with the offshore island shelf.

TABLE 1. A SIMPLIFIED SUMMARY OF THE CONTROLS AND POTENTIAL OF MANGROVE DEVELOPMENT IN JAMAICA AND WEST MALAYSIA.

CONTROL	JAMAICA		W. MALAYSIA	
	north coast	south coast	west coast	east coast
Detrital sediment supply	unfavourable	favourable	favourable	favourable
Coastal relief	"	"	"	"
Wave energy	"	fair	"	unfavourable
Tidal energy	"	unfavourable	fair	fair
Water depth	"	favourable	favourable	favourable
Mangrove Potential	Low	Medium	Good	Low

West Malaysia's east coast has a low potential for mangrove development due to the high energy wave trains generated by the N. E. monsoon. Other factors of the east coast however, seem favourable for mangrove development.

West Malaysia's west coast has a high potential for mangrove development, and has extensive spreads of mangrove along much of its length. All conditions seem favourable, with protection from the waves generated by the S. W. monsoon being provided by Sumatra.

Both Jamaica and West Malaysia's east coast are subject to tropical cyclones (Davies, 1972). These events, which may or may not be constructive coastal processes, are generally damaging to mangrove, and thus may cause temporary set-backs to its development, with a frequency depending upon the frequency of occurrence of the cyclone.

CONCLUSION

Within areas climatically suitable for mangrove vegetation, the favourable conditions of extensive mangrove development are a large supply of detritus, low coastal relief, low wave energy, shallow water depths, a high tidal range and a fine grained substratum. Of these, the substratum if not entirely favourable, may be modified once mangrove vegetates.

Jamaica's south coast has mangrove, while it is lacking on the north, and this pattern seems to result from a southerly tilting of the island block in Quaternary times producing an emergent coast on the north and a submergent coast on the south. The northern coast is unsuitable for mangrove development, while various sectors of the southern submerged coast are sufficiently sheltered for mangrove to vegetate. Material transported by east to west longshore drift (resulting from the prevailing winds and the Caribbean Current) has constructed low energy lagoons and bays where the mangrove has developed.

West Malaysia's east coast lacks mangrove, while extensive areas occur on the west coast. While many conditions for mangrove development are suitable on both coasts, the actual distribution is due to the unequal effects of the Asiatic Monsoon. During the N. E. monsoon the east coast experiences high energy waves, while during the S. W. monsoon the west coast is sheltered by Sumatra.

ACKNOWLEDGMENTS

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IF YOU SEE ONE RAT, COUNT TEN!

by

GENE LOGSDON

As more and more people in the suburbs and the countryside begin to raise, process and store their own food, they may unwittingly create a paradise for rats. Here's how to make sure you don't.

There's nothing that can strike revulsion and fear in most of us like a rat scurrying phantom-like across a room. Our intense dislike of rats is stronger, I think, than our instinctive fear of snakes, and certainly more justified. Even the most dangerous reptile does some good.

Not so Rattus norvegicus, the Norway or brown rat. It is all bad. Scientists believe that rat-borne diseases have killed more people than all the wars history. The rat carries 35 diseases of man and animals, including typhus, bubonic plague, jaundice, tuleremia, rabies and trichinosis. Its bite can produce a serious illness – rat-bite fever.

Rats ruin millions (some say billions) of dollars' worth of food each year. For every $2 worth one eats, say Extension specialists at North Carolina State University, a rat damages another $4 worth and contaminates an additional $6 worth. A hundred rats on a farm cost the farmer $1,200. Experts estimate the rat population on U.S. farms alone at 100 million. Add to that the number of rats in cities and we are facing rat numbers probably equal to our own.

Rats possess a frightening ability to increase and multiply. They breed at 3 to 4 months of age. Gestation lasts about 22 days, and females are ready to mate again a couple of days after giving birth. Litter size averages 8, though it can be as high as 22. The number of litters per year ranges from 3 to 7. It is no trick at all for a pair of rats to produce 50 offspring a year, many of which will themselves reproduce young during that same year.

Not only can the rat reproduce in remarkable numbers when conditions are favorable, but it can survive amazingly even when condi-

[1] Organic Gardening and Farming, December 1975. Reprinted with permission of the author.

tions are adverse. It policies its own population explosion lest the number of rats exceed the food supply. Weak rats in a crowded colony are run out or killed by stronger brethren. A healthy rat is a super-rat. It can fall 50 feet without serious injury (that's equivalent to a man falling 300 feet, or the length of a football field); it can swim half a mile in open water, or swim up sewer lines against swift currents. It can dive through a plumbing trap or gnaw through adobe brick, cinder block, oak planks, and even metal conduit occasionally.

In short, the rat is not just a curiosity for college biology students. It's a real menace and the problem is likely to get worse as more people move to the suburbs and countryside to grow and store their own food. Unwittingly, they may be providing a paradise for rats.

CONTROLLING RATS

Having spent much of my life on and around farms and therefore, experienced firsthand how absolutely necessary it is to kill rats, I know that some of what I have to say is going to sound callous. It certainly isn't any fun for me either. When you have to kill rats, think of a child suffering from rat-bite fever. Or think about bubonic plague, which reared its ugly head in the Southwest last year.

I was going to say that rats are one more reason I don't fully agree with the "let-nature-take-its-course" school of philosophy, but on second thought, I'd say the Norway rat isn't exactly a "natural" occurence. It isn't even native to this country. Its ecological niche is directly tied to man and his hardly natural life style. We have made the rat what it is. Rat thrive where man thrives and languish where man languishes. The more we waste our natural resources, the fatter grow the rats. Maybe that is why we hate them so. The way we live, we get what we deserve. And what we get are rats.

In any event, the first and absolutely essential step in controlling rats is to quit feeding and sheltering them. Rats eat what we eat and live where we live. Until we develop the discipline to protect our food in rat-proof containers and especially until we adopt more sanitary ways to handle our wastes, rats will be around regardless of any chemical, trap, predator or gun. That's what New York City learned in the 1960's when it waged relentless chemical war on the rodents. As long as there was waste food to eat and waste debris to hide in, the rat survived. Splendidly.

On your homestead, you must seal off from rats the food you store for yourself, your pets, and your farm animals. That does not necessarily mean rat-proofing a whole house and barn. Older homes especially are very difficult to rat-proof, and barns impossible. Good solid cement foundations, metal flashings on door and window frames, and self-closing devices on doors all help, but are not fail-safe. What you have to do is rat-proof specific containers, or rooms or bins in your buildings.

Your own canned and frozen food is safe, of course. Dried and bagged food of all kinds should at least be placed in tight cupboards, and preferably in glass bottles or tin containers like the old breadboxes. Allowing the kids to eat cookies in their bedrooms, snacking on popcorn in front of the TV in the living room, failing to sweep the kitchen after every meal — all mean food on the floor to lure rats and mice if you don't watch out. Table scraps not fed to animals must be scrupulously composted with scrupulous sanitation; rat-proof composting bins are highly desirable — even thouh proper composting will not draw rats.

Food that needs to be dried or cured over a long period of time, like popcorn, sweet corn for parching seeds, smoked hams, etc. can be hung in attics, garages, or storerooms in ways that prevent rodent infestation. The first way is to hang the foodstuffs from a wire strung from one wall to another. Since rats and especially mice can walk a wire like circus acrobats, you simply have to slip metal disks over the wire about a foot out from both walls. The rodents can't get around the disks. Large tin can lids work fine. Just punch a hole in the center of each disk with a hammer and nail, and slide one disk on either end of the wire.

You can resort to another and better way of hanging food out of rats' reach if you have a beam flush up tight against the ceiling of any building. At both ends, cover the beam with tin from the wall out to about two feet. Tap a row of nails along the rest of the beam's length, leaving them out far enough to act as hangers. There is no way a rat can reach the foodstuffs because he can't maintain a footing on the vertical metal surfaces of the beam ends. The only way he could get to the food would be to walk upside down across the ceiling and even a rat can't do that. In old barns, you can still find beams so equipped. Now you know why.

Don't let surplus garden crops stand for extended periods or over-winter in the garden. Shred, plow under, or otherwise dispose of anything rats would enjoy, particularly mature sweet corn. Store straw bales in your barn or shed at your own risk. The straw often contains wheat that was not threshed out properly at harvest. Rats and mice will burrow into the bales after the grain. On small suburban homesteads, it's better to buy straw as you need it. In any event, use the bales for bedding or mulch as soon as you can.

For the small homesteader with a few pets or farm animals, the most important rule of all is to keep all livestock and pet feed in metal containers. Steel 55 gallon drums are ideal, I think since they can still be purchased cheaply. Sometimes you can get them free. Be sure there are no residues in the barrels that might contaminate the feed. Wash them out thoroughly. I use pieces of roofing tin to cover my barrels, weighted down with a rock or piece of cement block. Neither rodent nor rain can get in. Set the barrels on wood pallets or any suitable platform to keep them off the ground so they don't rust out. In four drums you can store all the feed six chickens and a pig need in a year — with room to spare.

Larger homesteads and farms need larger grain-storage facilities, of course. There are all kinds of metal bins and cribs on the market. Old wooden cribs can be partially rat-proofed with hardware cloth or pieces of roofing tin, but only temporarily. Rats will almost always find a new place to gnaw a hole through. You must be eternally vigilant.

How do you rat-proof cheap, home made, ragtag buildings like I build? My small concrib made of logs will not keep out a racoon, let alone a rat. But I achieve rat control because each night our dog is tied to the crib, and he hates rats worse than I do. Also the cats, which have been raised and fed right next to the crib, spend a portion of each day inside it waiting for unsuspecting rodents.

Not many cats will hunt rats regularly, mostly because of the way they are kept. A good rat act is a hungry cat, and a hungry cat is a healthy cat. Unfortunately, most cats today are as overweight as their owners and have not been outside long enough to learn what the sky looks like, never mind a rat.

But to keep the rats away, even good rat dogs and cats need some help. Whenever you build a shed that must have a floor in it, build it up off the ground far enough so the dogs and cats can get under it easily. Rats like to burrow under things, not into open ground. They know instinctively that their predators can dig them out in open ground. A floor is perfect protection for their underground nests, if it rests on or near the earth.

For the same reason, keep all piles of wood and lumber up off the ground with planks and posts. (Better for the lumber anyway, since that keeps it from rotting.) Get rid of piles of rocks, old boards and junk.

Don't put solid floors in buildings that don't need them. That sounds stupid: a building with no floor certainly isn't rat-proof. But it makes sense. A chicken coop like mine, of pole construction and no foundation, has only an earthern floor. Rats can get in easily enough (if they get permission from the dogs and cats), but won't stay because there's no place to hide or dig under. Furthermore, once in the coop, the rat won't find anything to eat. We scrupulously try to feed our chickens so they clean up their troughs within an hour or two after feeding and definitely leave no mash available overnight when rats are active. It's an important detail in rat control and also good practice for the chickens. If they are leaving food in their troughs overnight, you're overfeeding them.

Only in the case of small chicks do you need total rat control. Rats will kill chicks. Ours are raised with a mother who will defend them to some extent. We always seem to have kittens and chicks about the same time, and we deliberately raise them together in the same building. It would take quite a rat to risk the ire of both mother hen and mother cat. And the kittens learn not to attack the chicks when raised this way.

Obviously, poisons have proved to be less than completely satisfactory, or we'd have exterminated the rat population by now. But used carefully with the aforementioned controls, poisons are partially effective. The trouble is rats are too smart. Violent poisons like arsenic and strychnine will kill rats (and everything else — which is their main drawback), but rats who watch other rats die with the kind of suffering strychnine induces, seem to put two and two together and avoid the bait.

Rats sometimes learn to avoid the safer, newer anti-coagulant poisons that have been so effective over the past 10 years. Anti-coagulants may take more than one feeding to killl. A rat that only get sick may refuse to eat the poison again. It seems to associate the odor of the bait with its sickness. That's why emphasis is on odorless poison today. But even more amazing, rats have recently shown some tendency to become immune to anti-coagulants.

A different kind of poison is being marketed now (Vacor, manufactured by Whitmoyer Laboratories, Myerstown, Pa., a subsidiary of Rohn and Haas of Philadelphia), which is supposed to kill a rat after one nibble and so prevent bait-shyness and immunity from developing. The poison is supposed to be "relatively safe for humans and other animals," but there is some difference of opinion on that score. At any rate, the label reads: "Keep out of reach of children. May be harmful or fatal if swallowed."

Trapping rats is the least effective way to deal with them, but helpfull as an additional control to good sanitation. By far the safest trap to use is a cage like the Havahart because if you catch the wrong animal (like a pet, which often happens when trapping rats), you can turn it loose unharmed. Bait your cage trap with grain or bread (bacon is the best bait in my experience, but at the present price I'm not about to waste even one slice on rats) and set it in an out-of-the-way corner of the barn or near where you have seen or suspect rats. Don't expect to catch one the first night, because normally rats are suspicious of any new object in their usual environment. By the third night you should get results.

Having a rat in a cage trap is kind of a problem itself. You still have to get rid of the pest. I have found the easiest, quickest, most "humane" way is to drop the cage with the rat in it into a barrel of water. The rat drowns immediately.

However well you clean up the rats on your place, never assume that you have licked them once and for all. Control is a continuous discipline. You can't let up. And don't minimize the problem if you see signs of rats. Remember the old adage of the farm now has scientific support. "If you see one rat, count ten!"

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EXPLOITATION vs. CONSERVATION OF LAND

"Exploitation to the engineer is a perfectly respectable term, meaning to develop for use or benefit. It comes from a word meaning to unfold. But the way it is used in the above title it has for the conservationist, an evil meaning. This meaning — namely of wrong, destractive and selfish use."

Conservation seems less difficult a concept, but only on the surface. It can mean to preserve intact. But as applied to land, it is coming to mean wise use for the greatest good of the greatest number for the longest time. This satisfies the tongue and ear, but not the inquiring mind, wisdom and good are subjective terms that cannot be formulated mathematically, or even made matters of easy and rough approximation."

PAUL B. SEARS

TOURISM AS AN INDUSTRY: A GEOGRAPHER'S VIEW POINT

by

DEVENDRA KUMAR JAIN[1]

Tourism has developed during recent times as one of the biggest single item of international trade in many countries and regions. The popular conception of tourism, merely in terms of recreation, has been modified within the last decade and its economic value has been realized particularly after August, 1973 when "United Nations conference on Tourism" emphatically stressed upon its economic aspects as a trade. In 1963, the total monetary transactions resulting from Tourism are reported to have exceeded 8 billion U.S. Dollars. In 1961 India earned about 200 million rupees from Tourism.[2] With a view to promoting this trade the United Nations has declared 1967 as Tourism Year."

Tourism has emerged as the world's largest and fastest growing industry. In the past two decades, it is estimated that in 1972 international tourism involved 200 million people the world over (in 1950 it was only 25 million where it was 14 million in 1948) and it was up by 18 million over 1971 figures. It is 10 percent average annual growth, therefore a unique phenomenon in the history. There have been vast movements but they have either been migrations or invasions. This concept of millions upon millions people travelling for peaceful purposes is something which is essentially and peculiarly a phenomenon of the second half of the 20th century.[3]

Though Tourism is an old phenomenon, as an acknowledged industry, it is still in its infancy in India. With the rich heritage of history, culture and the wide variety of natural scenery and beautiful monuments, India has great potential as a Tourist heaven. India was rather late in taking to Tourism. Infact, the materialistic outlook of travelling for pleasure hardly existed in this country where people left their place either for business or for religious purposes. Necessary infrastructure for development of tourism was therefore, never created in India and

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[2] Chib, S.N. Tourism in India, Major Industries of India 1964-65 annual vol. 13, p. 93.

[3] Gupta S.P. & Mrs. Krishna Lal: Tourism Museums & Monuments in India Oriental Publishers, page 1, 1974.

our country rightly came to be known as a "sleeping giant" in the world of tourism. This will be evident from the fact that our share in the world tourism receipts of $25,000 million in 1972 was only $68 million. As against this small countries like — Italy and Spain earned $2,174 and $2,608 million respectively on tourism during the same period.

The tourist industry in India is also greatly helped by the many international conferences and meetings which are now being held in this Country. The impetus that had been imparted to this flow in recent years is gathering momentum rapidly. Anticipating the increased flow, Government is planning on a scale that may not be quite as ambitious as in some of tourist countries like Italy, Switzerland, France or the U.K. but is nevertheless much more extensive than envisaged hitherto. Countries like Spain receive a tourist invasion, several times greater than their own total population. In the year 1969 Japan received more than 2.6 million tourists from the United States alone. Placed in this context, the Indian achievement fades because the target for year 1980 is no more than one million.

International tourism has rapidly grown during the jet age and is roughly twice the size of the oil industry. It is the single largest factor in the world in trade today and earns the huge foreign exchange. According to the tentative estimates, last year over 168 million tourists from 125 countries spent Rs.13,050 crores. Tourism involves approximately 2 billion persons in international travel.

Tourism is a Rs. 11,000 crore world busines today. In five years it will be worth Rs. 18,000 crores. An almost 75 percent increase. Investment in tourism earns the most foreign enchange in the shortest time. For instance, Yugoslavia invested Rs. 38.3 crores in tourism in 1968 and earned Rs. 140.3 crores. A net profit of 250 percent. And Spain could build two steel plants like Bhilai each year on her tourism earnings alone.

This great development is due to the growing affluence in certain parts of the world and the recent break-through in aviation. The bigger and faster planes have really helped in breaking national barriers but tourism is not merely a gross commercial proposition measured in terms of plane seats, hotel beds and taxi fares. It is much more than that. It is also the most direct, intimate, and enduring means of communication between people living under different political systems, historical traditions, geographical regions, economic stages, social customs, religious faiths and cultural patterns. Since tourism establishes and promotes such communications in an atmosphere of open-minded human curiosity, it has the power of stimulating and sustaining genuine international understanding and goodwill among men. Tourism, besides promoting international understanding and friendship, is of immense economic value. Domestic Tourism is a potent instrument in fostering national integration. The tourist industry, therefore, as a foreign exchange earner, has drawn the attention of all states for their development. It is one of the most effective instruments in promoting peace, goodwill, and understanding among the nations. Thus tourism has a widening impact of goodwil from persons to nations.

It is fashionable to describe tourism as an industry. It is more than that. It is a formative force which can help to mould a new outlook towards man and his world. It is a valuable and highly valued contributor to the economy and revenues of many of the most advanced countries and the developed nations. It also provides an easy and a fruitful channel for the exchange and intercourse which lead to international understanding, stability, and human progress. Tourism is the bridge of friendship between the countries and people of the world, and a powerful means of promoting and preserving peace between nations.

The 20th century has brought new developments in the recreation and tourist industry. The demand for outdoor recreation is booming today.[4] In the past leisure was the privilege of few,[5] but recently leisure has come to be enjoyed by the masses. Recreation is vital for life for young and old. Extensive recreational travel is increasingly becoming popular, "Tourist invasions have become a part of our civilization." Temporary human migrations take place on a large scale. A tourist is a person who travels for pleasure, recreation and culture visiting a number of places for his objects of interest, scenery, and the like. Tourists are by no means uniform in character. They have many purposes such as mountaineering, lodging, painting, photography, collective bathing, skiing, sight seeing and exploration. The various types of visits are attractive in different regions in varying degrees. Recreation is an area of human activity that is difficult to define.[6] After all recreation can not be achieved without going to the destination. In the study of Geography of Tourism, the first task is to find quantitative measurements.[7] Travel makes us more receptive and tolerant. It makes us more aware of the beauty and diversity of the world and the underlying identity of human joys, anxieties and aspirations. Thus, it serves to soften national angularities. Travel promotes a sense of kinship.

Tourist can no longer be regarded merely in the light of its pasttime view. It is a full-pledged industry which earns millions of dollars

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[4] Clawson Marion & L Knetsch Jack: "Economics of outdoor recreation resources for the future", Inc. The Johns Hopkins Pr. 1966 paper No. 1, p. 1.

[5] Yamamura, Janji: "Tourism and recreational developments around Tokyo" in Japanese Cities. A Geographical Approach, special publication No. 2, 1970, Page 71.

[6] Carlson, Albert S.: "Research Industry of New Hemisphere" Economic Geography — 1938 vol. 14, page 261.

[7] Lierer Clifford. M.: "Tourism and recreation in the West" Geographical Review. 1952. July, page 470.

for countries in the west. There is no reason why it should not be paying to us also, besides giving us an opportunity to earn the goodwill of our friends. The tourist industry increases the volumes of trade. The value of tourist trade is difficult to appraise because of the widespread diffusion of tourist expenditure. Free laborers find employments, farmers sell produce, and tradesman and craftmen sell their ware. In some foreign countries tourist trade forms a substantial part of the national economy and tourists are valued as the best of all customers. In 1950 France earned 26 million Francs out of tourists and Switzerland 28 million Francs while in 1954 Great Britain earned 180 million pounds.

There is a trend in Europe to develop tourism in certain holiday areas where the visitors hardly come in touch with the locals. They fly to airport near the resort, stay in specially developed hotels or villas and then fly back home. This concept seems to be a part of India's tourist planning as well. The new five star hotels being built by the India Tourism Development Corporation are so priced that, while they are reasonable for the visitor from abroad, they can be used only by Indians with expense accounts.

Tourism also offers numerous less tangible advantages which are non-economic in nature. It often has significant cultural implications (for example, the restoration of ancient monuments); aesthetic (the preservation of beauties of landscape and the safeguarding of the nation's heritage); social (the provision of recreational facilities for the health and welfare of the people); and political (the improvements of international understanding).

In addition, the availability of comfortable tourist facilities can be of major significance to an industrial promotion campaign. Given substantial facilities for developing tourism and the lack of real alternatives available to many of the lands, there can be little doubt that the tourist industry should be developed more fully.

Unfortunately, India has not yet caught up with jet age-boom in this field. Although in 1970, we did register an increase of 14.4 percent over 1969, our performance in relation to several other countries has been rather dismal. About 280,820 tourists in 1970 spending Rs 38.03 crores is not much of performance for a country which should be a "natural" paradise for tourists. In terms of the world's standard, our performance is totally disappointing. America earns millions of dollars. Many countries can even meet nearly 50 percent of their balance of trade deficits from tourist earning. Our performance, no doubt, is poor in comparison to other advanced countries of Europe and America. These countries have developed their tourism organizations over the past 50 years while India is comparatively a new entrant in this field. Moreover, these countries have certain geographical advantages which India does not have. Their large tourist traffic figures are mainly accounted for by intra-regional tourism. Thus, Canda gets millions of tourist every year from USA and vice versa mainly because of the two countries' proximity with each year.

India is a tourist paradise. It has everything that an average tourist want to see — its sights and sounds, its rich architectural and cultural heritage, its lovely hill stations, valleys and holiday resorts; wildlilfe and sanctuaries. India has greater potentialities for the development of tourism than any other Asian country because of her rich variegated landscape, cultural fairs, gay festivals. India with her history dating back more than 5,000 years has always been a paradise for visitors from all lands. It is high time in the national interest for the Indian Geographers and planners to concentrate upon the detailed studies of various resource centres of the country, from the tourist's point of view focusing upon the existing problems and suggesting ways and means for their future development. For one thing, our past planners did not, for reasons of their own, give this industry the importance it deserves.

Tourism does not have a seller's market. A tourist will not come to India just because it happens to be on the world map. It is a highly competitive commodity and its promotion must be treated as for a fan or a refrigerator or T.V. set or a vacuum flask or a pain relieving pill.

In recent years, much thought has been given in this country to this problem and tourism is being organized on a better footing. The union of Government has become more active and the state Government are also gearing up their machinery to derive benefits from this wonderful phenomenon on the economic front. During 1973 India received 4.1 lakh[8] visitors and it is estimated that by 1980 this figure would go to one million. This would still be a very small traction of tourist arrivals, but it would fetch for the country foreign exchange around Rs. 200 crores per year.

On these grounds an exceptionally bright future stands for the development of tourism in India. But the real significance of the tourism has not been realized both by the public and the Government as yet. In addition to the aspects of physical happiness and recreation, the effect of tourism should also be evaluated with respect to the spiritual uplift and mutual inter-relationship between the people of the area and the outer world.[9]

CONCLUSION AND SUGGESTION

India's target of ten lakhs tourists by 1980 is a very modest one in regard to India's potential and its small share in the world tourist

[8] 1 lakh = 100,000.

[9] Kayastha S L.: Tourist Industry of Kangara, Kulu and Mandi. National Geographical Journal of India. 1954. vol. II no. 3, pp. 128-148.

traffic. If we want to give a big push to this industry then a concerted effort by the Central and State Government, hotels, transport services, travel agents and others will be needed to bring up the industry. We should realize that tourism is essentially a business where there is a keen international competition. A tourist who provides so much of foreign exchange carries back nothing tangible but the impressions and it is this intangible quality which generates further business.

India's greatest tourism potential lies in her people. We have, however, not harnessed this side of human resource for the Industry. This has to be dealt with on two fronts. Firstly, training the tourist personnel in the specialized knowledge, and secondly, educating the masses through mass communication media. Most of the countries abroad have come up with programmed tourist education. Tourism as a subject has been introduced in higher secondary, diploma, and degree courses. Post graduate and research facilities are available in international center of advanced Tourist Education (CIEST) in Turin. Lebanon has a tourist research institute. Tourist education is a State responsibility in Greece and the Government has established a tourist training school (STE) whose operations are defined by law. The Spanish Institute of tourist studies grants fellowship to deserving candidates. Spain alone has 15 official hotel training schools. Thirteen of them are administered by the ministry of information and tourism.[10]

ACKNOWLEDGMENT

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Republika ng Pilipinas
PAMBANSANG LUPON SA PAGPAPAUNLAD NG AGHAM
(National Science Development Board)
Gen. Santos Ave., Bicutan
Taguig, Rizal

January 26, 1976

NSDB Office Order No. 001
Series of 1976

SUBJECT: *Amendment of Office Order No. 003 Series of 1974, Reconstituting Membership of the National Committee on Geographical Sciences (NCGS)*

NSDB Office Order No. 003, Series of 1974, is hereby amended to extend the tenure of office of the NCGS members from 31 December 1975 to 31 December 1976. The Committee shall be composed of the following:

Agency	*Discipline*
1. Phil. Geographical Society	— Geographical Societies
2. Bureau of Coast and Geodetic Survey	— Oceanography
3. Bureau of Mines	— Mineral Resources
4. National Irrigation Adm.	— Water Resources
5. Bureau of Soils	— Soil Resources and Agricultural Geography
6. Bureau of Forest Development	— Forest Resources and Agricultural Geography
7. Phil. Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)	— Meteorology & Climatology
8. National Census and Statistics Office	— Human Resources
9. Bureau of Fisheries and Aquatic Resources	— Fisheries and Aquatic Resources (vice DAR)
10. College of Arts and Sciences University of the Philippines	— Education Geography

Agency	Discipline
11. Commission on Volcanology	— Geology
12. National Science Development Board	— Ex-Officio member (non-voting member)

Thereafter, the tenure of office of the aforementioned NCGS members, as recommended by their respective agency heads and designated by the Chairman, NSDB, shall be four years, effective 1 January 1977, to coincide with that of the members of the International Geographical Union (IGU).

In the performance of their functions, the members as well as the alternate representatives of the Committee are hereby authorized to collect honoraria in accordance with NSDB Policy Instruction No. 5.2 as amended, in the amount of ₱50/meeting but not to exceed ₱300/month chargeable against NSDB funds.

All other pertinent provisions of NSDB Office Order No. 003 dated 12 February 1974 including amendments thereto, which are not inconsistent with this Order shall remain valid.

This Order shall take effect 1 January 1976.

By authority of the Chairman:

(Sgd.) PEDRO G. AFABLE
Officer-in-Charge
Office of the Chairman

——oOo——

IODINE IN FISH

"Along the coast where deep sea fish is a common article of diet, goiter is extremely uncommon. This is because of the iodine content in all sea foods. One of the best sources of iodine is the salmon, which does not loose this property even if canned. The iron element builds strong bones and teeth and is essential to the growth of everybody's cell.

"Protein, another highly desirable and necessary food substance is found in rich amount in salmon. This particle protein has the same food value as that of meat. Salmon may well be used as a substitute for meat. Both colourful and palatable, salmon is an appealing food abounding in health giving properties" — HEALTH DIGEST.

NATIONAL COMMITTEE ON GEOGRAPHICAL SCIENCES
As Per NSDB Office Order #001 Series of 1976

The representatives of the agencies appointed by the Chairman, National Science Development Board are the following members and alternates for the year 1976:

1. Dominador Z. Rosell Lydia P. Ordoñez	Phil. Geographical Society	Regular Alternate
2. Domingo C. Salita Telesforo W. Luna	Univ. of the Philippines	Regular Alternate
3. Wellington Miñoza Catalino Arafiles	P A G A S A	Regular Alternate
4. Antonio Samson Felix Antonio	National Census & Statistics Office	Regular Alternate
5. Gregorio Andal Felicisimo D. Peña	COMVOL	Regular Alternate
6. Antonio Ventura Mario Manansala	Bureau of Coast & Geodetic Survey	Regular Alternate
7. Inocencio Ronquillo Ruben Ganaden	Bu. of Fisheries & Aquatic Resources	Regular Alternate
8. Rufino Santos Camilo Galamay	Bureau of Soils	Regular Alternate
9, Oscar Crispin Jose Santiago	Bureau of Mines	Regular Alternate
10. Eduardo Llapitan Melanio Gacoscosin	Bureau of Forest Development	Regular Alternate
11. Benjamin U. Bagadion Jose del Rosario, Jr.	National Irrigation Adm.	Regular Alternate
12. Elvira O. Tan	NSDB	(ex-officio and/or representative)
13. Aurora S. Tolentino	NCGS	Executive Secretary

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