SODIS

Solar Disinfection (SODIS) in Kiribati

Solar water disinfection (SODIS) in Bairiki, Kiribati in 2014.

Background

Kiribati is highly vulnerable to the impacts of climate change due to its low elevation and lack of secure water supply. Increasing population pressure and limited available land for settlement in South Tarawa contribute to the pollution of groundwater, which is the main source of water.

As a consequence of consuming contaminated drinking water, childhood mortality from diarrhoea is more common in Kiribati than in other Pacific Island countries, with health officials reporting an average of three outbreaks of acute diarrhoeal disease every year.

To respond to these health risks, the Secretariat of the Pacific Community (SPC) through the European Union funded Global Climate Change Alliance: Pacific Small Island States (GCCA:PSIS) project, launched the Solar Water Disinfection Project (SODIS) in Bairiki, South Tarawa, Kiribati. The SODIS project has two aspects: community behaviour change and a research study. The research study was funded by the GCCA: PSIS project, SPC's Water and Sanitation Programme and the German Agency for International Cooperation (GIZ). The project is being implemented nationally by the Kiribati Ministry of Health and Medical Services (MHMS) – Environmental Health Unit.

What is SODIS?

Solar water disinfection (SODIS) is an effective, environmentally sustainable, low-cost solution for drinking water treatment at a household level. The process of SODIS uses solar energy to destroy pathogenic micro-organisms that cause water-borne diseases. It has the same effect that boiling water has in disinfecting drinking water.

Plastic bottles labelled with the PET recycling symbol are locally available and affordable in Kiribati. PET bottles no larger than 1.5 litres in size are recommended for SODIS. Their performance in drinking water disinfection has been tested in Tarawa and the plastic is strong enough to withstand solar radiation.

Community behaviour change

The project encourages sustained uptake of SODIS in Kawan Bairiki, one of the poorest and most densely populated areas of Tarawa, where families struggle daily to secure safe drinking water. In order to design the project and train the community in SODIS, four workshops were carried out. The workshops developed key messages and produced education and communication materials to prompt uptake of SODIS including demonstration sites, posters, starter packs and educational games.

Following the project launch in October 2014, six water champions were appointed in the community to encourage the uptake of SODIS.

As of February 2015, 76% of households were using SODIS. They have reported the positive effects of using SODIS to be:

- Decreases in diarrheal disease, especially in children.
- Noticeably more healthy children and less days of school missed.
- Decreases in respiratory illness, due to less firewood being burnt to boil water.
- Decreased spending on kerosene.
- Better tasting and smelling water compared to boiling.
- Decreased sugar intake, as with boiling water community members used to add sugar to the water to hide the taste and smell, and this is not needed with SODIS water.

The clinic in Bairiki is also reporting a decrease in incidences of diarrheal and respiratory illness with the number of cases of diarrhoea decreasing from 474 in September 2014 to 143 in February 2015.

National endorsement

With the success of SODIS in the community and the positive research results, the Kiribati Minister of Health and Medical Services launched SODIS nationally on 7th March 2015. The launch featured an educational video on SODIS produced by MHMS in Kiribati. This video and other promotional and educational SODIS materials are available from SPC and MHMS.

European Union

SPC Secretariat of the Pacific Community

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Summary of scientific research on SODIS

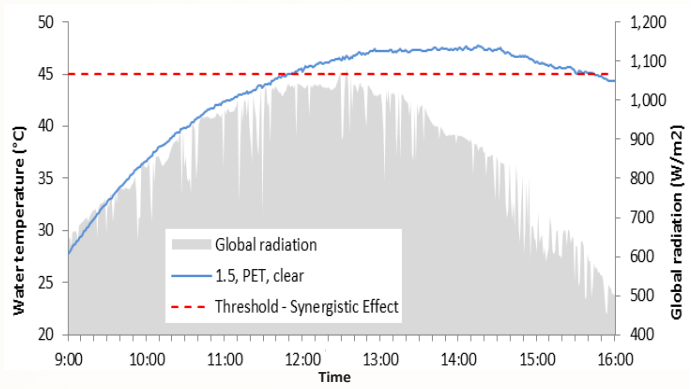

Figure 1: Global radiation and water temperature in PET bottle reactor, averaged for five sunny days in Bairiki, South Tarawa.

Figure 2: Percent of pathogens remaining over an average sunny and overcast day in PET reactors.

Introduction

Contaminated drinking water leads to a high risk of water-borne diseases such as diarrhoea, cholera and typhoid fever. Clinical trials and laboratory studies conducted globally have shown that ultra violet (UV) radiation as used in SODIS is effective against all water-borne microbial diseases.

The application of SODIS has spread throughout the developing world and is in use in more than 50 countries. Although more than five million people disinfect their drinking water with SODIS, this technique is hardly known in the Pacific region.

Kiribati shows the highest rate of mortality for children under five from diarrhoea in Pacific Island countries. Studies show that this rate could be reduced by up to 75% by sustainable treatment of contaminated water with SODIS. The environmental conditions in Tarawa are ideal for implementing SODIS, as Kiribati ranks as the country with the second highest UV radiation globally.

Objective and methods

The overall objective of this research was to test, evaluate and optimise the SODIS technique in Kiribati. All field measurements and tests were conducted in Bairiki, Tarawa from 7–26 October 2014. Polyethylene terephthalate (PET bottles) of 1.5 litres in size were selected as the SODIS reactors due to their availability and low cost. The reactors were filled with water from various contaminated sources and placed on a corrugated iron reflective surface in direct sunlight from 9am to 5pm daily. UV transmittance of the reactor, the water temperature, the amount of total coliform and E. Coli, and the UV radiation in Tarawa were measured.

Results

Pathogenic micro-organisms are vulnerable to two effects of sunlight: UV light and infra-red radiation. A synergistic effect occurs, in that the combined effect is more than double the sum of the single effects. Thus, the mortality of the pathogens increases if they are exposed to UV light and the water temperature exceeds 45°C at the same time.

Figure 1 shows the global radiation during an average sunny day in Tarawa and its effect on the water temperature in a SODIS reactor. At 11:50 am the threshold for the synergistic effect was reached at 45 degrees and all of the pathogens were destroyed after a short time.

Figure 2 shows that, even on days with an overcast sky, more than 99.9% of pathogens are eradicated in PET bottles in less than one day. On clear days and days with scattered clouds, only 3 hours are required to eradicate 99.9% of pathogens.

Conclusion

This study confirmed that after filling SODIS reactors with contaminated water and exposing them to sunlight, SODIS produces pathogen free drinking water. Water from all sources in Kiribati (non-saline groundwater, tap water and rainwater) can easily be disinfected using SODIS, and thus it is expected that SODIS is feasible on all islands of Kiribati.

On days with a clear sky, less than three hours is needed for treatment, compared to other tropical regions where the average recommended disinfection time is six hours. Furthermore, the research study demonstrates that SODIS works even on very cloudy days. However, in order to reduce the risk of some pathogens remaining in the water, this treatment method should not be used on fully overcast or rainy days.

Considering SODIS as a treatment method in drinking water safety planning and in emergency response is highly recommended. Further, this method contributes to energy security: SODIS is a zero-energy cost method that uses renewable energy and thus reduces CO_2 emissions, unlike disinfecting water by boiling using firewood or fossil fuels.

Many other Pacific countries and territories also receive high levels of UV radiation, and thus there is a huge potential for these countries to benefit from solar water disinfection techniques for treatment of contaminated water in everyday situations and following natural disasters.