**Annex B - Literature review on CWFs in emergencies in Myanmar**

It is reported that worldwide, there are approximately 4 billion cases of diarrheal disease annually that contribute to or cause the deaths of 1.5 million people – mostly children under 5 years of age (1). Approximately 850,000 diarrheal disease deaths are attributable specifically to inadequate WASH services and practices (2). The consequences of diarrheal disease at the global scale are immense. Health care systems are burdened in treating severe cases, lower productivity affects national economies and local livelihoods, poor households may spend large proportions of their income on treatment, and absenteeism may affect the education of children.

WASH encapsulates the main pathways by which humans are exposed to diarrheal disease causing pathogens, and therefore is a key priority area for governments and agencies. An enormous amount of research has been conducted over the past 15 years on topics related to WASH. In fact, research on research (known as ‘review studies’) is commonly performed to synthesize trends and results from multiple studies on the same topic. Various reviews conducted on WASH topics have revealed that WASH interventions (3), (4), (5), (6) and HWT interventions specifically (7) have the ability to significantly reduce diarrheal diseases. However, the results of WASH interventions in humanitarian and emergency contexts have been inadequately studied and the effectiveness of such interventions remain poorly understood (8),(9), (10). With respect to humanitarian situations, minimum standards have been defined to guide WASH interventions. The standard for water quality includes the absence of fecal coliforms (in a 100mL water sample) at the point-of-delivery and appropriate training, promotion, and monitoring of HWT methods deployed (11).

Various HWT technologies and methods have demonstrated the capability to reduce pathogen levels in drinking water and the likelihood of cases of diarrheal diseases (7). However, their appropriateness for scale-up, acceptance by the target population, context for sustained use, and cost-effectiveness remain ongoing questions (12).

Ceramic water filters (CWFs) represent one of many HWT methods promoted by development and humanitarian agencies around the world to improve water quality and health. CWFs have received particular attention due to their low cost, potential for local production, high performance, ease of use, and the fact that the taste of the water is not affected by treatment (unlike chlorine) (13). Various studies have shown that CWFs perform well under laboratory and field conditions at improving drinking water quality and in development (13), (14) (15), (16) and emergency settings (17). Several studies have also shown that consistent CWF use can be associated with decreases in diarrheal disease incidence (14), (16), (18).

CWFs consist of a clay pot coated with silver that is made porous by mixing the clay with a combustible material before being fired in a kiln. In Asian countries, the combustible material that is most commonly used is rice husk. To ensure quality production of the CWF, the type of clay, mixing ratios (water, combustible material, and clay), firing temperature/curve in the kiln, and quality control testing processes – should all be carefully controlled and monitored (19). Even if such methods are followed, there will be some variability between CWFs produced – as indicated by different initial 1-hour flow rates commonly observed. Flow rate is typically used as a quality control indicator for CWF production. Visual inspections and bacteria removal challenge tests are also performed to test CWF quality to ensure that it meets standards.

CWFs were first introduced to Myanmar in 2006 as a result of a partnership between UNICEF, Community Development Association (CDA), and Thirst-Aid. Thirst-Aid is a Myanmar based non-governmental organization that has played the lead role in supporting CWF production activities in the country (20). After the establishment of the first production factory in 2007, national attention and interest in CWFs was raised after Cyclone Nargis struck in 2008. As part of the emergency response, over 100,000 CWFs were produced and distributed. Thirst-Aid supported efforts to establish additional factories and improve production quality during this time. At one time, a total of eight production facilities operated in the country. Currently just three factories are operational in Myanmar – two in the village of Twantay (outside of Yangon) and one in the town of Pathein (west of Yangon). Those that are no longer producing CWFs may have the potential to re-start operations if demand grows. The three currently operational factories are producing CWFs to a quantity depending on the demand from development and humanitarian agencies.

At present, Thirst-Aid is commonly contracted by agencies and NGOs to assist with CWF procurement including quality control and monitoring of production based on a standardized inspection criteria manual (21). Individual agencies sometimes also set their own production, monitoring, and quality control parameters.

Thirst-Aid also specializes in CWF-related training-of-trainers to support the quality of field-level promotion activities conducted by agency staff. A variety of communication and training materials have been developed by Thirst-Aid to convey knowledge of operation and maintenance practices and to establish value of and importance for using the CWF. A CWF manual has also been produced. Reports and materials can be found on Thirst-Aid’s website (<http://www.thirstaidmyanmar.org>).

Several studies have been commissioned in Myanmar to assess CWF performance, production, and use. The first known study was conducted in 2007 by Myanmar Marketing and Research Development, and was commissioned to assess the performance of CWF distributions conducted by UNICEF and Malteser (22). The study revealed that CWF use was very high (81% and 100% at the two study sites) approximately three months after distribution. The study also characterized CWF operation and maintenance practices, satisfaction, reasons for disuse, and willingness to pay.

In 2009, in response to questions concerning CWF production quality, several assessments were conducted. CWF production processes were assessed at four factories prior to a UNICEF-initiated tender (23). The assessment revealed that all four factories were suitable for applying to the tender but quality of the facilities and organization of the processes differed from factory to factory. At one factory, inaccurate flow rate testing was observed. The report also posed recommendations to the factories and for agencies initiating future procurements.

A random batch of 200 CWFs were assessed in another 2009 study (24). Most notably, the study revealed that 87% of CWFs passed the visual inspection (deformities, cracks, shape), 79% of CWFs met flow rate standards (1.5-3.5 L/hr), and it was reported that CWFs may not be able to meet SPHERE standards for minimum water quantity (3 L/person/day). The study also reported that the CWFs can achieve an estimated total of 12 liters of filtered water per day assuming three fillings (morning, noon, and evening). CWFs are more likely to provide sufficient quantities for drinking water purposes only but much depends on the number of members in the household. Based on water quality testing and flow rate calculations, a new 1-hour flow rate guideline of 2-3.8 L/hr was recommended by the consultant. Thirst-Aid’s protocols suggest a recommended flow rate of between 1.5 and 4.5 L/hr.

In response to concerns as to whether arsenic may be leaching from the clays of the CWF, a 3rd study (25) revealed that filtered waters do have higher arsenic concentrations and at some cases above World Health Organization guidelines. This result is similar to the experience of other countries producing CWFs (26). However, like in other countries, high arsenic concentrations are observed only during initial filtration volumes and filtered waters are subsequently mixed with water from future batches resulting in the dilution of arsenic concentrations. As arsenic-related health effects are associated with chronic exposures, the consultant reported that the arsenic leaching issue does not pose a significant health risk to users in Myanmar.

While the Myanmar version of the CWF has not undergone any formal documented laboratory microbial challenge tests, the French Red Cross (FRC) informally evaluated 24 filters in 2009 to determine whether Fecal Coliforms observed in treated waters were the result of poor bucket cleaning practices or ineffective filtration through the CWF pot (27). FRC’s study revealed that high coliform counts were the result of a combination of poor post-filtration storage conditions and ineffectiveness of the filter itself. However, the small-scale study did not describe any water testing quality control measures (i.e. blank tests to ensure no recontamination) and does not describe the CWF configuration promoted by FRC.

After the ethnic conflicts in Rakhine State in 2012 and the subsequent humanitarian response – CWFs were introduced through various agencies supporting WASH interventions. By 2015, over 25,000 CWFs had been distributed at villages and camps affected by the protracted emergency situation (28). To support the WASH cluster’s promotion of CWFs in Rakhine and other regions, a concept note was developed in 2014 and revised in early 2016 (29).

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