Discussion paper on Water Supply Projects and Dengue Mosquitoes in Vietnam

October 2002

Australian Foundation for the Peoples of Asia and the Pacific (AFAP)
in partnership with the
National Institute of Hygiene and Epidemiology in Vietnam (NIHE) and the Queensland Institute of Medical Research (QIMR)

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About this discussion paper

This short paper aims to raise awareness about the potential for water supply programs to increase dengue risk in Vietnam and how this can be avoided.

The paper has come out of the issues and experiences of the 'Community Programs in Dengue Control' program being implemented by the Australian Foundation for the Peoples of Asia and the Pacific (AFAP) in partnership with the National Institute of Hygiene and Epidemiology in Vietnam (NIHE), the Institute Pasteur in Nha Trang (IPNT), the Queensland Institute of Medical Research (QIMR) and the Queensland University of Technology (QUT).

AFAP is distributing this paper to highlight the problem, encourage further research and promote inter-sectoral solutions to mitigate it.

1 Background on the Vietnam-Australia Dengue Control Programme

The rapid increase in dengue and the more serious dengue haemorrhagic fever (DHF) over recent decades have made it a leading cause of hospitalisation and death amongst children in south-east Asia[1]. The withdrawal of ill people from the workforce, high productivity losses, increased demands on women as primary carers, increased community anxiety and increased pressure on limited health care resources, all exacerbates the economic and social burden in these communities.

One of the most effective methods to control the disease has been developed in Vietnam through a unique partnership with Australian organisations. AFAP is managing a community-based biological control program in partnership with the National Institute of Hygiene and Epidemiology, the Queensland Institute of Medical Research, the Queensland Institute of Technology and the health departments of six provinces in northern and central Vietnam. During 1998, with funding support from AusAID and DFID, phase one of this program achieved the first eradication of the dengue carrying mosquito for 26 years by any method, and a world first using a combination of community participation and environmentally-friendly biological control (highlighted as a global achievement in the British Medical Journal, Feb 1999 and published in American Journal of Trop Medicine and Hygiene[2]). With ongoing support from AusAID, the second phase of this program has helped extend the model to central Vietnam and key aspects of the model are being incorporated into the national dengue control programme.

2 Water Supply systems and Dengue

The high incidence of dengue results from high levels of the dengue vector mosquito, *Aedes aegypti*. It breeds in clean standing water in containers such as water tanks, ceramic jars, wells and discarded containers. *Aedes aegypti* can multiply very quickly – they can go through an entire life cycle in as little as 13 days. They are able to find their way into water containers where they prefer to lay their eggs by following trails of water vapour. In this way they can enter water containers through such things as entrances to tanks, gaps in lids and drainage pipes.

Ironically, water supply projects aiming to improve community health can increase dengue risk through the creation of new mosquito breeding sites[3]. Although little research has been conducted on the extent of this impact, recent data collected by NIHE and AFAP from communes participating in a

[1] 'Guidelines for Treatment of Dengue Fever/Dengue Haemorrhagic Fever in Small Hospitals' by WHO, Regional Office for South-East Asia, New Delhi, 1999. The high incidence in children is largely due the fact that unlike adults, young children have not developed immunity from years of natural exposure to dengue.

[2] See Nam, Kay et al (1998) "Eradication of *Aedes aegypti* from a village in Vietnam using copepods and community participation." Am. Journ. of Trop. Medicine and Hygiene, 59(4):657-660

[3] The WHO/FAO/UNEP/UNCHS Joint Panel of Experts on Environmental Management guidelines on dengue control recognise that intersectoral barriers often impede the carrying out of multi-disciplinary solutions.

UNICEF-sponsored water supply program in Khanh Hoa province suggests that this impact can be quite marked.

The UNICEF project helped provide hundreds of large concrete jars able to collect and store up to 2,000 litres of rainwater in several communes in Ninh Hoa district during 1998 and 1999. During 2000, one of these communes joined the second phase of the AFAP-NIHE dengue control program. Entomological surveys of stored water sources were carried out to determine key *Aedes aegypti* breeding sites before and during project implementation. The base-line survey of September 2000, revealed that the UNICEF jars were the dominant breeding sites in the commune, accounting for 92% of the estimated *Aedes aegypti* larvae population (figure 1).

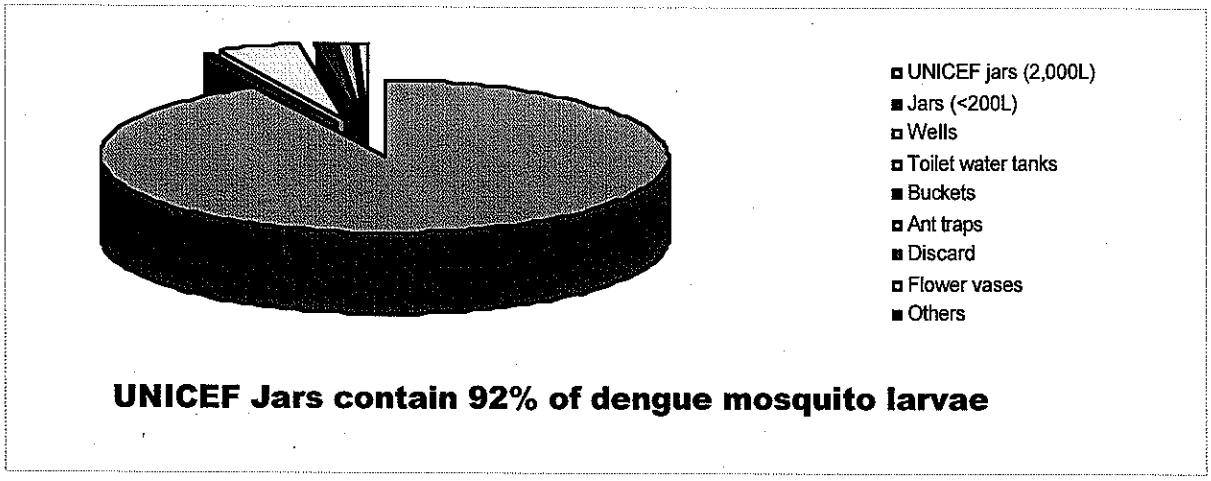

Figure 1. Results of *Aedes aegypti* larvae survey undertaken in Ninh Xuan during September 2000 by entomologists from Institute Pasteur, Nha Trang. (The survey used standardised sampling techniques and used volume correction factors to estimate total larvae populations. Provincial and district health officials undertook the survey following training and supervision from Australian and Vietnamese entomologists).

The significance of the contribution of the UNICEF jars to actual dengue incidence rates can only be fully determined in a careful comparative study with neighbouring communes over many years. However, data recently collated by project staff indicates that there may be a significant impact. The numbers of clearly recorded dengue and dengue haemorrhagic fever cases for communes in Ninh Hoa district was collected from district health records and converted into incidence rates to correct for differences in populations between communes.

As shown in figure 2, the results indicate that the incidence rates in communes selected for the UNICEF jars was comparable to neighbouring communes during 1996 and 1997. However, following the introduction of the jars during 1998, the incidence rates in the beneficiary communes became markedly higher than those in neighbouring communes. Notably, the rates also rose and remained higher than the provincial average.

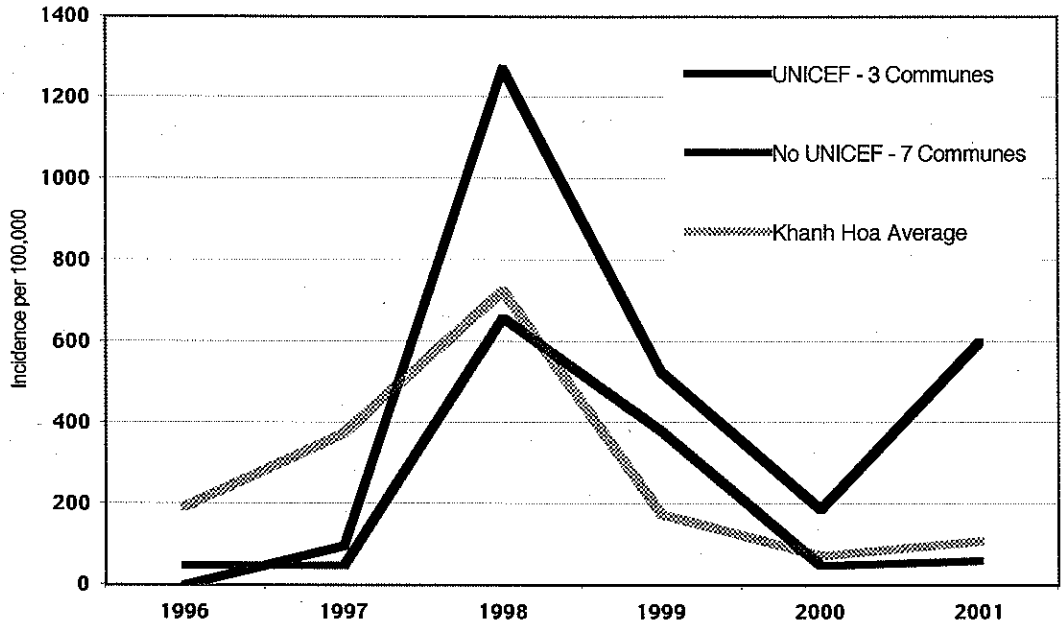

Figure 2. Case incidence rates for dengue and dengue haemorrhagic fever in Ninh Hoa district taken from the district and provincial health records. The black line shows the incidence in three of the communes that received UNICEF jars during 1998. During and after the introduction, the incidence rates were significantly higher than those for seven other neighbouring communes that did not receive jars (green line) and also higher than the average incidence rate for the whole province. Note that 1998 was a dengue epidemic year across the Vietnam and incidence rates were much higher than for the previous few years.

At the very least, this preliminary data suggests that in some cases, water supply projects can increase dengue risk and that there is an urgent need to study and better understand the nature of the impacts of water supply projects on dengue vector mosquito. However, we feel that through collaboration with managers and engineers working on water supply projects, vector control teams such as that at AFAP-NIHE could devise and implement simple measures that could significantly reduce or eliminate adverse impacts.

3 Options for Water Supply Projects

Despite advances in early detection and treatment of dengue victims, the most effective method to reduce dengue risk is to prevent the vector mosquito from breeding. Given the growing risk and costs of dengue, it would seem prudent that both donors and implementers of water supply projects ensure that their interventions do not provide breeding sites for dengue mosquitoes. This could be achieved by:

- improving designs of water supply systems;
- using biological control methods;
- improving community awareness and preventive behaviours; and
- helping local authorities establish on-going mosquito surveillance.

Tightly integrating these interventions could indeed dramatically reduce existing dengue risks and improve cost-benefit ratios of project interventions.

Whilst a good deal of experience has been building in community education, mosquito monitoring and biological control, experience in improving water system designs to minimise dengue risk has been

much more limited. This is partly due to a lack of awareness of the problem and a lack of inter-sectoral collaboration between infrastructure engineers and public health experts. Public health knowledge provides some starting points that water supply designers could consider:

- Dengue carrying mosquitoes breed in clean water and can multiply very quickly;
- These mosquitoes can detect evaporating moisture emerging from even the smallest cracks and use these to find their way into water tanks; and
- In many cases, there are some simple methods that can limit the mosquito breeding in vessels that can contain or retain water.

Whilst one obvious method is to reduce the number of incidental water storage containers and receptacles there are additional solutions that may be useful for different types of water supply programs. For larger scale water systems, these methods may include a combination of the following:

- Minimising the number of intermediate tanks and ensuring that they have secure fitting lids and drainage taps;
- Securely covering openings of water tank ventilation pipes with durable fine-mesh netting;
- Ensuring access-holes have secure covers; and
- Building elevated reservoirs to distribute water under pressure through household taps (and thus reduce the perceived need for householders to store water in case of power shortages to electric water pumps).

For smaller scale water systems, the methods could include:

- Ensuring that water vessels with volumes greater than around 200 litres, have a tap near the bottom and a secure fitting lid or contain biological control agents;
- Using convex-shaped lids for water vessels in order to prevent water retention;
- Educating and encouraging water users to use taps rather than scooping water from the top since they will often forget to cover the vessel securely; and
- Promoting water supplies containing requiring one large container with piped water than several smaller ones.

In order to determine the nature of the potential dengue risk, to help decide on a mitigation strategy and to monitor the success of that strategy, it is essential to undertake surveillance of dengue mosquito populations and breeding sites before and during project activities.

At a minimum, such dengue control measures coupled with mosquito monitoring will help ensure that water supply projects do not contribute to any increase in the productive capacity for *A. aegypti*. More optimistically, a well designed set of interventions that address wider water-use issues can enable water supply projects to dramatically reduce existing dengue risks. The AFAP, NIHE and QIMR program has shown how this can be achieved through a program of community engagement, biological control and vector surveillance. The program partners are keen to see a wider reduction in dengue risk through collaborations with organizations involved in water supply in dengue endemic areas. Such collaborations could include:

- Providing technical advice on reducing mosquito breeding sites;
- Training local authorities in how to undertake standardised dengue mosquito surveillance;
- Developing educational and community awareness materials and campaigns;
- Researching effectiveness of water system design changes in minimising mosquito breeding sites; or
- Helping set up a complete community-based dengue control program based on the model developed by the existing AFAP program.