Mosquito control and the Katherine flood April 2006

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Introduction

In January 1998 the town of Katherine, approximately 280 km south of Darwin, was extensively flooded. In the aftermath of the flood, the Medical Entomology Branch (MEB) of the Centre for Disease Control (CDC) in the Department of Health and Community Services (DHCS) carried out large-scale mosquito control operations, which reduced mosquito numbers and prevented an outbreak of mosquito borne disease.1

On 7 April 2006 Katherine was again flooded. Katherine has a seasonal risk of the mosquito borne disease, including Murray Valley encephalitis (MVE), which has a peak risk from March to June in the Top End. Mosquito monitoring in Katherine just before the flood showed relatively high numbers of Culex annulirostris, the main mosquito vector of MVE, which indicated that mosquito control was required urgently to prevent a possible outbreak of disease, as well as to prevent a major pest problem from mosquitoes.

Mosquito control in Katherine in general is limited to regular fortnightly applications of larvicide to the storm water drain system by the Katherine Town Council. Larval control of the other defined mosquito breeding sites is either by the landowners or by a contracted pest control company. The flood disrupted local capabilities of mosquito survey and control and the extent of the flood meant that large-scale mosquito control was beyond the local resources.

This report outlines the result of the DHCS survey and subsequent mosquito control operations in Katherine.

The Katherine Flood April 2006

The Katherine River peaked at 19.01 metres early after midnight on the morning of 7 April 2006. By the morning of 8 April, the river began to drop and many residents in the town were able to return to their houses. This was the worst flooding in Katherine since the floods of January 1998, when the Katherine River reached a peak of 21 metres and flooded various urban areas with up to 3 metres of water.

Many of the recently flooded areas were major mosquito breeding sites in 1998. The extent of the flood and the disruption to normal services meant that extensive mosquito monitoring and control was beyond the resources of local health staff.

Mosquito survey and control

It was clear from the 1998 flood that mosquito egg-laying would begin about 1 to 2 days after the peak of the flood. This meant that larvae would be at the first or second growth stage by day 4 after the peak of the flood, leaving 2 to 3 days to carry out control measures before the larvae reached the late fourth instar and began transformation to the pupal stage, at which stage insecticide treatment would no longer be effective.

The MEB team of 4 arrived by road in Katherine on the evening 10 April and immediately began setting mosquito traps to evaluate the level of adult mosquitoes. The MEB survey team overflew the Katherine area within a 5 km radius of the town centre on the morning 11 April. Areas of flooding were mapped on large aerial photos and landing coordinates were recorded with a GPS unit. An on-ground assessment of the mosquito breeding was made by 3 MEB staff running through flooded areas within 100m of each helicopter landing site and assessing the habitats by dipping for the presence and density of mosquito larvae.

Details for each collection, including the GPS coordinate, the average number of larvae per dip, habitat type and the developmental stages of the larvae were recorded on the sample jars at each landing site. The flooded areas and the average density of mosquito larvae and GPS coordinates were marked on the aerial photos.

The survey of the flooded areas indicated that floodwaters covered a considerable area and were still actively draining back to the river in most areas. However there were considerable
areas of stabilised water. Mosquito larvae were present in most areas surveyed. The mosquito larvae were either absent or present at varying densities. Some sites had very low densities while other areas had a medium density of larvae from 4 to 5 per dip. Sites with sewage contamination had relatively large densities of up to 100 per dip. The flooded areas and areas of mosquito breeding are outlined in Figure 1.

High numbers of larvae were found in areas with rotting legume vegetation or high organic wastewater. The highest concentrations of larvae were found in water contaminated by the primary sewage pond overflow at the sewage treatment plant. In general the mosquito larvae were relatively young (mainly first and second stage or less commonly third stage). The majority of larvae in most collections were *Culex annulirostris* (the common banded mosquito). However there were also numbers of *Ochlerotatus normanensis* (the floodwater mosquito), *Cx. pullus* and *Cx. gelidus* in a few collections.

The larval surveys indicated that the flooded areas upstream from the town had little mosquito breeding. These areas were generally relatively shallow, open with sparse native grass and had not received run off from urban areas.

The areas designated for aerial control were chosen with a priority on higher density of larvae and the proximity of the breeding to urban areas. Aerial spraying was carried out on the afternoon of 11 April and all day on 12 April.

The helicopter equipment included a 400 litre insecticide belly tank equipped with 2 spray booms with 32 T jet flat fan nozzles which produce droplets of around 500 micron size. The swath width was 15 to 18 metres using a spray height of 2 to 3 metres and an air speed of 50 knots.

The larvicide used was an aqueous suspension of Vectobac®, which contains *Bacillus thuringiensis* var. *israelensis* (Bti), a biological insecticide. This was applied at around 1.7 litres active ingredient per hectare, although the rate was increased to around 2 litres per hectare for the deepwater sewage overflow area near the sewage treatment ponds. In general one 400 L load was applied over 7 ha. Approximately 88 ha on 11 April and 42 ha on 12 April was treated by helicopter. The areas sprayed are shown in Figure 1.

The area of sewage overflow treated by Bti on 11 April was re-assessed on the afternoon of 12 April and found to contain very high numbers of newly hatched first instar larvae of *Cx. annulirostris*. A second spray operation using the higher rate of Bti was applied to this area on the afternoon of 12 April.

The ground-based larval control used all terrain quad bikes equipped with a 100L tank and a pressure spray unit. Bti was applied to smaller areas of 0.5 ha and 0.3 ha respectively on 11 and 12 April by ground application of temephos granules and Bti application using the quad bike sprayer.

An area of flooded grass near a semi rural development on the Gorge Road was sprayed by a local pest control company on 12 April and 18 April using a vehicle mounted spray unit following complaints about adult mosquitoes biting in the area.

It was obvious from the survey operation that there were some engineering aspects adding to the flooding and mosquito breeding problems. There were a number of critical choke points in drains or drainage pathways in the Katherine town and semi rural area that were restricting flood water drainage back to the Katherine River. Some of these choke points were holding back very large areas of floodwater and were responsible for considerable areas of mosquito breeding.

The most important choke points were the road culverts on the Kalano access road and the Stuart Highway south of the main town, which blocked access of residents to emergency services during, and for a short time after the flood. Both of these culverts are under sized and restricted flood drainage from very large areas that could breed mosquitoes from 3 or 4 days to up to 3 weeks post flood. The drainage could be rectified by installing increased sized culverts, and deepening the approach and exit flow paths in the vicinity of the culverts.

The most mosquito productive area was the non-draining area of overflow from the sewage treatment ponds. This problem could be solved by the installation of a pipe from the flooded
Figure 1. Katherine residential flooding survey 11-12 April 2006

Figure 2. Katherine residential flooding survey 18 April 2006
area to the Katherine River. The next highest priority is the drainage enhancement around Hickey’s Lake to reduce mosquito numbers affecting the main urban and nearby rural areas. A list of these choke points has been tabulated and is available.

Improvements in post flood drainage are needed to both reduce the extent of the flooding and the extent of flooded areas requiring mosquito larval control. The drainage improvements would enable earlier access to certain areas and ensure floodwaters drained much sooner after flooding. It could also prevent property damage in some areas when the next flood occurs. Some of these points were included in a MEB report on the previous Katherine flood of 1998 but only the Hickey’s Lake area had been partially rectified when the present flood occurred.

Reduction in areas of mosquito breeding is required because large scale mosquito larviciding operations as carried out in this instance may not always be possible after floods due to the unavailability of insecticides, personnel, helicopters or other unforeseen aspects. Large areas of mosquito breeding close to residential areas, if untreated, could lead to outbreaks of either Ross River virus disease, Barmah Forest virus disease, or the more dangerous MVE virus disease.

The potential mosquito breeding areas were again surveyed on 18 and 19 April in a similar manner to the first survey. The priority areas were the sewage-contaminated areas near the sewage treatment ponds. The floodwaters had retreated considerably since the first survey period. Flooding in the Hickey’s Lake area was much smaller due to the drainage via the drain leading to the Katherine River. The flooded area around the sewage treatment works had retreated considerably (Figure 2).

Aerial control operations were similar to the first operation. Approximately 43 ha was sprayed with Bti and 36 ha with methoprene applied at 360 mls per ha during this second episode.

Mosquito and disease monitoring

The routine adult mosquito monitoring in Katherine was last conducted on 24 March, just before the flood. Adult mosquito monitoring was carried out during the flood control operations and continued by the Environmental Health Officer each fortnight after the flood. The adult mosquito monitoring results are shown in Figure 3 for the Hickey’s Lake site and Figure 4 for the sewage ponds site.

For the Hickey’s Lake site, the rainfall figure (cumulative rainfall between mosquito monitoring periods) indicates that the steep rise in mosquito numbers before the flood was due to rainfall in the period before the flood (Figure 3). Culex annulirostris adult numbers were actually relatively low 4 days after the flood, which was probably due to the disruption of the breeding sites by the flood. However if the larvae found during the survey and control operation were not controlled, adult mosquito numbers would have reached enormous levels a week after the flood. This did not happen. It is obvious that the Cx. annulirostris numbers on 21 April and 5 March were well down from those before the flood and this great result is directly due to the 2 episodes of larval control.

For the sewage ponds site (Figure 4) there was no increase in Cx. annulirostris numbers in the 2 weeks following the flood, and there was a steep decrease following the second aerial control episode. This containment or decrease is remarkable when it is considered that there were very high numbers of larvae and a very large area of mosquito breeding near the sewage ponds following the flood.

There were a number of black flies (Austrosimulidae species, family Simulidae) in the traps and there were a number of complaints about “midge attack” by some residents, particularly in the Gorge Road area. MEB officers collected some black flies biting in the area between Katherine and Katherine east on 12 April. It is possible this is the species reported in plague numbers in outback Queensland following floods. These specimens are being further investigated by MEB.

The DHCS has a sentinel chicken program at major towns to provide an early warning system for mosquito borne flavivirus disease activity. This program involves the monthly bleeding of a flock of chickens to detect antibodies to Kunjin virus and MVE virus. One of the sentinel chicken flocks is situated just south of Katherine and was not affected by the flood. Testing for these sentinel chickens was resumed.
Figure 3

HICKEYS LAKE - 2006

Katherine rainfall between the current and preceding monitoring period

Flood occurred on 7/4/06

Aerial larval control on 11/4/06 & 12/4/06

Aerial larval control on 18/4/06

Figure 4

SEWAGE PONDS - 2006

Katherine rainfall between the current and preceding monitoring period

Flood occurred on 7/4/06

Aerial larval control on 11/4/06 & 12/4/06

Aerial larval control on 18/4/06
immediately after the flood. On 11 April, 2 of the Katherine sentinel chicken, seroconverted to Kunjin virus. However this virus transmission must have occurred before the flood, as it takes some time for chickens to produce antibodies after being bitten. Testing of the sentinel chickens in May showed further seroconversion in 2 chickens to Kunjin virus. Although this has been due to virus activity after the flood, it was relatively limited and there has been no evidence of MVE activity in the Katherine area so far this year to date.

There have been no human MVE or Kunjin virus disease cases to date in the Katherine area following the flood.

The DHCS issued MVE and Kunjin virus warnings for the Top End, including the Katherine area, in March, April and May 2006. These warnings hopefully alerted people to take personal mosquito protection against mosquito bites. Efforts to reduce vector numbers and these personal measures contributed to a reduced risk of MVE and Kunjin disease.

Ross River virus disease cases in humans are usually on the decrease after February of each year. The fact that there has been no increase in RRV cases in April is not a reflection of the aerial control program but rather the normal seasonal pattern of RRV.

Conclusions

The Katherine flood on 7 April 2006 created large areas of mosquito breeding which was evident 4 days after the flood peak. Some of these areas were in excess of 30 hectares and produced a very high density of Cx. annulirostris larvae, a good vector of MVE virus disease and Kunjin virus disease. Disasters including floods are often associated with a high incidence and risk of mosquito borne disease. The mosquito control operations, by DHCS, were carried out in a very timely manner, and prevented any large hatch of adult mosquitoes. This control has been a major factor in the lack of any appreciable mosquito pest problem.

There were many aspects that contributed to the successful mosquito control operation. These include the use of a specific cost code to quickly organise the required consumables such as insecticides, the DHCS contacts on the Katherine Region Recovery Coordinator who assisted enormously in facilitating local arrangements and clearances, the use of a private tanker company to supply water for the spray operation, and the use of a helicopter to conduct speedy and large scale survey and spray operations. Perhaps the most vital parts of the recipe was an expert and experienced MEB team and a specifically experienced helicopter pilot in carrying out the survey and control operations.

There were also many learning experiences from the operation. The principal lesson was that the area of mosquito breeding could have been dramatically reduced if there had been flood mitigation works carried out after the flood in 1998. During the 1998 floods, speedy action was taken to unblock a drain across the Stuart Highway. There needs to be an avenue of communication and a capacity to make quick decisions during disasters to carry out such engineering options to reduce areas of mosquito breeding and enable better vehicle access to various areas.

The suggested flood mitigation works should now be a high priority so that post flood drainage can prevent access problems for residents and prevent pest and disease problems from mosquitoes. There should also be an annual maintenance program in the storm drain system in the dry season of each year to improve drainage flow in the event of flooding during the wet season.

The survey and control operation could have been speeded up with use of 2 helicopters and would have enabled surveys to take place while control was carried out. The use of methoprene pellets, while more expensive, would allow control in flooded areas for up to 30 days, which would remove the need to resurvey controlled areas and save money on re-applications.

The adult mosquito problem in Gorge Road indicated that mosquito monitoring after floods in Katherine needs to be over a wider area, and that public complaints about mosquitoes need to be relayed to the MEB as soon as possible.

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Detection

A Perkins container ship arrived in Darwin Harbour from Singapore on Wednesday 10 May 2006 and docked at the international wharf at Perkins Shipping at 04.30. An Australian Quarantine and Inspection Services (AQIS) officer conducted a pre-clearance inspection of the container ship on Thursday 11 May 2006. A quarantine inspection of the container ship was then conducted by AQIS on the morning of Friday 12 May 2006. During this quarantine inspection, mosquito larvae were found breeding in water pooling at the bottom of 6 large earthmoving tyres. The tyres were stacked upright, and protruding from the top of an open, uncovered shipping container.

Six mosquito larvae, 1 pupal skin and 1 pupae were collected and preserved in 70% ethanol on site by the AQIS officer. There were larvae observed in all of the 6 tyres that were inspected and adults were observed flying in the vicinity. AQIS estimated that there were at least 50 larvae observed in 3 of the tyres and probably less than 50 larvae in the other 3 tyres. Following a preliminary identification of the samples at the AQIS vector laboratory a medical entomologist at the Medical Entomology Branch (MEB) of the Northern Territory Department of Health and Community Services (DHCS) confirmed them to be *Aedes albopictus* on the same day of collection. This exotic species is a very good potential vector of dengue and chikungunya virus.

This risk importation was assessed as being moderate to high because the tyres were exposed and untreated at Perkins international wharf for a period of over 48 hours, and large numbers of larvae (and probably pupae) and adults were observed, and a pupal skin was collected in the sample, indicating that adult mosquitoes had probably emerged from this breeding site and dispersed out of the area. Perkins Shipping is located in very close proximity to Darwin City.

There are a number of residential buildings within 500 metres of the wharf facility that could potentially provide a blood meal for a female during out of hours, Andy Bilske of Murray Pest Control for ground larval control in the Gorge Road area, and various media agencies for public information dissemination, including Amy Collett, Leon Compton and Andrew Priestly.

References