

OVERVIEW OF PROJECT ON WASTEWATER REUSE IN AGRICULTURE IN VIETNAM : WATER MANAGEMENT, ENVIRONMENT, AND HUMAN HEALTH ASPECTS

Liqa Raschid-Sally¹

DEVELOPMENT OBJECTIVE:

To optimize and sustain the overall benefits of wastewater irrigation in peri-urban areas in Vietnam, including reduction of health and environmental risks.

PROJECT PARTNERS:

- KVL : Royal Veterinary and Agricultural University, Denmark, (Dr Anders Dalsgaard and Dr Jens Raunso Jensen)
- DHI : Danish Hydraulic Institute – Water & Environment, Denmark, (Dr Anders Refsgaard in Denmark and Dr Leif Basberg in Vietnam)
- VIWRR : Vietnam Institute for Water Resources Research, Vietnam, (Dr Doan Tuan, Center for Participatory Irrigation Management)
- NIHE : National Institute of Hygiene and Epidemiology, Vietnam, (Dr Phung Dac Cam)
- NISF : National Institute of Soils and Fertiliser, Vietnam, (Dr NC Vinh)

With assistance for some analytical work from:

- NDCPM : Nam Dinh Center for Preventive Medicine, Vietnam (Dr Tran Van Quang)
- CEETIA: Centre for Environmental Engineering of Towns and Industrial Areas, Hanoi, (Dr Viet Anh)

PROJECT PERIOD:

November 2000 to March 2006

SPECIFIC OBJECTIVES:

- To improve the understanding of wastewater irrigation in the context of integrated water resources management.
- To evaluate the health and environmental risks associated with wastewater irrigation and quantification of their impacts.
- To develop rapid assessment tools and methodologies to quantify risks and benefits, enabling users and decision-makers to evaluate tradeoffs in different situations.
- To evaluate cost-effective technologies, support systems and management methods, to reduce tradeoffs between irrigation performance and health and environmental risks, and
- To assess multi-institutional, user-inclusive mechanisms for the adoption of the recommended range of options.
- To enhance the capacity of Vietnamese institutions and the other collaborating institutions to assess the costs and benefits of wastewater reuse in agriculture.
- To provide scientific support to the DANIDA Sector Program Support for the water sector in the field of reuse of wastewater.

¹ Project Leader, International Water Management Institute, Accra, Ghana. Lraschid@cgiar.org

DESCRIPTION:

Vietnam is an agricultural nation where, human excreta and wastewater have been used very effectively for centuries for agricultural purposes and for aquaculture. The well known VAC system typifies this, where complete recycling of nutrients takes place and all forms of waste are put to productive use. The overhung latrine in many rural households, directly over the fishpond is still quite common. Fish thrive on this nutrient source. An alternative is the single or double vault latrine where the fecal matter is collected through an opening at the back of the pit or vault and is carried to the fields in buckets for spreading. These practices are still extensive in rural and peri-urban communes where agriculture is the main source of livelihood.

With growing urbanization and higher usage of water, waste disposal practices in urban areas changed. Instead of feces/household waste/wastewater being a resource to be utilized in the fields, they now pose disposal problems. Septic tanks and open sewer lines in Vietnamese cities are causing widespread pollution of water bodies which were the source of irrigation water for urban and peri-urban farming communities. Many cities in Vietnam specially those in river deltas are also prone to flooding due to high rainfall (1689 mm with over 80% of it occurring between May and October); and there are complex systems of stabilizations ponds and drainage canals to protect them. All these water infrastructures are polluted with urban wastewater, and this same water still serves agriculture and aquaculture. From a health perspective wastewater related disease and particularly those associated with using polluted water for agriculture needed investigation.

The project undertook a first phase of study, to understand the extents, nature, and driving forces of wastewater agriculture and the background health risks from waterborne parasitic infections in Vietnam. It comprised

- a survey of 60 cities to understand wastewater irrigation practices and the extents of direct use of wastewater (with little or no dilution) in agriculture particularly rice cultivation
- a survey of health literature to review existing data and published literature in Vietnam on three important groups of parasites whose infection may be associated with the reuse of wastewater: Intestinal helminthes, foodborne Trematodes, and Cysticercosis.

Findings from Phase 1:

Survey of wastewater irrigation practices

- 93 % of the cities sampled use wastewater for agriculture or aquaculture or both.
- The predominant wastewater crop in Vietnam is Paddy in the spring and summer seasons (76 and 85% respectively),
- Wastewater irrigated areas (direct use with untreated sewage or very polluted water) vary from about 0.5% to 5% (average 1.56%) of the total agricultural land in the cities; with 70% of the cities falling into the range of 1-2% .
- Extrapolation of these findings to the national level gives a range of 6000 to 9500 hectares as a national figure for wastewater irrigated agriculture.

Helminth review

- From prevalence estimates in 29 provinces it was estimated that 33.9 million people in Vietnam are infected with ascaris (prevalence 44.4%), trichuris (prevalence 23.1%) and 21.8 million with hookworm (prevalence 28.6 %).

- Prevalence for ascaris and trichuris showed a declining trend from north to south of the country, probably related to climatic conditions. Hookworm is more uniformly distributed but is concentrated in peri-urban and rural areas.
- Vegetable cultivation in which nightsoil is used as fertilizer is a risk factor for hookworm infection especially among adult women.
- Helminth control programs should be targeted at school-children in the northern provinces. Specific interventions are needed throughout the country for women of agricultural communities.
- There is clearly a need for more detailed analysis of risk factors to quantify the relative contributions of factors of climatic, environmental and human behavioral factors in the transmission of intestinal nematode infections in Vietnam.

Trematode review

Serious trematode zoonoses as clonorchiasis, opisthorchiasis, paragonimiasis, and fascioliasis, are common in many regions in Vietnam, and in the case of the latter two, are increasing.

Liver flukes – *Clonorchis and Opistorchis*

- Prevalence data for the first two suggest a geographical separation between *C.sinensis* and *O.viverrini* transmission with the former in the north and the latter in the south. The highest prevalence for *C.sinensis* was 26% in Nam Dinh Province and for *O.viverrini* was 36.9% in Phu Yen. *C.sinensis* was relatively higher in middle-aged males.
- *C.sinensis* prevalence was related to fish consumption. Studies show that 7 species of fish and 4 species of snail were found to harbor the parasite. Cats and dogs were also found to be infected.
- Endemic presence of *C.sinensis* is associated with the urban/coastal coastal/red river delta habitats. The explanation may lie in the consumption of fashionable raw meats by urban populations

Lung flukes – *Paragonimus heterotremus*

- The infection rates in people ranged from 0.2% (in Son La) to 11.3% (in Hoa Binh). Data on age distribution of infection showed that younger persons are more at risk, but there was no relation with sex.
- Crab infection rates in the 8 endemic provinces was very high. Consumption of crab was associated with the infection. Eating of dog meat was also surmised as playing an important role in human infection since the percentage of infected dogs was relatively high

Fasciolopsis buski

- This is widely reported in Vietnam but the point prevalence of persons infected are relatively low.
- Water spinach consumption is surmised to be associated with the infection but data is not conclusive. Pig surveys showed high prevalence of infection and may also be a path of contamination.
- A survey in northern Vietnam showed a prevalence of 11.9% but recent surveys suggest that the occurrence of this trematode may have decreased over the past several decades.

Cysticercosis review

- Hospital surveys indicate that cysticercosis is emerging as a serious health problem in the country though most of the information comes from the Hanoi area.
- More men than women are being treated for cysticercosis with most patients being young to middle-aged adults though several juvenile cases have been seen in the south
- Surveys for human taeniasis in central and northern provinces indicate a prevalence of 0.2-7.2%
- Risk factors investigated thus far suggest that consumption of raw pork, inadequate or absent meat inspection and control, poor sanitation and the use of untreated human waste as fertilizer may play important roles in Vietnam.
- The evidence thus far collected suggests that a national surveillance program for cysticercosis is a great need for Vietnam.

Phase 2: It was seen conclusively that more detailed study at field level of a rice irrigation system using wastewater, including the sources of contamination (industrial and other) in the wastewater generating catchment, and the institutional environment within which wastewater agriculture occurs, was necessary to understand (waste)water and nutrient usage and the associated socio-economic and health impacts. Accordingly, the site selected was a rice irrigation system just outside the boundaries of Nam Dinh city, to the south of Hanoi.

The overall objective of the field studies would be to assess the assimilation capacity (treatment potential) of rice based irrigation systems with (untreated) wastewater application, and the impacts on crops, soil and human health.

To achieve this objective 7 studies were conducted covering the different aspects described below.

An agronomic study: The objective was to describe and analyse the agronomic dimensions of a wastewater irrigated rice production system emphasising on biomass production and nutrient utilization and balances for assessment of nutrient management strategies and wastewater assimilation capacity.

Irrigation delivery and water balance study: The objective was to estimate the irrigation deliveries and the water balance under field conditions, as an element of assessing nutrient and pollutant loading rates in wastewater irrigated rice lands

Helminth and skin infection studies: The objective was to assess the risk of helminth and skin infections associated with wastewater-fed rice cultivation

Farming practices and their socio-economic impacts study: The objective was to understand wastewater farming practices in rice cultivation systems and their socio-economic, through an in-depth quantitative and qualitative survey of farmer households

Application of hydrological modelling tools: The main focus was to establish a field monitoring program and evaluate the results using hydrological modeling tools. The hydrological modeling tools were then used to establish a water balance and a nutrient balance for the Nam Dinh project area.

Health risk perception and behavior study: the objective was to understand health risk awareness in farming communities using waste(water) and human excreta in agricultural production

Heavy metal contamination and assimilation study: The objective was to assess the assimilation of Cadmium and other heavy metals (treatment potential) of rice based irrigation systems with (untreated) wastewater application, and potential impacts on crops, soil and human health.

In addition, to better understand the study site a rapid assessment of the sources of contamination within the wastewater generating catchment and a study of water management in the irrigation system, were conducted. The institutional environment and legislation governing irrigation and agricultural use of wastewater use were also studied.

Description of study site and sample of farming households.

The field site comprised heavy textured alluvial soils. The climate is sub-tropical with a main rainy season from May to October. The main crop is wetland rice with a substantial Spring Crop (Feb-Jun) and a smaller Summer Crop (Jul-Oct)

The 3 sub-scheme areas investigated (Fig. 1) are described below:

WW1 is part of Hong Long cooperative served by the Quan Chuot pumping station delivering raw municipal wastewater. The field investigations were conducted in a 20~25 ha area along the main canal. The entire scheme is irrigated during each irrigation event.

WW2 is part of Cong Hoa in Tan Tien cooperative 1.5 km north of WW1, served by the Cong Hoa pumping station delivering water from the main drainage canal. The drain water is a mix of diluted wastewater, field runoff and groundwater. The water distribution practice in the scheme is rotational with different sections irrigated on different days, and the agronomic field studies took place mainly along the lower part of the main irrigation canal of the scheme.

NW is part of Thuong Trang hamlet in Tan Tien cooperative, 1.5 km north of WW2 and adjacent to the main canal of an irrigation scheme served by a pump station delivering water from the Red River upstream of the Nam Dinh city drainage canal outlets.

The experimental data covered both very dry and relatively wet spring seasons over the study period extending from 2003 to 2005.

The detailed study on irrigation practices and the socio-economic and health impacts of wastewater use on farm households, was conducted in the communes of My Tan and My Trung both in the My Loc district of Nam Dinh province. Sample villages from these two communes were selected. The farmers from these villages had plots in the wastewater and non-wastewater sites studied. Based on the total numbers of non-agricultural and agricultural households in the study area, a sample of 288 households was selected randomly from 3 villages in the My Tan commune, and 250 from 3 villages in the My Trung commune which was equivalent to 10% of the total population for each of the communes. All the farmers from the villages selected in the My Tan commune had both wastewater and clean water plots. On the other hand most of the farmers from villages belonging to the My Trung commune had only cleanwater plots. The same households were used for the health study where the sample households for the control study were selected from amongst farmers who had no wastewater plots (ie essentially from villages in the My Trung commune).

Findings from phase 2:

The findings from these sub-components are presented as short papers in the following pages.

PUBLISHED PROJECT OUTPUTS TO DATE:

1. Report of Workshop held in Vietnam was published as IWMI Working Paper “*Wastewater Re-use in Agriculture. Proceedings of the Workshop on Wastewater Re-use in Agriculture in Vietnam: Water Management, Environment and Health Aspects*. Hanoi, Vietnam, 14th March 2001. IWMI Working Paper No. 30” and disseminated
2. A Book chapter on “National Assessments on Wastewater Use in Agriculture and an Emerging Typology – The Vietnam Case Study” in *Wastewater use in irrigated agriculture – confronting the livelihood and environmental realities*. (CABI Publication , editors Scott et al)
3. A Special edition of the Southeast Asian Journal of Tropical Medicine and Public Health on “Current Status of Parasitic Diseases in Vietnam”. Volume 34 Supplement 1, 2003.
4. Journal paper in press Title “ Low risk for helminth infection in wastewater-fed rice cultivation in Vietnam” in Journal of Water and Health.
5. Short article in Urban Agriculture magazine on “Skin problems as a major occupational health hazard among farmers engaged in wastewater irrigated agriculture” . Published by RUAF

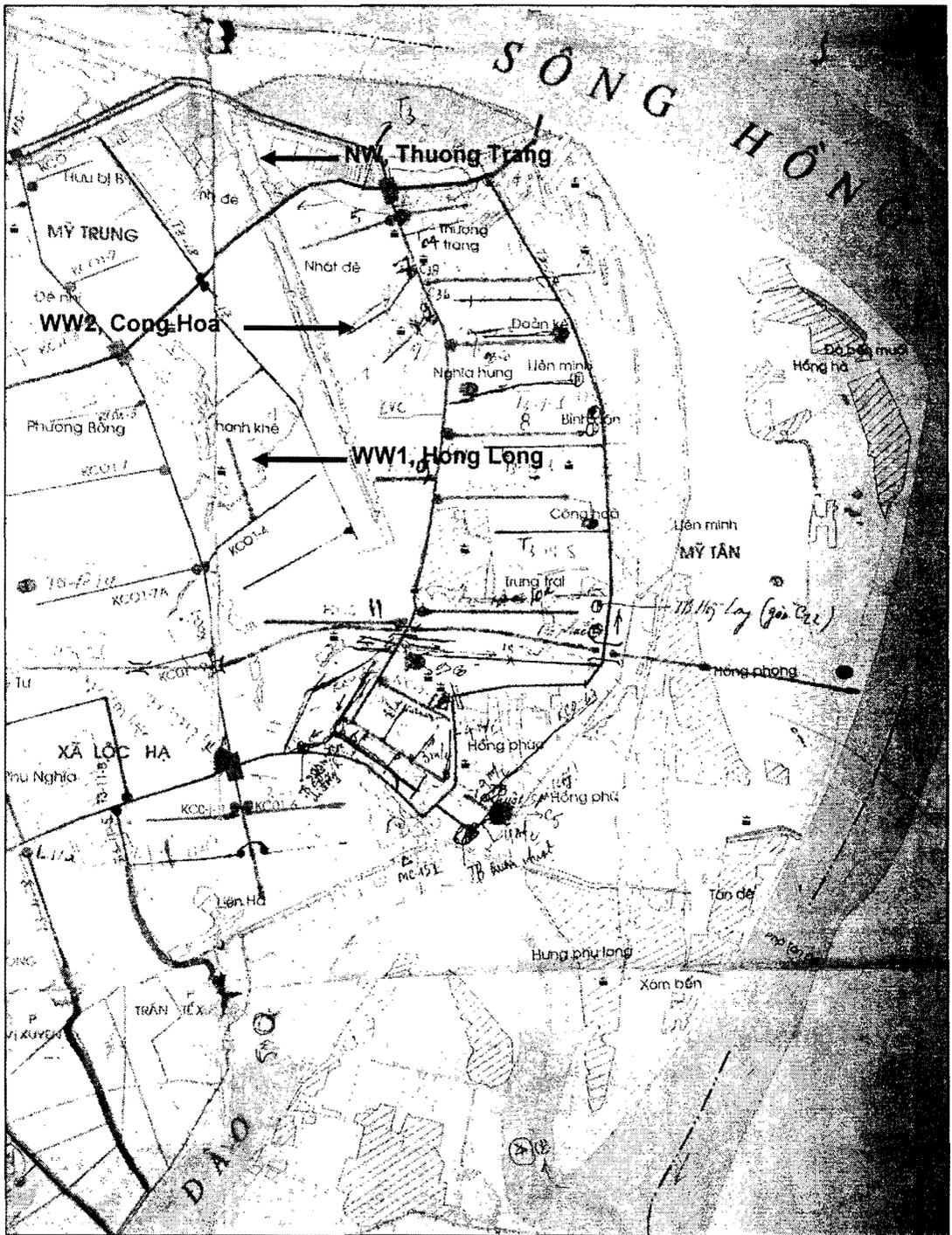


Figure 1: Study sites