

# POTENTIAL HEALTH HAZARDS OF THE WATER RESOURCES DEVELOPMENT: A HEALTH SURVEY IN THE PHITSANULOK IRRIGATION PROJECT, NAN RIVER BASIN, NORTHERN THAILAND

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## INTRODUCTION

The development and implementation of the Phitsanulok Irrigation Project in the Nan River Basin, Northern Thailand to increase agro-economics are believed to have an impact on several environmental components to varying degrees. It may result in changes in public health and may affect directly on human and his environs. Thus, the Department of Tropical Medicine, Faculty of Tropical Medicine, in collaboration with the Division of Epidemiology, Ministry of Public Health, conducted a survey to obtain baseline data on health conditions of the people residing in the project area between April 1977 and May 1978. The survey was undertaken to establish whether schistosomiasis was present and to determine other water-borne parasitic diseases in the project area.

### Description of the area

The area coverage under the Phitsanulok Irrigation Project is estimated about 827,000 rai (about 132,320 ha.) and extends to cover the major fertile soil of two provinces, Phitsanulok and Phichit (Fig. 1). With the aid of aerial topographic map (scale 1:50,000), 33 out of 398 villages were statistically selected as sample size. Of these 33 villages, 13 are in Phitsanulok and 20 in Phichit Provinces. There were 16,386 residents, of which 8,039 were males and 8,347 were females registered during 1977.

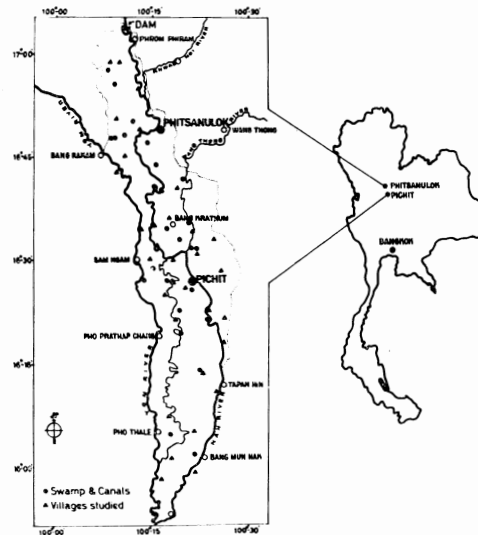


Fig. 1—Showing the locations of sampling villages and water reservoirs in the project area.

Rice farming is the main occupation of the people. The other occupations are lotus-planting, fishing and agro-industrial production. Annual rainfall (av. 1,324 mm) is high from May onwards with a peak in September and is low for the remainder of the year. Living standards in these villages were considered better than other parts of the country in terms of housing structure, but environmental sanitation in most villages was poor. Toilet facilities was available for only 33.8% of households; promiscuous defecation is a common practice, in the bushes or into the water ways. Untreated drinking water was obtained from natural sources.

## MATERIALS AND METHODS

Health investigations among the inhabitants of 33 selected villages in the project area were conducted village by village throughout. About 13% of 2,997 households (or 393 families) with all their members were selected for this study. The total number of population finally covered in the survey was 1,499 of which 659 were males and 840 were females. The study was limited to previous history of illness, general physical examination, intradermal test for schistosomiasis, stool examination for the presence of any intestinal parasitic infection and blood examination for haemoglobin and sero-immuno diagnosis of schistosomiasis and leptospirosis. History of previous illness and general physical examination with special emphasis on enlargement of liver and spleen were recorded and analysed. Intradermal test for schistosomiasis was performed on adults and young children aged above 6 years of the selected families against schistosome infection using crude veronal buffer *Schistosoma japonicum* antigen obtained from Yokogawa's Laboratory, Japan. Technique and interpretation of the results were based on the criteria described by Kagan and Pellegrino (1961).

Blood samples from finger-prick were drawn into 2-4 heparinized capillary tubes for haemoglobin and immunodiagnosis determinations for schistosomiasis. Blood sera, after haematocrit reading, were kept in an ice box and sent to the laboratory for circumoval precipitin tests (COPT) for schistosome infection (Yokogawa *et al.*, 1967). Dry blood on filter paper technique was employed for leptospiral antibody determinations (Sundhargiati and Harinasuta, 1965). Titre equal to or greater than 1:100 was considered positive for leptospirosis. The stool specimens were collected and examined using the merthiolate-iodine-formalin concentration method (Blagg *et al.*, 1955). Modified Harada-Mori culture for hookworm species identification were also

performed on all hookworm-positive stool specimens (Sasa *et al.*, 1965). Intensities of infections for hookworm and *Opisthorchis viverrini* were determined by Stoll's dilution technique (Stool, 1923). All specimens were examined at the laboratory of Department of Tropical Medicine in Bangkok.

## RESULTS

Table 1 summarizes the results of medical history and physical examinations. Analyses of the records on the previous illness showed that 913 (60.9%) of the villagers experienced gastrointestinal disturbances such as bloody-mucous or mucous and/or combination of colic and tenesmus symptoms. From history taking 350 (23.3%) revealed that they experienced intensive itchy symptom upon contact with water while working in the fields or fishing in the swamps.

Table 1  
General physical examinations of 1,499 residents in the project area.

Signs and Symptoms	No. of cases	%
Poor general health condition	165	11.0
Gastrointestinal symptoms	913	60.9
Oral and dental hygiene	254	16.9
Cercarial 'itchy' dermatitis	350	23.3
Chronic skin diseases	63	4.2
Diseases of the eyes	29	1.9
Neurological sequelae	5	0.3
Liver and spleen enlargement	0	0

A total of 1,499 population, from 1-86 years of age, who were physically examined did not show positive signs of having liver and spleen enlargement; 165 (11.0%) were found to have poor general health conditions including anaemia and malnutrition. Oral and dental hygiene were considered poor among 254 (16.9%) of the total people examined. The most common oral diseases

including dental caries and pyogingivitis were found in 236 (93.0%) persons, while 97 persons showed signs of other diseases: 63 (4.2%) had *Tinea versicolor*, 29 (1.9%) chronic conjunctivitis and trachoma and 5 with neurological sequelae from poliomyelitis.

The results of blood haemoglobin determinations from 1,108 revealed that anaemia was not a serious public health problem among the population residing in the project area: 37 (3.3%) had haemoglobin below 10

gm%; 765 (69.1%) at 12 gm% and above (Table 2).

Table 2  
Prevalence of anaemia amongst the population in the project area.

Hb. level gm %	No. of cases	Percentage
< 10	37	3.3
10-11.9	306	27.6
> 12	765	69.1

Table 3  
Prevalence of intestinal parasites among residents of 33 villages in Phitsanulok Irrigation Project Area, Northern Thailand, 1977-1978.

Villages	No. exam.	Prevalence of intestinal parasites*								
		Protozoa			Helminth					
		E.c.	G.l.	Hw.	A.l.	T.t.	E.v.	O.v.	Int.f.	T.sp.
Nuen Kum	27	7	-	67	4	-	4	55	-	-
Tha Makam	32	3	-	22	-	-	-	3	-	-
Klong Kalon	30	3	-	57	-	-	-	23	-	-
Nuen Saat	57	9	-	58	2	4	-	16	-	-
Sanam Kli	34	6	-	38	9	-	-	3	-	-
Wang Tabua	33	21	-	55	3	-	-	9	-	-
Chom Thong	70	7	4	34	1	4	-	4	3	-
Hua Thae	63	6	2	65	37	-	-	2	6	-
Wat Prick	40	7	-	48	10	-	-	5	5	-
Wang Pet	27	18	4	70	4	-	-	18	4	-
Huai Dang	58	7	-	40	22	-	-	-	9	-
Wat Tap Tim	48	10	-	31	-	-	-	50	2	2
Ban Don	48	21	2	42	2	-	2	-	4	2
Thung Samran	40	2	-	57	-	-	2	12	2	-
Pa Makhap	40	10	-	67	2	-	-	52	2	-
Nam Hak	32	9	3	69	3	-	-	22	3	-
Hat Sung	29	7	-	45	3	3	10	3	3	-
Rong Chang	47	2	-	34	-	-	-	13	-	-
Bung Si Fai	32	6	-	16	6	-	3	19	-	-
Wang Ai Nui	33	15	-	30	3	-	-	67	6	-
Khao Phra	16	19	12	69	-	-	6	56	6	-
Lai Chado	38	10	8	60	-	-	-	71	-	-
Kamphang Din	26	11	-	31	19	-	-	8	-	-
Tha Put Sa	18	22	-	67	-	-	-	11	-	-
Wang Wai	35	6	-	34	-	-	-	77	-	-
Yang Khli	40	10	-	35	12	-	-	15	-	-
Phai Luang	28	3	-	25	3	-	-	39	-	-
Tha Nang	53	15	-	58	2	-	-	21	-	-
Sapan Hin	72	8	-	28	1	-	1	3	1	-
Tha Na	40	7	2	50	-	-	2	-	-	-
Tha Toei	40	7	-	32	-	-	2	10	-	2
Tha Chang	16	25	-	31	-	-	-	25	-	-
Huai Khot	56	16	-	37	16	-	-	23	-	-
Total	1298	10	1	45	6	0.5	1	20	2	-

\* Percentage to nearest whole number.

Hw. = Hookworm, A.l. = *Ascaris lumbricoides*, T.t. = *Trichuris trichiura*,

E.v. = *Enterobius vermicularis* O.v. = *Opisthorchis viverrini*,

Int.f. = Intestinal flukes, T.sp. = *Taenia* species, E.c. = *Entamoeba coli* cyst.

G.l. = *Giardia lamblia* cyst.

Stool specimens obtained from 1,298 persons (595 males and 703 females) showed that 799 (61.6%) were positive for protozoal and helminthic infections. There were differences in prevalence rates for parasitoses between villages, but the reasons for the differences are unknown. The data have been pooled and presented for all villages (Table 3). In total, helminthic infections were the most common with an average morbidity of 73.7% followed by the protozoal infections with the prevalence of 10.9%. From hookworm positive stool cultures, 96% were *Necator americanus*, 2% were *Ancylostoma* sp. and the rest *Strongyloides stercoralis*.

Intensities of parasitic infections are shown in Table 4; 305 persons had mild hookworm infections, 115 had moderate and 9 had heavy infections. For people who were infected with *O. viverrini*, 103 had mild intensity and 17 had moderate intensity.

Table 4  
Intensity EPG (number of eggs per gramme of faeces) of hookworm and *O. viverrini* infection.

Parasitic Infection	No. of cases
Hookworm	
Mild < 2000	305
Moderate 2000-10999	115
Severe > 11000	9
<i>O. viverrini</i>	
Mild < 1000	103
Moderate 1000-10000	17
Severe > 10000	-

Intradermal tests for schistosomiasis japonica performed on 1,422 (94.9%) out of 1,499 people examined showed that 149 (10.5%) gave positive or doubtful skin reaction to schistosomiasis (Table 5). Individual serum from these people and about 10.0% of control, nonreactive skin tests, were tested against *S. japonicum* eggs, Mekong strain,

Out of 449 people tested, 4 males and 3 females, age ranging from 13-61 years, showed a strong positive COPT to schistosomiasis japonica.

The agglutination tests for leptospirosis performed on 1,358 dried blood samples from 602 males and 756 females showed leptospiral antibody titre (tested against 12 leptospiral serotypes) equal to or greater than 1:100 in 6 people (0.4%) infected with three widely known spirochetes: *Leptospira autumnalis*, *L. canicula* and *L. javanica*.

## DISCUSSION

The health conditions of the people residing in the Phitsanulok Irrigation Project area were considered to be satisfactory in this study. Complaints of gastro-intestinal symptoms in 61% and 17% with poor oral hygiene and a few cases of mild anemia are generally found among the rural people in Thailand. Parasitic infections are of great concern to public health among the people in the project area. In this survey, prevalence of hookworm infection (16-70%) was the significant soil-transmitted disease and opisthorchiasis (0-77%) was the common parasitic disease.

Hookworm prevalence was moderate with low intensity and was unlikely to cause any morbidity change in general. Other soil-transmitted helminthiases such as ascariasis, enterobiasis and trichiuriasis were low. These diseases, generally, are considered as diseases that are quite easily controlled by mass treatment and good sanitation. Prevalence of *Opisthorchis viverrini* infection was found to be low (20%) as compared to that in endemic areas in Northeast Thailand where prevalences were as high as 80% (Harinasuta *et al.*, 1970.) Abundant population of *Bithynia*, snails, the first intermediate host, and Cyprinoid fish, the second intermediate host harbouring infective metacercariae of *O. viverrini* among fish sp. examined (15.7%) were found

in all natural water reservoirs surveyed in the project area (Sornmani *et al.*, 1979). In future, after completion of irrigation system there may be an increase in the population of intermediate hosts. Together with habits of eating raw or undercooked fish, promiscuous defecation, poor sanitary condition and possible infected migrants from endemic areas in the Northeast, it is expected that opisthorchiasis will play an important public health problem in this area unless effective control measures are strongly enforced.

Leptospirosis is common in Thailand, especially in the rural areas (Sundharagiati and Harinasuta, 1964). Small mammals as dogs, rats serve as the reservoir hosts, and route of infection is through contamination of water by infected urine of animals. In this survey, 6 (0.4%) human blood samples were positive (Table 5) and small field rodents trapped from habitats near the villages and around the water reservoirs were also positive for leptospiral infection (9.6%) (Sornmani *et al.*, 1979). Thus, the chance of people to come in contact with water contaminated with the spirochetes is considerably high during the rice planting season. This disease is being considered as potential threat to public health in this water resource development area if

rodent control campaign is not widely implemented.

Table 5  
Serological tests for schistosome and leptospiral infections among the residents of Phitsanulok Irrigation Project Area, 1977-1978.

	No. examined	No. positive (%)
Schistosomiasis		
Skin test	1,422	149 (10.5)
COPT	499	7 (1.6)
Leptospirosis	1,358	6 (0.4)

One of the most important water-borne parasitic diseases as a potential health hazard to humans in the area is schistosomiasis. This blood fluke infection has been reported to exist in the area under the Phitsanulok Irrigation Project (Lee *et al.*, 1966; Sarakoon *et al.*, 1973). Ten percent of the people examined were positive for skin test against crude *S. japonicum* antigen and 7 cases (1.6%) gave serologically strong positive for antigenic property with *S. japonicum* ova by COPT. However, Sornmani and Vivata-

Table 6  
Skin reaction, COPT and intestinal parasites among 7 cases, by age and sex.

Sex	Age (yrs)	Skin test Reaction	COPT	Intestinal Parasites				
				Hw.	O.v.	A.l.	E.v.	Int.f.
F	40	Negative	+	+	+	-	+	-
F	13	Negative	+	+	-	-	-	-
F	33	Negative	+	+	+	+	-	+
M	61	Negative	+	-	-	-	-	-
M	38	Positive	+	+	-	-	-	-
M	45	Positive	+	+	-	-	-	-
M	22	Negative	+	+	+	-	-	-

Hw = Hookworm, O.v. = *Opisthorchis viverrini*, A.l. = *Ascaris lumbricoides*, E.v. = *Enterobius vermicularis*, Int.f. = Intestinal fluke.

nasesth (1977) reported that the COPT produced some cross reaction between sera of heavily infected *O. viverrini* cases and *S. japonicum* ova, Mekong strain. As shown in Table 6, the youngest was 13 years old and the oldest was 61. All except one were infected with one or more intestinal parasites, 6 cases were infected with hookworm, 3 with *O. viverrini*. High prevalence rates of animal schistosomes (40% *S. incognitum* and 1% *S. spindale*) in small field rodents and domestic animals in this area (Sornmani *et al.*, 1979) and the finding of the strong sera positive COPT obtained from this study suggest the possibility of cross reaction. There is no evidence of human cases in this survey or known susceptible intermediate hosts recovered in the snail survey by Sornmani *et al.*, in 1979. Thus, schistosomiasis, a significant water-borne parasitic disease, is not a potential public health hazard in the Phitsanulok Irrigation Project area.

In conclusion, the health problems arising following any water resource development can be estimated by exploring conditions of the people in the area before the construction, followed by periodic surveillance of individual endemic and parasitic infections especially the water-borne diseases. Information obtained from these studies would be useful in the prevention and control measures.

#### SUMMARY

A health survey was carried out among residents of 33 villages under the Phitsanulok Irrigation Project Area, Nan River Basin, Northern Thailand, whereby general health conditions were examined including intradermal tests for schistosomiasis japonica, stools for intestinal parasites and sera tested by circumoval precipitin test for antibodies to *S. japonicum* and by agglutination test for leptospiral infection.

Health investigations revealed that 913

(60.9%) of 1,499 people examined had experienced gastro-intestinal disorders, 254 (17%) had poor oral hygiene and a few had mild anemia. 799 (62%) of 1,298 examined had intestinal parasites. Hookworm (45%) was most common, followed by *Opisthorchis viverrini* (20%), *Entamoeba coli* (10%), *Ascaris lumbricoides* (6%), intestinal flukes (2%), *Enterobius vermicularis* (1%) and *Giardia lamblia* (1%).

149 (10%) of 1,422 people gave positive skin reaction to crude *S. japonicum* antigen. Circumoval precipitin test was strongly positive in 7 (1.6%) persons out of 449 tested for schistosome infection and 6 (0.4%) out of 1,358 people were positive for leptospiral infection. The significant endemic diseases as potential health problems in this water resources development are discussed.

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