[Jpn. J. Parasitol., Vol. 45, No. 5, 391–399, October, 1996]

Approaches to the Elimination of Schistosomiasis on Bohol Island, Philippines

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(Accepted November 1, 1996)

Abstract

An isolated focus of schistosomiasis covering an area of 2,000 ha is confined in the northeastern part of the Island of Bohol, Philippines. An ambitious program to eliminate schistosomiasis was initiated on the Island in February 1986. The main control strategies are: (1) to control snails by clearing of vegetation and applying of chemical molluscicides at six-month intervals supplemented with agro-engineering environmental measures such as filling, ponding, cement-lining, and converting to ricefields with improved farming practices; and (2) to find cases by stool examination to diagnose and treat positive cases. Since August 1994, no *Oncomelania quadrasi*, the intermediate snail host of *Schistosoma japonicum*, has been observed in all the 15 snail habitats. In 1995, 8,779 stool samples (70.8% of the target population) were examined in the endemic villages. The number of positive was only seven, giving a prevalence of 0.08%. To know the prevalence among the different mammal reservoirs, 86 dogs, 57 pigs, 97 carabaos (water buffaloes), 93 cows, 51 goats and 122 field rats in the endemic villages were examined for schistosome infection in February 1996. Only one rat (0.82%) was found to be infected. The island province of Bohol is now on the verge of eliminating *O. quadrasi* snails and schistosomiasis.

Key words: schistosomiasis; elimination; molluscicide; land reclamation; Bohol; Philippines.

Introduction

Schistosomiasis due to *Schistosoma japonicum* continues to be a major public health problem in the Philippines (Blas *et al.*, 1989). The disease occurs in 24 endemic provinces on the islands of Luzon, Mindoro, Samar, Leyte, Bohol and Mindanao. The limited foci of schistosomiasis are known in the northeastern part of the island of Bohol and are confined in the two municipalities of Talibon and Trinidad. It was anticipated that elimination of the disease on the island of Bohol might be feasible since the endemic area has been relatively small and far away from the schistosomiasis foci of the neighboring islands.

A collaborative project of the Schistosomiasis Control Service of the Philippine Department of Health and Sasakawa Memorial Health Foundation on schistosomiasis control in Bohol commenced in 1981. Area-wide malacological surveys and snail control by the clearing of vegetation and chemical molluscicide combined with agro-engineering environmental methods have been conducted since 1986 (Yasuraoka *et al.*, 1989). On the other hand,

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approximately 70 to 90% of inhabitants in the endemic villages have been examined annually by stool examination. All egg positive cases except for pregnant women have been treated with praziquantel. Periodic surveys revealed the absence of *Oncomelania quadrasi* snails since 1994 and a few egg positive cases (0.08% in 1995) in the endemic area where 12,000 inhabitants reside.

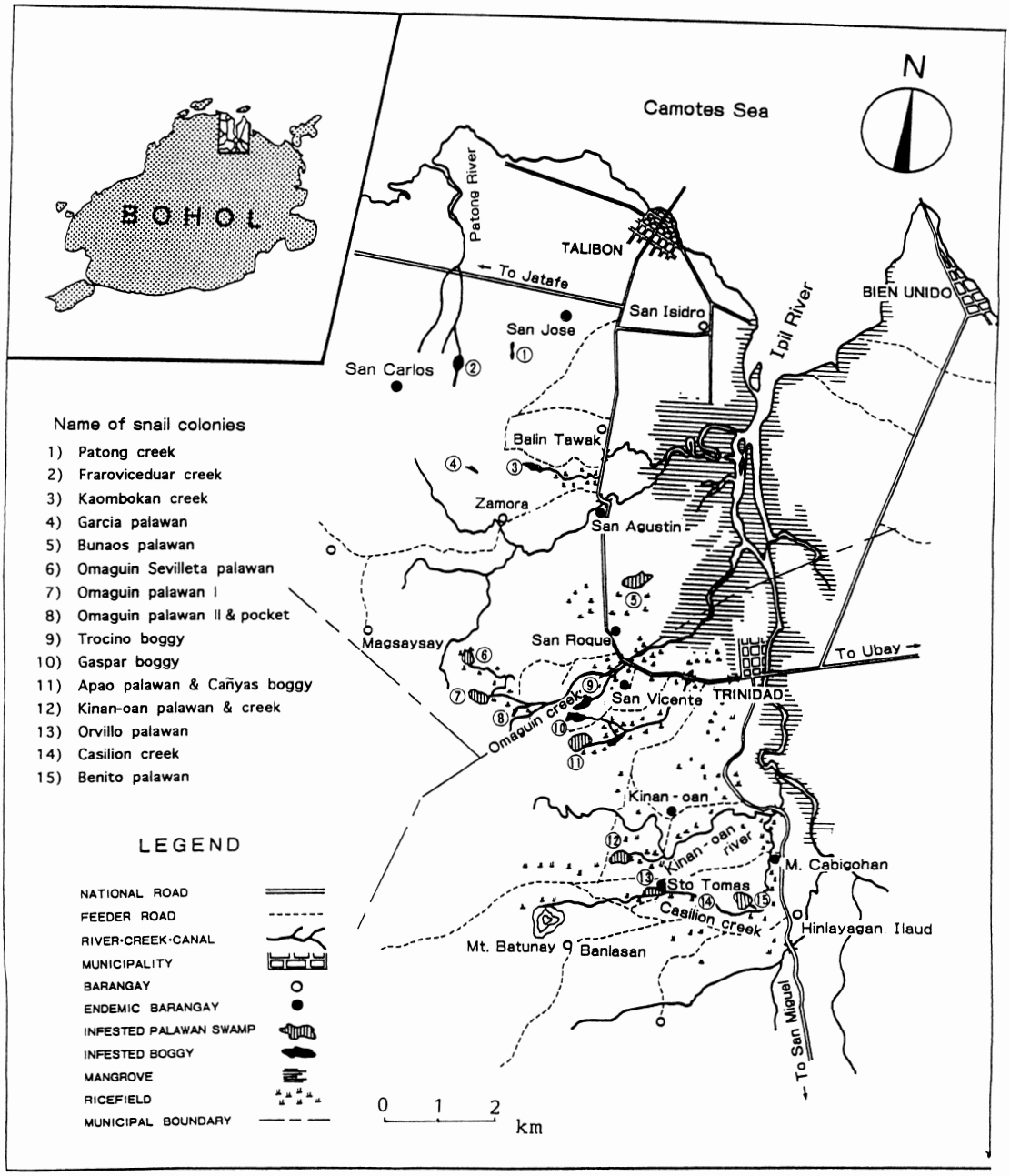


Fig. 1 Map of Northern Bohol showing snail colonies of *Oncomelania quadrasi* in Talibon and Trinidad.

Study Area, Materials and Methods

Bohol Island covering 4,117 km^2 lies in the heart of the Visayas between Cebu to the northwest and Leyte to the northeast. The limited foci of schistosomiasis are known in four villages in Talibon and three villages in Trinidad with population of approximately 12,000 in the northeastern part of the island. This area is characterized by a rolling landscape with alluvial lowlands, narrow valleys and small hills. Most of the low lands and valleys are converted into ricefields. In addition to six localities from which *O. quadrasi* were previously recorded by Blas and Dazo (1968), we succeeded in locating nine more colonies, five in 1985, two in 1987, one in 1989 and another one in 1990 (Fig. 1). The topographical positions of the 15 snail colonies were obtained by using a hand-held global positioning system (Trimble Navigation Ltd.) (Table 1). The Patong and Fraroviceduar creeks flow into the Patong River and then into Camotes Sea, while all the others drain into the Ipil River and then into Camotes Sea. Out of the 15 colonies, nine were in small swamps with dense palawan (Figs. 2, 4). Four colonies, Patong creek, Fraroviceduar creek, Kaombokan creek and Casilion creek, were in mendering sluggish and vegetation-clogged streams in the folds of low hills. The remaining two colonies, Trocino and Gaspar, were in small swamps overgrown with exuberant vegetation of tall grasses.

There is no pronounced rainy period nor is there any dry season, with an average annual rainfall of 168.5 cm. January to May are the drier months.

Twice-yearly snail surveys were carried out immediately before the weed clearance and application of molluscicides. Snails were collected manually by five to six well-trained men searching for 15, 20 or 30 minutes and the findings were reported as number of snails per man per hour.

A team of laborers cleared vegetation by mowers and rakes and then applied molluscicides. Niclosamide (WP-70) was applied at doses of 1 to 5 g/m^2 by hand broadcasting. A 25% liquid form of Phebrol (B2, sodium 2,5-dichloro-4-bromophenol) (Kajihara *et al.*, 1979) was sprayed with a sprinkling can at doses of 5–10 g/m^2. The plant-origin molluscicide, the seeds of *Jatropha curcas* (tubang bakod in Tagalog) (Yasufaoka *et al.*, 1984) was tentatively used in July 1983, at a dose of 4 g/m^2 (Table 2).

Each house in all endemic villages was marked with a number, and all the inhabitants of each house were registered by name, age and sex. Stool samples were collected in plastic containers. Each yearly

Table 1 Snail colonies in Bohol

Snail colony	Latitude/Longitude		Area (m^2)
Talibon			
1) Patong creek	10° 07.910'N/124°	18.259'E	500
2) Fraroviceduar creek	07.837'N/	17.259'E	1,500
3) Kaombokan creek	06.955'N/	18.560'E	2,000
4) Garcia palawan	06.920'N/	17.526'E	800
5) Bunaos palawan	05.327'N/	19.314'E	1,200
6) Sevilleta palawan	04.766'N/	17.981'E	1,200
7) Omaguin palawan I	04.534'N/	18.115'E	2,000
8) Omaguin palawan II	04.532'N/	18.259'E	2,000
Trinidad			
9) Trocino boggy	10° 04.099'N/124°	18.821'E	1,000
10) Gaspar boggy	04.028'N/	18.984'E	10,000
11) Apao palawan & Canas	03.861'N/	18.949'E	2,500
12) Kinan-oan palawan	02.775'N/	19.072'E	1,000
13) Orvillo palawan	02.525'N/	19.794'E	1,800
14) Casilion creek	02.500'N/	19.454'E	1,500
15) Benito palawan	02.340'N/	19.136'E	1,800
		Total	30,800

Table 2 Amount of molluscicides used

Month/Year	Amount of molluscicides used (kg)		
	Niclosamide	Phebrol	Tuba seeds
Jul/ 1983	50	–	20
Jul/ 1984	11	–	–
Jul/ 1985	28	20	–
Jul/ 1986	50	17.5	–
Jan/ 1987	12	29.0	–
Jul/ 1987	10	7.5	–
Feb/ 1988	–	22.5	–
Jul/ 1988	–	30.5	–
Feb/ 1989	–	28.5	–
Jul/ 1989	54	–	–
Feb/ 1990	108	–	–
May/ 1990	110	–	–
Jul/ 1990	108	–	–
Nov/ 1990	110	–	–
Feb/ 1991	118	–	–
Jul/ 1991	106	–	–
Feb/ 1992	74	–	–
Jul/ 1992	72	–	–
Feb/ 1993	88	–	–
Jul/ 1993	55	–	–
Feb/ 1994	125	–	–
Jul/ 1994	15	–	–
Total	1,304	155.5	20

case-finding survey comprized the examination of two 27 mg Kato-Katz smears from each stool sample. All those who were passing schistosome eggs were treated with praziquantel at 40 mg per kg body weight in two divided doses spaced 4 hours apart.

Infection by *S. japonicum* in domestic animals, such as dogs, cows, pigs, carabaos (water buffaloes) and goats, in endemic barangays was determined by formalin-ether sedimentation of eggs in feces. Field rats were caught by village volunteers and sacrificed by cervical dislocation. At autopsy, the mesenteric and portal veins, liver and lungs were thoroughly examined for adult flukes and foci due to schistosome infection. The intestinal contents were examined for eggs in the same way as used for domestic animals.

The Provincial Schistosomiasis Eradication Task Force of Bohol was created in March 1992 under the lead of Regional Health Office No. 7, DOH. The Task Force is composed of staff from different agencies and non-governmental organizations to coordinate and implement case finding, environmental sanitation and agro-engineering activities.

Results

Elimination of the snail colonies

Molluscicide application after clearing of vegetation was done once a year from 1983 to 1986, and twice a year from 1987 to 1994. In 1990, molluscicide was exceptionally carried out four times a year. Niclosamide and phebrol used so far totaled 1,304 kg and 155.5 kg, respectively (Table 2). In most of the colonies it followed various ecological (engineering) control measures that alter the snail habitat. Types of the measures accomplished were:

- *converting swampy areas into rice-fields after earth filling*; in the Garcia palawan in 1990–1992, Sevilleta palawan in 1986, Gaspar boggy in 1990, Orvillo palawan in 1993, Apao palawan in 1994 (Figs. 2, 3) and Benito palawan in 1994;

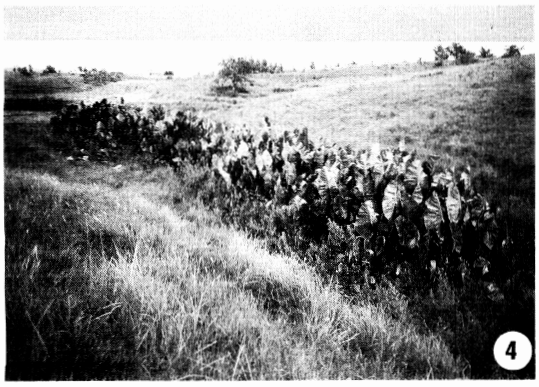
Fig. 2 Apao palawan swamp; before reclamation (February 1992).
Fig. 3 Apao palawan swamp; rooting out of palawan, earth filling, and then converting to ricefield (August 1994).

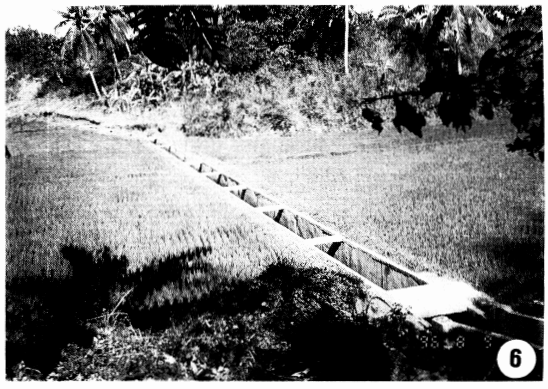
- *clearing and ponding*; in the Fraroviceduar creek in 1992;
- *clearing and drainage*; in the Kaombokan creek in 1993;
- *filling in*; in the Omaguin palawan II in 1991 (Figs. 4, 5); and
- *cement-lining*; in the Casilion creek in 1995 (Fig. 6).

These snail control operations resulted in virtually complete control of *O. quadrasi* as will be seen from the snail survey data summarized in Table 3. Recolonization of snails was seen in some colonies, such as Kaombokan creek, Omaguin palawan II, Trocino boggy and Gaspar boggy, several years after the first elimination. In these cases, only the peripheral areas which had been left unnoticed and never received any type of snail control were responsible for their presence. Success in eliminating the snail population was thus complete in all the snail colonies in 1994, and no snails have been found there since then.

Case finding and treatment

Mass stool examination of one-year-old-and-above persons in all the endemic villages has been conducted since 1981. Examination of not less than 80% of the target population was the coverage required by the DOH. The coverage was more than 90% in 1989 and 1990. All those who are passing *S. japonicum* eggs, except for pregnant women, were treated with praziquantel. As a result of the implementation of the project in the past 15 years, the prevalence was reduced from 4.70% in 1981 to 0.08% in 1995 (Table 4).





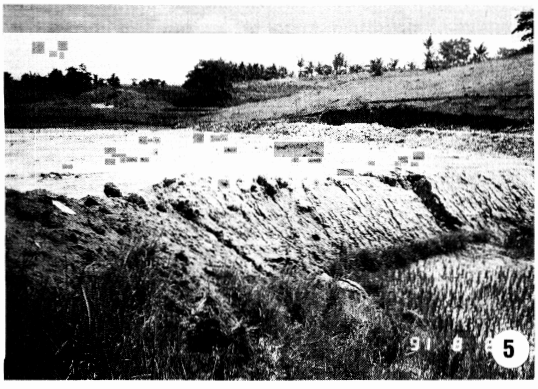


Fig. 4 Omaguin palawan swamp II; before reclamation (August 1988).
Fig. 5 Omaguin palawan swamp II; after earth filling (August 1991).
Fig. 6 Cement-lined Casilion creek (February 1996).

Infection in domestic and wild mammal reservoirs

As the prevalence in man has considerably decreased, domestic and wild mammal reservoirs may be playing a more important role in transmission than before. Field surveys on animal infection were therefore conducted in February 1996 in four endemic villages, San Roque in Talibon, and San Vicente, Kinan-oan and Sto. Tomas in Trinidad. Fecal specimens were collected from 86 dogs, 57 pigs, 97 carabaos, 93 cows and 51 goats and examined for *S. japonicum* eggs. None of them were found positive. Of 122 field rats caught and examined, only one (0.82%) was infected with four pairs of adult *S. japonicum* (Table 5).

Discussion

In several ways, the results of this project are encouraging. The most important demonstration is that through continued molluscicide after clearing and ecological control measures that alter the snail habitat, *O. quadrasi* can be completely eliminated. The experience in Bohol indicates that a comprehensive program involving elimination of vector snails, as well as mass examination and selective chemotherapy, can succeed in eliminating schistosomiasis from a given endemic area.

The second encouraging feature is that reclamation by converting swampy areas with dense palawan (*Cryptosperma merkusii*) into ricefields has successfully controlled or even eliminated snails. We cannot overlook the cooperation of the landowners themselves, as well as the intersectorial cooperation through the Provincial Schistosomiasis Eradication Task Force of Bohol. Rice cultivation is an environmental method of snail control in that it brings about

Table 3 Results of biyearly survey of snail colonies in Bohol for period 1986–1995, showing changes in snail densities in each of the 15 snail colonies in which control operations have been carried out

Snail colony	Snail densities (snail/man/hr)*							
	Jun.'86	Jan.'87	Jun.'87	Jan.'88	Jun.'88	Jan.'89	Jun.'89	Jan.'90
Patong creek	–	–	–	–	–	–	–	–
Fraroviceduar	–	–	–	55.5	286.9	88.6	89.1	0
Kaombokan creek	0	20.4	11.0	4.9	52.5	3.3	17.0	11.3
Garcia palawan	–	–	–	–	–	–	146.1	17.0
Bunaos palawan	–	–	–	132.0	138.0	102.6	45.0	29.0
Sevilleta palawan	198.3	40.8	0	0	0	0	0	0
Omaguin palawan I	0	0	0	0	0	0	0	0
Omaguin palawan II	140.0	70.8	36.0	9.9	12.0	0	44.5	0
Trocino boggy	98.9	8.0	12.0	0	0.9	0	0	1.0
Gaspar boggy	37.7	12.8	2.0	41.3	12.0	0.9	0	0
Apao & Canas	186.3	99.8	45.0	99.0	207.0	125.1	69.3	28.6
Kinan-oan palawan	1.4	0	0	0	0	0	0	0
Orvillo palawan	128.6	172.6	2.5	3.3	9.9	34.2	26.0	0
Casilion creek	102.9	68.8	27.0	16.3	3.9	26.5	67.3	0
Benito palawan	239.1	10.3	0	0	0	0	0	0

*Expressed as number per man per hour. This involves counting number of snails collected with forceps by 5 to 6 experienced workers for a given period of time, 15, 20 or 30 minutes.

Table 3 (continued)

Snail densities (snail/man/hr)										
Jun.'90	Jan.'91	Aug.'91	Feb.'92	Aug.'92	Feb.'93	Jul.'93	Feb.'94	Aug.'94	Feb.'95	Dec.'95
–	88.5	6.6	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
2.3	0	0	66.6	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	79.9	0	0	0
0.6	0	104	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	21.7	0	0	0
0	42.5	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0.8	0	0	0	0	0.6	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

ecologic changes, which eventually reduce snail habitats. Intensive rice cultivation, with proper seedling spacing, weeding, and water management, has led to snail control in ricefields in the Philippines (Garcia, 1988). In addition, it would appear that the agricultural benefits might be great enough to offset completely the cost of control measures.

Studies on the prevalence of *S. japonicum* in

Table 4 Changes in prevalence of schistosome infection in Bohol for period 1981–1995

Year	Population	Sample examined	Number egg-positive	Percentage egg-positive
1981		2,595	122	4.70
1982		3,337	59	1.77
1983		2,922	50	1.71
1984		3,212	139	4.33
1985		3,642	39	1.07
1986		2,641	71	2.69*
1987		5,807	92	1.58
1988	6,726	4,135	59	1.43
1989	6,862	6,162	31	0.50
1990	8,123	7,307	22	0.30
1991	11,031†	9,536	59	0.62
1992	11,345	8,054	32	0.40
1993	12,152	6,954	14	0.20
1994	12,225	8,642	15	0.17
1995	12,395	8,779	7	0.08

*A highly endemic section was found in San Vicente, Trinidad, in 1986.
†An endemic barangay, San Jose, Trinidad, with a population of 2,500 was found in 1991.

Table 5 Prevalence of *S. japonicum* in different animal reservoir hosts in the Philippines

Host	Prevalence (%) (no. positive/no. examined)		
	Leyte	Leyte	Bohol
Dog	18.2 (31/170)	16.4 (61/373)	0 (0/86)
Pig	13.3 (80/603)	12.6 (70/555)	0 (0/57)
Carabao	1.5 (2/137)	8.7 (8/92)	0 (0/97)
Cow	38.2 (13/34)	2.2 (1/46)	0 (0/93)
Goat	1.4 (1/69)	7.1 (2/28)	0 (0/51)
Rat	22.7 (46/203)	–	0.82 (1/122)
Authors	Pesigan *et al.* (1958)	Fernandez *et al.* (1982)	Present authors

animal hosts in Leyte, Philippines have indicated that dogs and pigs are good reservoir hosts, and a large number of viable eggs are discharged in the feces (Pesigan *et al.*, 1958; Fernandez *et al.*, 1982) (Table 5). In the present study, however, a total of 384 domestic animals were examined and surprisingly none was found positive for *S. japonicum*. In addition, of 122 field rats examined only one (0.82%) was found to be infected. The near absence of animal infection in Bohol would be the best criterion of the actual results obtained.

The island province of Bohol is now on the verge of eliminating *O. quadrasi* snails and schistosomiasis. The continuous snail control operations backed up with selective population chemotherapy hold promise of the ultimate elimination of the disease in Bohol.

Acknowledgements

Without the constant cooperation from the six technical assistants of the Bohol Schistosomiasis Control Team, Ms. A. G. Crescencio, Ms. C. Avenido, Mr. L. Puracan, Mr. F. Evangelista, Mr. A. M. Amba and Mr. F. S. Estapia, the present project would not have been possible. We are grateful to the previous team leaders, Dr. V. Guiritan, Dr. A. F. Maniwan and Ms. R. B. Pacheco for their courteous help and support. We are also indebted to Dr. E. Teleron and Ms. C. C. Auza, Schistosomiasis Co-ordinator, Regional Field Office No. 7-DOH, and Dr. A. Redulla, Chairman, Provincial Task Force on Schistosomiasis Eradication in Bohol, for their active operations of the Task Force. We finally thank all of the village captains, land owners and villagers in the municipalities of Talibon and Trinidad for their participation in this program.

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