

# Operation Sumatra Assist: post-tsunami environmental and public health response in Banda Aceh

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THE EARTHQUAKE AND TSUNAMI of 26 December 2004 left more than 200 000 people dead or missing in the province of Aceh,<sup>1</sup> and 70 000 in the capital Banda Aceh, population 450 000. In Banda Aceh, the devastation was complete up to 3 km from the shoreline, with substantial flooding and damage up to 5 km inland. Survivors moved to host communities (in unaffected parts of the city or other villages) or to spontaneous settlements which became internally displaced persons (IDP) camps. More than 500 000 Acehnese were displaced.<sup>1</sup>

Most essential services were affected, with water reticulation destroyed or contaminated, loss of waste disposal programs, and vector control brought to a standstill through loss of staff and equipment.

The potential for disease outbreaks was recognised from the outset, so environmental health and engineering support formed an important part of the Australian Defence Force's commitment to Operation Sumatra Assist.

## Abstract

- ◆ There was a real risk of disease following the earthquake and tsunami. Most essential services were affected. Tens of thousands moved into internally displaced persons camps or host communities.
- ◆ While much of the world's attention was focused on immediate medical care, the Australian Defence Force deployed Engineer and Environmental Health teams which combined with other agencies to mitigate the serious threat of water-borne and vector-borne diseases.
- ◆ Environmental Health personnel gave technical assistance to ADF Engineers and the aid sector in the provision of potable water, helped investigate and control potential disease outbreaks, and provided environmental health support to displaced persons.
- ◆ The mission highlighted the value of real-time health threat assessment, the need to develop lightweight Environmental Health kits, and the importance of pre-deployment preparation of personnel.
- ◆ The Environmental Health team's emphasis on collaboration, coordination and communication overcame potential barriers to make an important contribution towards the prevention of (widely predicted) large disease outbreaks.

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The ANZAC Field Hospital (AFH), consisting of elements of the 1st and 2nd Health Support Battalions and other units (including the New Zealand Defence Force), deployed to Medan in Northern Sumatra on 2 January and to Banda Aceh a few days later. The AFH included an Environmental Health Section (EHS), with two additional environmental health personnel under command of the 5th Aviation Regiment detachment at Banda Aceh airfield and, in Medan, one Environmental Health Officer with the Squadron Medical Element and the Senior Medical Officer (Public Health Physician) on the Combined Joint Task Force (CJTF) Headquarters. At the peak, 16 environmental health personnel were deployed on Operation Sumatra Assist. There was also a section from the 1st Combat Engineer Regiment (1 CER).

The CJTF was part of a huge international response. More than 400 organisations were registered in Aceh. The United Nations and Indonesian government agencies held regular meetings (including health, surveillance and water and sanitation) to coordinate the humanitarian and disaster relief effort.



*Banda Aceh, seen from the window of the first Royal Australian Air Force C-130 Hercules sent to deliver humanitarian aid and a medical assessment team to the devastated area after the tsunami.*

The EHS quickly established liaison with counterparts in civilian and military agencies. Principal among these were the Indonesian Ministry of Health (MoH), German Field Hospital's entomologist and environmental health personnel, German Disaster Relief Organisation, and US Navy counterparts and their deployable laboratory, the Naval Medical Research Unit (NAMRU-2). These liaisons facilitated exchange of information, sharing of equipment and access to laboratory results, and greatly assisted the disease control effort.

The EHS implemented a disease prevention program, which included helping to restore water supply and sanitation, carrying out disease surveillance and vector control, and advising on environmental and occupational hazards.

## Water and sanitation

### *Establishing the first water point*

Following the tsunami, a supply of potable water was the most pressing population health need.<sup>2,3</sup> The requirement was exacerbated by the rapid establishment of IDP camps, where crowded conditions created ideal circumstances for the spread of enteric disease.

Banda Aceh is served by a conventional water filtration plant which draws water from the Krueng Daroy river. Following the earthquake and tsunami, there were breaks in water mains and the system lost pressure, providing ideal conditions for contamination. On many days, the town water was inadequately disinfected. Samples contained *Escherichia coli* and thermotolerant coliform bacteria (up to 136 colony forming units per 100 mL), indicating significant faecal contamination. The presence of complex chemical pollutants could not be assessed. Water supply was cut off to many parts of the city. People were forced to drink untreated household

well water, usually reserved for bathing and laundry. Others were supplied with or obtained bottled water.<sup>4</sup>

EHS personnel helped the engineers establish the first water point, which drew water from a broken main across the Krueng Aceh river. Water was treated by a Cross Plate Clarifier 20 (CPC 20) trailer-mounted treatment unit and distributed (in collapsible 10L containers supplied by AusAID) to hundreds of people who queued patiently each day. The CPC 20 treats water by coagulation (the addition of alum and polyelectrolyte), filtration (through anthracite) and disinfection with chlorine. The Disaster Response Team recovered and restored three water tankers; these provided the first means for water to be distributed in bulk to IDP camps. The team monitored the quality of drinking water and ensured that the water tankers were maintained in a clean and sanitary condition.

The water point was a focus of community and media attention and became a cogent symbol of Australia's response. The supply and distribution of potable water to the community from this early stage was the most significant of the many CJTF contributions towards protecting public health.

### *The ANZAC Field Hospital*

The AFH was based at the Dr Zainoel Abidin General Hospital in Banda Aceh. Initial environmental health tasks at the general hospital included constructing latrines, helping to clear hospital buildings of mud and debris, and helping Indonesian clinicians disinfect a number of wards with a chlorine solution.

Clearly, the hospital could not function without adequate water supply and sewerage services. The hospital's engineer, who had survived the tsunami, worked with Indonesian, CJTF, German and US Navy personnel to progressively restore water supply and sewerage services. The AFH's



*Queue at the water point, with water being distributed in collapsible containers.*

plumber was kept extremely busy repairing and then maintaining the reticulation and drainage networks.

The General Hospital has its own bore and water filtration plant. This had been inundated with mud and seawater, and restoring it to service required significant effort. Once the mud had been cleaned out, the clear water tank was super-chlorinated. A chlorine contact time of more than 1 hour was allowed before water was drawn through the reticulation system. Chlorine was added by hand each day, as the dosing pumps were faulty. Within weeks, a CPC 20 water treatment unit was set up to bypass the hospital's plant, allowing more reliable filtration and chlorination. Water from the CPC 20 was connected to the General Hospital reticulation for use on the wards, and distributed to locals.

The EHS monitored the quality of water produced by CJTF water points, and performed water analyses for non-government organisations (NGOs). Field testing (for free chlorine, pH, turbidity, total dissolved solids, and indicator bacteria) was performed, and feedback was provided to the operators to ensure optimal water quality. Water analysis was also performed for NGOs.

Throughout Operation Sumatra Assist, CJTF personnel consumed imported bottled water, which contributed to the logistic demand. The CPC 20 treated water was used by the CJTF for personal hygiene and by the local community for all purposes. The treatment process was adequate to inactivate bacteria, viruses and most protozoa (including *Giardia*). However, for long-term consumption (> 30 days), more sophisticated testing and treatment, such as reverse

### I: Summary of surveillance by week (2005): Aceh Provincial Communicable Diseases Centre<sup>6</sup>

Disease-specific indicators	Week 3	Week 4	Week 5	Week 6	Week 7	Comments
Agencies reporting	19	28	21	21	21	
Acute watery diarrhoea	426 (68.2)	998 (55.6)	527 (62.3)	529 (37.7)	450 (34.6)	One death in Week 3. Hundreds of cases each week, but no cholera.
Bloody diarrhoea	38 (6.1)	80 (4.5)	18 (2.1)	43 (3.1)	45 (3.5)	<i>Shigella flexneri</i> , <i>S. sonnei</i> (but no <i>S. dysenteriae</i> ) and <i>Entamoeba histolytica</i> identified in isolated cases in Banda Aceh and other districts. Some cases drug resistant.
Malaria (confirmed)	37 (5.9)	51 (2.8)	32 (3.1)	71 (5.1)	40 (2.8)	Cases observed mainly in adults. AFH diagnosed 17 cases of malaria in locals; 12 were <i>Plasmodium vivax</i> and 5 were <i>P. falciparum</i> . Some cases in patients who presented for unrelated conditions. It is likely some cases were acquired outside Banda Aceh and some were long standing. No cases in CJTF personnel while deployed.
Other fever above 38° C	126 (20.2)	332 (18.5)	381 (45.0)	438 (31.1)	259 (18.4)	Isolated cases of dengue fever identified.
Suspected measles	6 (1.0)	20 (1.1)	0 (0)	10 (0.7)	10 (0.7)	
Acute respiratory infection	361 (57.9)	3835 (213.7)	2513 (296.9)	2594 (184.4)	1104 (78.6)	Two deaths per week in Weeks 3, 4 and 5. AFH treated 16 cases of pneumonia. Provincial Health Laboratory identified multi-drug resistant <i>Acinetobacter baumannii</i> in one patient.
Acute jaundice syndrome	2 (0.3)	2 (0.1)	2 (0.2)	1 (0.1)	2 (0.1)	Hepatitis A and hepatitis E virus diagnosed in one patient. Ingestion of contaminated water during the tsunami was a possible source.
Meningitis	1 (0.2)	0 (0)	1 (0.1)	1 (0.1)	1 (0.1)	One death in Week 7; occasional cases.
Total consultations	6240	17948	8465	14047	12992	

Values are number of cases (rate/1000 consultations). AFH = ANZAC Field Hospital. CJTF = Combined Joint Task Force.

## 2: Surveillance summary: other diseases of interest<sup>6</sup>

### Dengue fever

German Field Hospital diagnosed dengue haemorrhagic fever in a patient from an outlying district. Field investigation revealed a household cluster of four cases. The ANZAC Field Hospital (AFH) diagnosed dengue fever (IgM and IgG positive) in a patient who had lived for the preceding 2 weeks with a host community in Banda Aceh.

### Other vector-borne diseases

Cases of filariasis identified. Potential vector mosquito species present in abundance in Banda Aceh. One case of scrub typhus in a local. No known Japanese encephalitis cases before the tsunami, and none identified during the immediate post-tsunami period. Relative absence of pigs (an important amplifying host).

### Faecal-oral, gastrointestinal

**Typhoid fever:** Sporadic cases identified in Banda Aceh and other districts. Multi-resistance reported.

**Parasites:** *Giardia* and *Blastocystis hominis* (but not *Cryptosporidium*) found in patients with diarrhoea. Helminths endemic. The AFH diagnosed roundworm (*Ascaris lumbricoides*) and pinworm (*Trichuris trichiura*) in locals.

**Suspected foodborne illness:** Suspected outbreak (247 cases) in an internally displaced persons camp. Cases of gastrointestinal illness in Combined Joint Task Force personnel associated with the consumption of local foods. Generally resolved within 24 hours.

### Respiratory transmission

**Tuberculosis:** Endemic. AFH treated 9 cases — posed significant infection control risk for CJTF.

**Measles:** Outbreaks in two displaced persons camps in an outlying district, including two cases in recently vaccinated children. UNICEF sponsored an extensive vaccination program.

### Contact diseases

**Tetanus:** Cases arose quickly. Admissions peaked on 11 January, no admissions after 25 January (91 hospital admitted cases identified).

**Melioidosis:** Cases of melioidosis were reported to the Ministry of Health. One case reported by the AFH.

not suitable for in-ground disposal of effluent, as the soil was saturated and the surface covered in mud. To reduce the load on the sewerage system, burn-out latrines were constructed at AFH and at the airfield. Each day effluent was burnt off with aviation fuel. With the help of 1 CER's workshops, an inclined plane incinerator was constructed to deal with the contaminated waste generated by the AFH.

## Internally Displaced Persons camps

Conditions in IDP camps, which were housing tens of thousands in Banda Aceh, were poor, and there were serious fears of outbreaks of cholera and vector-borne disease.<sup>3</sup> Through the health sector meetings, the EHS was introduced to NGOs that had assessed needs in the IDP camps, including a Chilean medical team and the International Organization for Migration (IOM). It was clear that the capabilities of the EHS and 1 CER would be in demand.

The CJTF worked in a large urban IDP camp housing more than 4000 people. The camp latrines were insufficient for the population and in poor condition. Washing facilities were inadequate and water quality was poor. The EHS and 1 CER worked with IOM's Indonesian health staff to plan culturally appropriate latrines, wash points, and waste disposal. 1 CER constructed these facilities and established a water point, using a CPC 20 unit drawing on a bore source in the camp. Treated water was distributed via a ring main throughout the camp. After some weeks, Oxfam took responsibility for delivering potable water, which was distributed through the reticulation system installed by 1 CER.

When the EHS became aware of needs which could not be met immediately by CJTF resources, these were reported at Water and Sanitation coordination meetings. Indonesian authorities and NGOs were then able to address these needs.

## Other disease and environmental threats

Little was known about specific health threats in Banda Aceh, as many staff and most records were missing. This was an ideal opportunity to deploy a Health Threat Assessment Team with expertise to assess risks associated with environmental and disease hazards. Although a Health Threat Assessment Team was not deployed, the EHS took on this role and, while not possessing some specialist skills and equipment, nevertheless produced a credible health threat assessment report. The most frequently reported conditions among CJTF personnel were gastroenteritis and upper respiratory tract infections. Health threats were summarised to produce a Post Deployment Medical Insert Slip for the medical records of all deployed personnel.

The Aceh Provincial Communicable Diseases Centre and the World Health Organization (WHO) instituted a Mortality and Morbidity Weekly Surveillance System (Box 1 and Box 2).<sup>6</sup>

osmosis, may be needed to remove *Cryptosporidium* and organic chemical contaminants.<sup>5</sup>

Specialised tests at accredited laboratories were required to fully assess the risks associated with locally obtained water. However, appropriate sampling equipment could not be obtained from Australia, so these tests were not performed.

Wastewater at the General Hospital flows to a series of septic tanks and then to a wastewater treatment plant. Conditions were



Private Jessica Hood uses a thermal fogger to control a potential outbreak of dengue fever in a local Banda Aceh community.

Data were reported by health care facilities and diagnostic laboratories (including the Provincial Public Health Laboratory, which was supported by NAMRU-2). Much of the reporting was syndromic. There was limited referral of specimens to laboratories and it is likely that the true incidence of disease was underestimated. Very few deaths were reported.

### Vector-borne diseases: surveillance and control

Malaria is endemic in Aceh. The tsunami hit during the wet season, resulting in larger than normal bodies of standing water during the time of most active breeding. CJTF personnel conducted mosquito vector surveillance (larval surveys and carbon dioxide light traps) and control at each location they occupied.

Surveillance found that *Culex* spp. predominated with fewer numbers of malaria (*Anopheles* spp., including *subpictus* and *sundaicus*) and dengue vectors (*Aedes albopictus* and *aegypti*). Pioneer *Anopheles* spp. were thought to be colonising inundated areas, which became brackish following heavy rains. Trap catches at the General Hospital declined steadily over time, most likely due to drier conditions and effective control. There were remarkably few dengue fever vectors in the inundated zone, but larger numbers elsewhere. MoH entomologists considered that risk of vector-borne disease in Banda Aceh was generally low, but there was potential for this to change with movement of infected people into the city and changes to mosquito vector populations following the tsunami.

Personal protective measures included malaria prophylaxis (usually doxycycline), permethrin impregnation of uniforms and mosquito nets, wearing sleeves down and application of repellent to exposed skin. Wearing of short sleeves was allowed when performing tasks with an increased risk of heat stress (eg, working in the sun). The importance of wearing long sleeves as a preventive measure against mosquito bites required regular reinforcement.

The value of doxycycline in the prevention of diseases other than malaria was demonstrated by a case of leptospirosis in a CJTF member who was on an alternative chemoprophylaxis regimen. Leptospirosis should be considered in the differential diagnosis of febrile illnesses in similar environments.

The EHS applied larvicides to areas of standing water. Accommodation and work areas were treated by residual spraying of synthetic pyrethroid pesticide. A program of thermal fogging of pesticide was also established. Rodenticide baits were maintained at the airfield, where rats were a problem.

Following diagnosis of a case of dengue fever by the AFH, the EHS conducted a field investigation in collaboration with the MoH and WHO. *Aedes albopictus* larvae were found in pots near the patient's house. The mosquito was well established in this area. The EHS assisted the MoH to carry out mosquito control within a 100m radius of the patient's house.

The EHS also carried out mosquito control in five IDP camps and an orphanage (application of larvicide, internal residual sprays and thermal fogging) and trained camp residents in spray techniques. The availability of transport, which was limited at times, was essential for the completion of tasks in IDP camps.

### Environmental health threats

#### Air quality

Air quality in Banda Aceh was very poor, with high levels of dust, exhaust and smoke. The burning of household waste exacerbated the situation.

#### Noise

Personnel working at the Banda Aceh Airfield, the General Hospital landing zone and Medan Airfield were exposed to aircraft noise for prolonged periods. The Squadron Medical Element Environmental Health Officer assessed noise exposure at the airfields to be between 85 and 100 dB(A). Many areas were classified as hearing protection areas.

#### Road safety

Local vehicles were used to transport CJTF personnel. Safety was a concern, because of damaged roads and bridges and congested conditions. Many vehicles were not fitted with seatbelts.

#### Earthquake/tsunami damage

Many buildings were damaged by the earthquake and aftershocks, and were structurally unsound. Engineers inspected buildings occupied by CJTF personnel. Some buildings had damaged fibrous cement sheeting, and asbestos was confirmed in some areas. A hazardous materials team from the Incident Response Regiment helped clear locations where asbestos was found.

Mud and standing water at the General Hospital and the airfield contained *E. coli* and *Pseudomonas* spp. The mud also

contained dangerous materials, including broken glass and used needles and syringes.

### **Flora and fauna**

Large numbers of cats and packs of dogs that had survived the tsunami were roaming throughout the city. There were no reports of attacks on people. A number of small snakes were observed in the grounds of the General Hospital in the fortnight following the tsunami. The snakes were not aggressive and no bites were recorded.

## **Reflections on the environmental and public health mission**

Operation Sumatra Assist demonstrated that ADF environmental health assets are well placed to deliver support in a disaster setting. The EHS worked in a complex and challenging environment to protect CJTF personnel and help with restoration of essential services, rebuilding of local capacity and the transition of environmental health support to civilian agencies.

Initial delays in the arrival of environmental health equipment demonstrated the need to develop lightweight, portable kits containing essential items, including basic water testing, pesticides, and vector control equipment. Such kits would provide a capability from the moment that personnel “hit the ground”. Follow-on equipment should include all necessary sample containers for complete water analysis by an accredited laboratory in Australia.

The Health Threat Assessment Report and Post Deployment Medical Insert Slip provided timely information of better quality than that collected on previous operations. The usefulness of this information shows the importance of contemporaneous assessment of potential health threats during operations and a role for a Health Threat Assessment Team as an early and integral part of deployment. The information gathered by the EHS should provide better information for management of enquiries into potential health effects and may assist research by the Centre for Military and Veteran’s Health.

Operation Sumatra Assist highlighted an ongoing issue with effective command and control. Most environmental health personnel were part of the AFH, although there was a team of two with 5th Aviation Regiment. Bringing all environmental health assets under a single command may allow for optimal manning and tasking across the Area of Operations and increased effectiveness.

Pre-deployment preparation of personnel is important. During Operation Sumatra Assist, environmental health personnel provided briefings on “staying healthy”, and reinforced the importance of permethrin impregnation of uniforms and malaria chemoprophylaxis. It is simpler to carry out these tasks before deployment.

Although the available health sector surveillance data are incomplete, the predicted outbreaks and high mortality did not eventuate.<sup>7,8</sup> An important contributing factor to the success of Operation Sumatra Assist was the EHS’s partnership with Indonesian Government agencies (MoH), WHO, IOM, other military and NGOs. The EHS performed a significant amount of work beyond the perimeter of CJTF force elements and their outcomes demonstrate the importance of language skills, coordination, collaboration and communication in overcoming potential barriers.

The ADF can be justifiably proud of its contribution towards the humanitarian and disaster relief effort in Aceh, including the contribution made by its environmental health and engineer personnel towards the prevention of disease.

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## **Competing interests**

None identified.

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