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Table of Contents

1. Health impacts of wastewater use in aqua- and agricultural production systems in four Southeast Asian cities

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Abstract

The Papussa (Production in AquaticPeri-urban Systems in Southeast Asia) project was initiated and began to be implemented in January 2003 . To ascertain baseline information and livelihoods of people engaged in aquaculture and agriculture, a baseline and three successive monitoring surveys were carried out for one year in 4 Southeast Asian cities, Ba. This current report only describes a general health picture of the people involved in wastewater fed aquaculture in these four cities. Only skin problems were considered a health condition in relation to wastewater use in aquatic food production since from our studies they were consistently reported as the major health problem that farmers faced. Other health problems reported were back pain and fever but not in association with exposure to wastewater. Self-treatment was common when farmers had health problems. Univariate analysis was done to determine several essential factors influencing skin problems and results showed that exposure to wastewater and pesticides affected significantly the appearance of skin problems. However, using protective measures when working with wastewater or pesticides seemed not to be an effective protection from these skin problems. Involved in wet work and aquaculture also were seen associated factors with skin problems. Other information such as livelihoods; socio economic status would be taken into account in further analyses to combine with the current results. The results from the study are anticipated to be submitted to international peer-reviewed journals.

1.1. Introduction

The cultivation of fish and aquatic vegetables is widespread throughout many cities in Southeast (SE) Asia. It provides employment, income and food, particularly to low-income urban households (Leschen *et al*., 2005). In many cases wastewater from the city is utilised as a reliable source of water and nutrients for aquacultural and agricultural production. In Phnom Penh (PHP) it has been estimated that 20% of the total daily vegetable consumption of the city comes from three peri-urban wetlands that are fed by untreated wastewater (Muong, 2004).

Despite its importance, urban aquaculture remains by and large an unplanned activity, which has received very little attention in official statistics, planning and decision-making by local, national, and international organizations. Authorities are often reluctant to get involved because of the perceived human health risks associated with the consumption of produce from water that is mixed with sewage from the city. If enforcement of restrictive legislation or treatment of the wastewater before use is not an option, authorities often turn a blind eye to the practice.

To safeguard human health, WHO has developed a new set of guidelines for the safe use of domestic wastewater in aquaculture (WHO, 2006). These guidelines take a different approach to health protection compared to the previous edition (Mara and Cairncross, 1989). They define an acceptable and realistic level of public health protection, which can be achieved

through a combination of setting microbial water quality targets and implementing health protection measures. Certain health risks of wastewater-fed aquaculture have been well described, especially the risk for trematode infections to consumers of raw, or inadequately cooked fish or aquatic plants (WHO, 2006). Very few studies have assessed the occupational health risks to aquaculture farmers and their families of exposure to wastewater.

The WHO guidelines can help policy-makers and their advisors to develop national standards. In adopting wastewater use guidelines for national standards, policy-makers should consider what is feasible and appropriate in the context of their national situation. They should use a risk-benefit approach that carefully weighs the benefits to household food security, nutrition and local economic development against possible negative health impacts. Mitigating health risks while maximizing benefits requires holistic approaches that involve all stakeholders in a process to enhance knowledge sharing, promote realistic measures for hygiene and sanitation improvement, to generate income and to produce food for better livelihoods and sustained strengthening of (waste) water and sanitation services at household and community levels.

As part of the PAPUSSA research activities, it was decided to ask farmers and their family members involved in aqua- and agriculture for their health problems experienced during their work in wastewater and non-wastewater irrigated production systems. This was done to assess major health problems experienced and to obtain health-related information for the planning of in-depth health studies of farmers engaged in wastewater-fed aquaculture.

1.2. Methods

The present study was part of the EC-funded Production in Aquatic Peri-urban Systems (PAPUSSA) project in SE Asia carried out in parallel in Bangkok (BGK), Phnom Penh (PHP), Hanoi (HAN) and Ho Chi Minh City (HCM). The PAPUSSA project implemented a baseline and three monitoring questionnaire-based surveys in these cities from April 2004 to February 2005. Sampling procedures of households in the 4 cities are described in 4 separate survey reports by PAPUSSA partners that are available at www.papussa.org/publications.

Health related questions in the different surveys pertained to health conditions that were expected to have a possible relationship with wastewater exposure, such as diarrhoea and skin problems, and others that were not expected to have any relation with wastewater use such as back problems. Other issues covered included the use of protective measures when doing agricultural or aquacultural work, and medical treatment sought for health problems.

Well-trained project staff from partners in the 4 cities conducted the surveys and entered data into a computer database that had the same structure in each city. Data was double-checked before analysis. Microsoft Access version 2000 was used to store and manage information collected from these surveys and SPSS version 10 was used to analyse data and assess risk factors for health problems of people engaged in wastewater-fed agriculture and aquaculture in SE Asia.

1.3. Results

Baseline characteristics of the study population were shown at the individual level (Table 1) and at the household level (Table 2). The tables show that there were important differences between the 4 cities in educational level, socioeconomic status, and water supply and sanitation. This is of course not unexpected as the general level of development is quite different from one city to the other. Approximately 90% of households living in peri-urban aquatic food production areas in Phnom Penh (PHP) city had a low Social-Economic Status

(SES), followed by Ho Chi Minh City (HCMC) with 75% SES low level households. Rates of household ownership of toilet were found consistently high in Bangkok (BGK), HCMC and Hanoi (HAN) (98-99%). Only 39% of households in PHP owned a toilet whereas more than 90% of households in other cities had access to good quality water supply.

A low educational level of each household member was defined as people having gone to primary school only. As seen in Table 1, farmers in HAN and HCM peri-urban areas involved in aqua and agriculture had higher educational level than farmers in other cities.

Table 1 Age, sex distribution and educational level of the study population (data from the baseline survey).

	BGK (n=927)	**PHP (n=1232)**	**HCM (n=834)**	**HAN (n=1023)**	**Total 4 cities (n=4016)**
Average age (years)	33.6 ± 19.8	24.3 ± 15.7	31.5 ± 17.2	31.4 ± 18.98	29.8 ± 18.2
Females (%)	51	50	48	48	49
Low educational level (%)	61	73	39	16	48

Table 2 Characteristics of the study population at household level (data from the baseline survey).

	BGK n=192	**PHP n=200**	**HCM N=197**	**HAN N=209**	**Total 4 cities n=798/819**
Poor wealth ranking (%)	16.7	56.1	24.9	8.6	22.3
Low SES level (%)	15.3	89.4	75.4	23.1	47.8
Ownership of toilet (%)	99.5	39	98	98.1	84
Good domestic water supply (%)	44.2	89.8	17.3	41.6	47.6
Involved in fish culture (%)	6.3	25.5	7.6	2.9	10.3
Involved in aquatic plant culture (%)	3.7	41.5	17.8	1	15.5
Exposed to wastewater (%)	0	75.5	68	70.3	54.1

It turned out to be difficult to use a common definition for “aquaculture”. In Hanoi, many farmers used wastewater from the To Lich river to irrigate plants grown in fields along the river. Plants including morning glory, water cress, water mimosa and water dropwort are cultured in soil, not ponds, with wastewater pumped into the fields as a source of water and nutrients. Such production methods were common in Hanoi and explain why only 1% was reported to be involved in truly aquatic plant culture. In any case, farmers using this practice were involved in wet work and were exposed to wastewater.

Households in PHP had poor socioeconomic indicators but the highest coverage of good domestic water supply. This is because the communities benefited from a successful water supply scheme in PHP. However, sanitation coverage was very poor in PHP. In general the study household members had a high exposure to wastewater except in Bangkok where the farmers which we studied did not use any wastewater.

In the four cities, skin problems of the household members were reported by 4.1% of the heads of the households during the last month of the baseline survey. Other common health problems reported were backache and fever, and to a lesser extent respiratory problems and diarrhoea (Table 3). In the further analysis, only skin problems were considered with each study, individuals being categorized as having reported a skin problem, or not, during any of the 4 surveys.

Table 3 Health problems self-reported by the heads of households during the baseline survey. Figures are number of household members (%) whose health conditions were reported by the heads of the households

Major health problems	BGK		PHP		HCM		HAN		Total 4 cities	
	N=927	%	N=1232	%	N=834	%	N=1023	%	N=4016	%
Skin problems	35	3.8	80	6.5	18	2.2	35	3.4	168	**4.1**
Back problems	63	6.8	8	0.6	20	2.4	59	5.8	150	**3.7**
Fever	14	1.5	83	6.7	17	2	24	2.3	138	**3.4**
Respiratory problems	13	1.4	8	0.6	0	0	16	1.6	37	0.9
Diarrhoea	0	0	36	2.9	5	0.6	2	0.2	43	1
Eye infection	6	0.6	5	0.4	7	0.8	16	1.6	34	0.8

From the information provided by the heads of the households when asking them about where their family members got the health problems treated it can be seen that 30% treated themselves while 24% of respondents visited a community or village clinic (Table 4).

Table 4 Source/location of treatment when having health problems (data from baseline survey)

Health respond	BKK (n=166)	PP (n=237)	HCM (n=75)	HN (n=196)	4 cities (n=674)
Self treatment	**30 (18.1)**	**55 (23.2)**	**34 (45.3)**	**86 (43.9)**	**205 (30.4)**
Visit a traditional healer	5 (3)	4 (1.7)	5 (6.7)	6 (3.1)	20 (3)
Consult a GOV doctor in the city	58 (34.9)	6 (2.5)	7 (9.3)	4 (2)	75 (11.1)
Consult a private doctor	4 (2.4)	51 (21.5)	9 (12)	20 (10.2)	84 (12.5)
Confined in a hospital	22 (13.3)	12 (5.1)	0	31 (15.8)	65 (9.6)
Visit community/village clinic	**37 (22.3)**	**102 (43)**	**6 (8)**	**19 (9.7)**	**164 (24.3)**
Recover without doing anything	10 (6)	1 (0.4)	14 (18.7)	27 (13.8)	52 (7.7)
NGO health clinic or facility	0	5 (2.1)	0	2 (1)	7 (1)
Don't know	0	0	0	1 (0.5)	1 (0.1)
Not applicable	0	1 (0.4)	0	0	1 (0.1)

(): percent shown in blanket

Univariate risk analysis showed that exposure to wastewater while working in agriculture and aquaculture was a risk factor for skin problems (crude Odds Ratio (OR): 1.8; 95% Confidence Interval (CI): 1.3-2.6) during the baseline survey. Surprisingly, using protective measures while working with wastewater in agriculture and aquaculture did not protect against skin problems (crude OR: 15.5; 95% CI: 8.6-28.4).

In the 1st monitoring survey, pesticide application for aquatic production also seemed to be a risk factor (crude OR: 222.3; 95% CI: 33.5-4313.6) for skin problems but surprisingly using protection while spraying pesticide did not protect against skin problems (crude OR: 73.3; 95% CI: 23.3-291.3). It could be that current protective measures were not appropriate and effective to protect farmers from contact with pesticides. However, further in-depth analysis as well as further studies should be done to determine the magnitude of risks for skin problems caused by these and other factors. Multivariate analysis needs to be done in the further analyses to account for confounding by the different variables that might play a role in the relation between protective measure use and skin problems.

Table 5 Univariate analysis of potential risk factors for skin problems

Potential risk factors	Total N=4016	Skin problems n (%)		Univariate analysis (Odds ratios)	95% CI
		Yes	No		
Working with ww (baseline data)					
Yes	866	245 (28)	621 (72)	**1.8**	**1.3-2.6**
No (ref)	289	52 (18)	237 (82)	1	
Using protective measures while working with ww (1st monitoring data)					
Yes	335	104 (31)	231 (69)	**15.5**	**8.6-28.4**
No (ref)	531	15 (2.8)	516 (97.2)	1	
Pesticide use for aquatic production (1st monitoring data)					
Yes	377	118 (31)	259 (69)	**222.3**	**33.5-4313.6**
No (ref)	489	1 (0.2)	488 (99.8)	1	
Use of protective means while spraying pesticides (1st monitoring data)					
Yes	374	116 (31)	258 (69)	**73.3**	**22.3-291.3**
No (ref)	492	3 (0.6)	489 (99.4)	1	
Gender (baseline data)					
Male	2048	98 (4.8)	1950 (95.2)	1.4	1.0-1.92
Female (ref)	1968	69 (3.5)	1899 (96.5)	1	
Age of HH members (baseline data)					
≤ 15 yrs old (ref)	976	9 (0.9)	967 (99.1)	1	
> 15 yrs old	3040	283 (9.3)	2757 (90.7)	**11.03**	**5.5-23.0**
Involved in aquaculture[1] (baseline data)					
Yes	240	82 (34.2)	58 (65.8)	**32.8**	**18.6-58.2**
No (ref)	556	23 (4)	533 (96)	1	
Involved in wet work[1] (baseline data)					
Yes	245	85 (35)	160 (65)	**14.2**	**8.2-24.7**
No (ref)	554	20 (3.6)	534 (96.4)	1	

ref: reference level

1.4. Discussion

The present study shows that skin disease is a common problem among households involved in peri-urban agriculture and aquaculture. The study also suggests that exposure to wastewater is an independent risk factor for skin disease.

Skin disease seems to be an important health problem that people themselves associate with working in water that contains pollutants. The authors have noticed this at other locations in Asia, including cities in Vietnam, India, and Pakistan (unpublished information).

Because of a lack of previous studies on this subject it is not possible to put our results in the context of an existing knowledge base. However, several studies have been done among sewage treatment plant workers and farmers in Europe, North America, and developing countries. Study subjects consistently mentioned skin irritation as a major health problem that they perceived as being related to wastewater exposure. Studies in France, Spain, the UK, the Netherlands, Canada, and the USA have noted an increased occurrence of "itchy skin", "skin rash", or "skin irritation" (see for example Douwes et al. 2000). But in all cases the description was rather non-specific and the cause of the perceived skin problems remained obscure. It was hypothesized that the skin problems would be related to allergic and non-allergic reactions to chemicals in the water, maybe also involving interactions of chemicals with pathogens.

[1] Only data about heads of households' current works was collected

Obviously, the population and environment in the four cities differed in other aspects than just the variables captured in the present study. Although the same questionnaire was used throughout, after an elaborate training program, each city had its own team of research assistants and some form of interviewer bias cannot be excluded. Although the study had four rounds of questionnaires over a considerable time period, it could still be seen as a series of cross-sectional surveys, in which exposure and outcome were assessed simultaneously among the individuals in the study population. This poses obvious limitations to drawing causal inference from the results.

In future studies, specific exposures should be linked to specific outcomes. There can be many substances in the water, biological and chemical, that could cause skin problems. Long lasting skin diseases could be caused by chemicals in the wastewater that have a local action on the skin, especially of hands and feet. This can lead to contact dermatitis (eczema), with clearly demarcated areas of rash at sites of exposure. One group of chemicals is irritants that directly damage the skin such as certain heavy metals (chromium, cadmium, arsenic), industrial solvents, detergents, and even water itself. The other group is sensitizers (certain metals such as nickel, dyes, oils, plant materials) that can produce allergic reactions.

It is too early to use the information from the present study for planners and decision makers. We don't know whether it is the water itself ('wet work'), certain substances in wastewater, or other factors that cause skin problems. Also we have no information at present about the public health importance (such as treatment costs, human suffering, the development of chronic related conditions) of the skin problems that households in peri-urban aquaculture production areas report. However, it seems obvious that the problem deserves more attention and well-designed epidemiological studies.

1.5. Conclusions

We conclude that a substantial number of families involved in peri-urban aquaculture in Southeast Asia report skin problems. We formulate the hypothesis that exposure to wastewater is a risk factor for skin disease, especially dermatitis (eczema) of the hands and legs. This hypothesis would have to be tested in future analytic studies. Such studies should also attempt to relate specific biological and chemical factors to specific skin conditions. The present study did not point to self-reported health problems, other than skin disease, as being important in the context of peri-urban aquacultural production systems.

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1.7. References

Douwes J., 't Mannetje A., Heederik D. (2000). Work-related symptoms in sewage treatment workers. Ann Agric Environ Med, 8: 39-45.

Feachem R. G., Bradley D. J., Garelick H., and Mara D. D. (1993). Sanitation and Disease: Health Aspect of Excreta and Wastewater Management. John Wiley, Chichester.

Leschen W., Little D., Bunting S. (2005). Urban Aquatic Production. Urban Agriculture Magazine (14): 1-7, Available at www.ruaf.org

Mara D., Cairncross S. (1989). *Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture*. World Health Organization, Geneva.

Muong S. (2004). Avoiding Adverse Health Impacts from Contaminated Vegetables: Options for Three Wetlands in Phnom Penh, Cambodia. Unpublished report.

van der Hoek W., Tuan Anh V., Cam D. P., Vicheth C. and Dalsgaard A. (2005). Skin Diseases Among People Using Urban Wastewater in Phnom Penh. Urban Agriculture Magazine (14): 30-31, Available at www.ruaf.org

WHO (2006). Guidelines for the Safe Use of Wastewater, Excreta and Greywater. Volume 3: Wastewater and Excreta use in Aquaculture. World Health Organization, Geneva

2. Skin diseases among people using wastewater for agriculture and aquaculture in Phnom Penh and Hanoi

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Abstract
As part of the health component of the PAPUSSA project and based on the findings in the baseline and monitoring studies, three questionnaire based surveys were done in Phnom Penh and Hanoi to estimate the prevalence of skin disease in peri-urban farming communities. In the populations studied, the prevalence of skin disease was much higher among people using wastewater in agriculture or aquaculture than among people not exposed to wastewater. Many farmers in Hanoi used protective measures such as gloves and boots but apparently this could not prevent skin disease. The most common diagnosis by dermatologists was contact dermatitis (eczema) of hand and feet and fungal infection of the nails. Further analysis of available data will assess to what extent wastewater exposure is a risk factor for skin disease, relative to other potential risk factors such as poor hygiene, exposure to water in general (wet work), and exposure to other skin irritants such as pesticides.

2.1. Background and introduction

In many developed and developing countries wastewater is used for irrigation in agriculture and for supplying aquaculture ponds. In this way, nutrients in the wastewater are used for growing plants and fish. Wastewater is an alternative source of water in places where water is scarce.

However, wastewater can contain disease-causing micro-organisms, heavy metals, organic compounds and other compounds that can have a negative impact on human health. While certain health risks, like risks for helminth parasite infections, have been well described, there are other potential health risks for which only anecdotal information is available. Health problems often reported by farmers engaged in wastewater use are skin ailments and skin irritation. The literature however gives very little scientific information on the possible association between wastewater and skin diseases. It was therefore decided that a major focus of the in-depth health research in PAPUSSA should address and assess the risks for skin problems among farmers engaged in wastewater-fed aquaculture.

2.2. Objectives

Specific objectives

i. Estimate the prevalence of skin diseases among people in peri-urban Hanoi and Phnom Penh involved in agricultural and aquacultural work
ii. Determine whether wastewater exposure is associated with skin diseases

2.3. Methodology

2.3.1. Hypothesis

People engaged in wastewater fed aquaculture in peri-urban areas of Hanoi and Phnom Penh have an increased risk for skin problems.

2.3.2. Study setting

2.3.2.1. Phnom Penh, Cambodia

Boeng Cheung Ek lake located to the west of Phnom Penh city, receives untreated wastewater from Phnom Penh residential areas and from industrial estates (garment and other factories) and rain-water run-off. Many households living around the wastewater lake earn their living by cultivating aquatic vegetables of which water spinach is the main type.

Two non-wastewater exposed sites were selected. Boeng Samrong (Prek Phnov) is a big lake located 15 kms from the centre of Phnom Penh. The second control site was a 1 ha fish pond (located in Phum 4 village, Reseykeo district approx. 4 kms from Prek Phnov lake). This pond received rain water during the rainy season. However, in the dry season, water was often pumped from O Veng canal (300 meters far from the fish pond) by farmers into the fish pond due to lack of rain.

2.3.2.2. Hanoi, Vietnam

Hoang Liet commune is an area along the To Lich River, which receives untreated wastewater from Hanoi. The water from the To Lich River is pumped and used for irrigation by farmers living in Hoang Liet on fields which are located along this river. Observations from field visits of the research team showed that farmers mostly seemed to do their work in the field without wearing boots or gloves. During the field visits farmers exposed to wastewater reported skin irritations and itching on parts of the skin that were in contact with wastewater (mainly feet and hands).

The non-wastewater exposed site in Hanoi was Long Bien commune, Long Bien district, where farmers have comparable cultivation practices including vegetable growing, but without use of wastewater for irrigation. The irrigation water source is river water.

2.3.3. Study design

Cross - sectional studies were carried out in both cities. In Phnom Penh, 3 studies were done in July 2004, and January and May 2005. A total of 200 households that were already selected for the PAPUSSA baseline and monitoring surveys were included in the study, 154 households were located in the wastewater exposed area and 46 households in the non-wastewater exposed area. In Hanoi, the cross-sectional surveys were conducted in May, September and December 2005. In Hanoi, the initial study population also consisted of 200 households (100 households at each site). However, in Hanoi the interviews were restricted to only those individuals that were actually involved in farm work in the field. Household members not engaged in agriculture or aquaculture were therefore excluded.

A questionnaire was developed to obtain information on self-reported skin problems (Annex 1). The questionnaire was based upon the standardized Nordic Occupational Skin Questionnaire (NOSQ-2002), which is intended for surveys on work-related skin disease and exposures to environmental factors (Susitaival et al. 2003). The questionnaire was adapted to the local context of Hanoi and Phnom Penh with the inputs of dermatologists from local clinics. People who reported having a skin problem at the time of a household interview were referred to a dermatologist for examination and free treatment. Details of the skin diseases were entered on a survey form by the dermatologists (Annex 1).

2.3.4. Research team and supervision

Epidemiologists and dermatologists from NIHE, IWMI, KVL, and local departments of dermatology participated in the questionnaire design. Local teams from the Royal University of Agriculture in Phnom Penh, and the National Institute of Hygiene and Epidemiology in Hanoi carried out household interviews. To ensure the quality of the information collected, the field team in Phnom Penh was trained by medical professionals / dermatologists whereas the field team in Hanoi consisted of medical doctors or other with a medical background.

2.3.5. Research tools

The questionnaire and examination form are shown as Annex 1. Photos of common skin diseases were taken by dermatologists / medical professionals during physical examinations, if permission was given by the patient.

2.3.6. Results

2.3.6.1. Phnom Penh

Prevalence of skin disease was 19% at the first survey (n=705), 12% at the second survey (n=726), and 15% at the third survey (n=750).

Clearly, the prevalence of skin problems was much higher among the people exposed to wastewater than among those not exposed to wastewater (Table 1).

Table 1 Exposure to wastewater and skin problems in 3 surveys in Phnom Penh

Exposed to wastewater	**Skin problem**				
Survey 1	Yes	No	Total	χ^2	*p-value*
Yes	132	474	606		
No	3	96	99	19.3	<0.001
Survey 2					
Yes	89	543	632		
No	2	92	94	10.7	0.001
Survey 3					
Yes	108	539	647		
No	2	101	103	15.4	<0.001

Skin problems were mostly located on feet, legs and hands (Table 2).

Table 2 Location of last skin problems (during 3 months prior the interviews) self-reported by farmers

	Location of skin problems				
Survey number	**Foot**	**Leg**	**Hand**	**Forearm**	**Total**
2	280 (80%)	311 (89%)	280 (80%)	299 (85%)	350 (100%)
3	425 (92%)	381 (82%)	422 (91%)	311 (67%)	464 (100%)

The people actually involved in farming were asked about the use of protective measures while working in the fields in contact with wastewater. Few farmers used any protection (Table 3) and if used, it was mostly gloves (Table 4).

Table 3 Frequency of protective measure usage as self-reported by farmers

Survey number	Using protective measures during work			
	No protection	Always	Sometimes	Total
2	290 (83%)	11 (3%)	49 (14%)	350 (100%)
3	437 (94%)	25 (5%)	2 (1%)	464 (100%)

Table 4 Kind of protective measures applied when working in the field

Survey number	Kinds of protective measures during working				
	Boots	Shoes	Gloves	Others	Total
2	4 (6.7%)	5 (8.3%)	51 (85%)	0	60 (100%)
3	4 (15%)	0	23 (85%)	0	27 (100%)

Those who were having a skin problem at the time of interview were referred to a dermatologist for physical examination and treatment. At the first diagnosis and treatment round in July 2004 a total of 77 patients were examined by the dermatologists. This showed that contact dermatitis (74%) was the most common skin disease followed by superficial fungal infection (18%) and urticaria (9%). Skin diseases were located on the hands (56%), feet (36%) and legs (34%). Major symptoms included itching (86%), dry skin with scaling or flaking (53%) and papules (51%).

Picture 1. Farmer with fungal skin infection of the foot.

2.3.6.2. Hanoi

2.3.6.2.1. 3-month period prevalence of skin problems

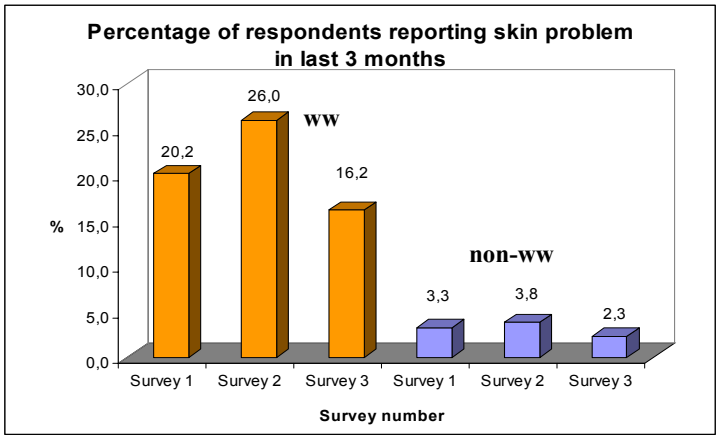
In Hanoi, the questionnaire primarily focused on skin problems that people had experienced in the 3 months before each survey. There was a remarkable difference in period prevalence between the wastewater exposed and non-wastewater exposed individuals (Table 5 and Figure 1).

Table 5 Percentages of skin problems self-reported by farmers during the last 3 months prior the studies were carried out

Survey number	Hoang Liet (wastewater)		Long Bien (non-wastewater)	
	Skin problems	Total	Skin problems	Total
1 (May 2005)	24 (20.2%)	119 (100%)	4 (3.3%)	123 (100%)

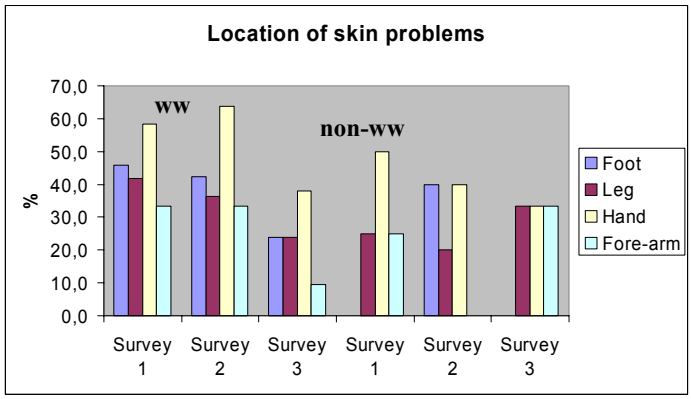
Survey number	Hoang Liet (wastewater)		Long Bien (non-wastewater)	
	Skin problems	Total	Skin problems	Total
2 (Sept 2005)	33 (26%)	127 (100%)	5 (3.8%)	130 (100%)
3 (Dec 2005)	21 /16.2%)	130 (100%)	3 (2.3%)	129 (100%)

Figure 1 Percentages of skin problems self-reported by farmers during the last 3 months prior the studies were carried out



Skin problems mainly affected hands, feet and legs (Figure 2). Fungal infections of fingers and toenails are not included in this figure.

Figure 2 Location of skin problems



2.3.6.2.2. Skin problems registered at the time of interviews

Prevalence of skin problems at the times of the interviews were 20% (n=242), 13% (n=257), and 8% (n=259) for the 1st, 2nd, and 3rd survey, respectively. Of interest is that the majority of farmers in the study locations in Hanoi were women (Table 5).

Table 5. Characteristics of study population in Hanoi

Survey number	Average age	Sex		Total
		Male	Female	
1 (May 2005)	45.8 ± 9.7	52 (21.5%)	190 (78.5%)	242 (100%)

2 (Sept 2005)	46 ± 9.7	64 (24.9%)	193 (75.1%)	257 (100%)
3 (Dec 2005)	46 ± 9.9	64 (24.7%)	195 (75.3%)	259 (100%)

Exposure to ww was associated with appearance of skin problems in surveys 1 and 2, but not in survey 3 (Table 6).

Table 6 Exposure to wastewater and skin problems in 3 surveys in Hanoi

Exposed to wastewater	**Skin problem**			χ^2	*p-value*
Survey 1	**Yes**	**No**	**Total**		
Yes	41	76	117	31.96	< 0.001
No	7	115	122		
Survey 2					
Yes	27	94	121	12.6	<0.001
No	7	108	115		
Survey 3					
Yes	21	163	184	3.6	0.057
No	1	45	46		

While working in the field, feet and hands of the farmers were the main body parts in contact with wastewater (Table 7). Rubber boots and cloth gloves were common protective measures that farmers used during work (tables 8.1 and 8.2). In fact, the majority of farmers in Hanoi used protective measures always or sometimes (Table 9).

Picture 2. A farmer with dermatitis of the hand.

Table 7 Body parts in contact with wastewater as reported by farmers

Survey number	**Locations of farmers' body in contact with wastewater**				**Total**
	Feet	**Legs**	**Hands**	**Forearm**	
1 (May 2005)	104 (43%)	72 (30%)	116 (48%)	14 (5.8%)	242 (100%)
2 (Sept 2005)	107 (42%)	26 (10%)	120 (47%)	25 (9.7%)	257 (100%)
3 (Dec 2005)	127 (49%)	63 (24%)	183 (71%)	33 (12.7%)	259 (100%)

Table 8.1 Kind of protective measures

Survey number	**Boots**	**Shoes**	**Gloves**	**Total**
1 (May 2005)	202 (84%)	1 (0.4%)	139 (57%)	242 (100%)
2 (Sept 2005)	170 (66%)	1 (0.4%)	97 (38%))	257 (100%)
3 (Dec 2005)	209 (81%)	0	124 (48%)	259 (100%)

Table 8.2 Kind of protective measures

Kind and materials of protective measures (data from survey 3 only)	
Cloth gloves (only)	3 (1%)
Cloth gloves and rubber boots	101 (39%)
Cloth masks, gloves and rubber boots	15 (6%)
No reported	52(20%)
Rubber boots (only)	88 (34%)
Total	259 (100%)

Table 9 The frequency of using protective measures

Survey number	**No**	**Yes**		**Total**
	No protection	Always	Sometimes	
1 (May 2005)	23 (10%)	141(58%)	78 (32%)	242 (100%)
2 (Sept 2005)	80 (31%)	127 (49%)	50 (20%)	257 (100%)
3 (Dec 2005)	47 (18%)	157 (61%)	55 (21%)	259 (100%)

2.3.6.2.3. Skin and nail diseases diagnosed by dermatologists

Contact dermatitis (eczema) was the most common skin disease diagnosed with the prevalence of fungal infection of nails also being very high (Table 10).

Table 10 Diagnoses by dermatologists among farmers reporting skin and nail problems in Hanoi

Survey number	**Contact dermatitis**	**Atopic dermatitis**	**Urticaria**	**Fungal infection of toenail or fingernail**	**Others**	**Total**
1 (May 2005)	7 (14.9%)	0	1 (2%)	37 (78.7%)	3 (6%)	47 (100%)
2 (Sept 2005)	15 (22%)	1 (1.5%)	2 (3%)	50 (73.5%)	0	68 (100%)
3 (Dec 2005)	4 (9.1%)	1 (2.3%)	1 (2.3%)	33 (75%)	5 (11.4%)	44 (100%)

2.4. Conclusion

This study found a much higher prevalence of skin disease among people using wastewater in agriculture or aquaculture compared to people not exposed to wastewater. The most common diagnosis by dermatologists was contact dermatitis (eczema) of hands and feet and this suggests that skin irritants present in the wastewater, either biological or chemical, are associated with the problems observed. However, a proper risk factor analysis will be needed to account for other possible factors such as exposure to pesticides and poor hygiene practices. The use of protective measures against wastewater exposure was much greater in Hanoi than in Pnom Penh. Nevertheless, prevalence of skin disease in Hanoi was high and apparently the protective measures were not effective in preventing skin disease. Further data and analyses and possible future investigations are needed to elucidate why current applied protective measures are apparently not reducing the risks for skin problems.

One group of chemicals that could play a role in contact dermatitis are irritants that directly damage the skin such as certain heavy metals (chromium, cadmium, arsenic), industrial

solvents, and detergents. However, even water itself has been identified as a skin irritant in previous studies. The other group of chemicals is sensitizers (certain metals such as nickel, dyes, oils, plant materials) that can produce allergic reactions. The skin diseases due to these substances are generally described as “contact irritant dermatitis” and “contact allergic dermatitis”. However, it is difficult to distinguish between contact irritant dermatitis and contact allergic dermatitis without specific (patch) tests. As no facilities for patch testing were available, no distinction could be made by the dermatologists between contact irritant dermatitis and contact allergic dermatitis.

2.5. Acknowledgements

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2.6. References

Susitaival P, Flyvholm MA, Meding B, Kanerva L, Lindberg M, Svensson A, Olafsson JH (2003). Nordic Occupational Skin Questionnaire (NOSQ-2002): a new tool for surveying occupational skin diseases and exposure. *Contact Dermatitis*, 49:70-76.

Annex 1 Examination form and Questionnaire (see the file in excel format)

(HH_CD) Household code: _____
(as same as with the one used in the referred card)

SKIN DISEASE - DIAGNOSIS

(only used for doctors/dermatologists)

(D2) Date of examination: _____/_____/_____

(DerName)Name of doctor: _____

(A2) Patient's name: _____

(A1) Personal code: _____(must be as same as with the one used in the referred card)

(A4) Sex: 1. Male 2. Female

(A3) Date of birth: _____ (age: _____)

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1. (H1) How long ago did the skin problem start?
   _____day *if possible, specify the date of onset of the skin problems* ___/___/_____
   _____ week
   _____ month
   _____ year

2. (H2) Has your skin been in contact with something that caused rash?
   1 yes, (H2a) specify:_____
   0 no

3. (H3) Have you ever been suffered from:

(H3a) Allergic rhinitis/Nasal allergy	1. yes	0. no	9. don't know
(H3b) Allergic sinusitis	1. yes	0. no	9. don't know
(H3c) Asthma	1. yes	0. no	9. don't know
(H3d) Uticaria	1. yes	0. no	9. don't know
(H3e) Atopic dermatitis	1. yes	0. no	9. don't know
(H3f) Drug allergy	1. yes	0. no	9. don't know
(H3g) Other allergy:			

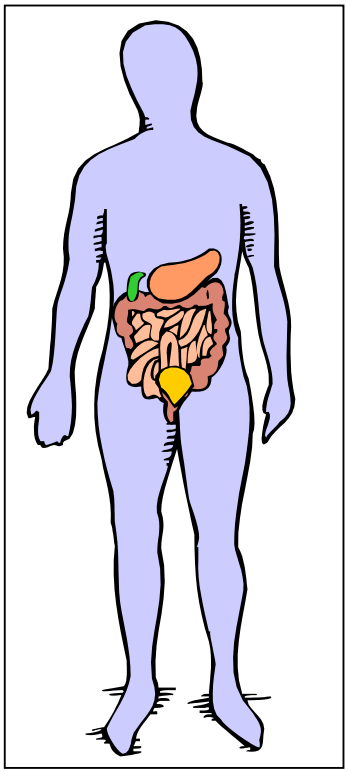
4. (H4) What symptoms did you have with your current skin disorder (tick-off on the answers)

	Yes(1)	No (0)	Don't know (9)
1. (H4a) Redness	☐	☐	☐
2. (H4h) Itching	☐	☐	☐
3. (H4i) Burning, prickling or stinging	☐	☐	☐
4. (H4l) Aching or pain	☐	☐	☐
5. (H4k)Tenderness	☐	☐	☐
6. (H4e) Tiny water blisters (vesicles)	☐	☐	☐
7. (H4f) Papules	☐	☐	☐
8. (H4n) Pustules	☐	☐	☐
9. (H4b) Dry skin with scaling/flaking	☐	☐	☐

10. (H4o) Hyperpigmentation ☐ ☐ ☐
11. (H4c) Fissures/cracks ☐ ☐ ☐
12. (H4p) Ulcers and moist ☐ ☐ ☐
13. (H4d) Weeping/crusts ☐ ☐ ☐
14. (H4g) Rapidly appearing itchy wheals/welts (urticaria) ☐ ☐ ☐
15. (H4q) Fingernails and toenails are eroded with loss of the nail plate ☐ ☐ ☐
16. (H4r) Fingernails and toenails are thickened and their colour become discoloured ☐ ☐ ☐
17. (H4m)Other symptoms: _____

5. (H5) Diagnosis (cycle on the final diagnosis):

1. (H5a) Contact dermatitis/eczema
2. (H5b) Atopic dermatitis
3. (H5c) Urticaria
4. (H5d) Superficial fungal infection
5. (H5e) Bacterial skin infection
6. (H5f) Parasitic skin infection
7. (H5g) Viral skin infection
8. (H5h) Skin ulcer
9. (H5i) Cuts
10. (H5k) Itching: cause unknown
11. (H5l) Fungal infection of toenail or fingernail
12. (H5m) Other nail disorders (specify): _____
13. (H5n) Other skin conditions not mentioned above: _____
14. (H5p) Irritated dermatitis
15. (H5q) Cutaneous candidiasis (intertrigo)
16. (H5r) Superficial skin infection



6. (H6) Localization (draw in the picture)

1. (H6a) Head
2. (H6b) Trunk
3. (H6c) Arms
4. (H6d) Hands
5. (H6e) Legs
6. (H6f) Feet
7. (H6g) Whole body

7. (H7) Treatment

Does the patient need to be treated (cycle on the answer)? 1. Yes 0. No

(H7a) If yes, specify: _____