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SOLUTIONS LAB - PROJECT REPORT - EXPERIMENTATION PROJECT

TURNING SALT WATER INTO FRESH WATER: SOLAR DESALINATION

CONTEXT

Likotuden, the district capital of Flores Island in East Nusa Tenggara province and an hour's drive from Larantuka, is an arid area where rice crops frequently fail and soil is too poor to grow most vegetables. In addition to difficult farming conditions, sources of fresh water are limited. Families living in Likotuden village currently have drinking water piped from Leto Matan water spring to a central water tank in the village from where they then collect drinking water.

The Leto Matan spring is not only the water source for Likotuden but also for the wider Larantuka community. According to an online article by Mongabay Indonesia, water crises and environmental degradation in Larantuka have made access to fresh water an urgent issue. The Leto Matan water spring is drying up with an output of just 32 liters of water per second in 2016 compared to the previous year's of 110 liters per second. Such a reduction in output means Likotuden's water source is at critical risk.

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HYPOTHESIS

Kopernik hypothesized that the Carocell 3000 Water Purifier would successfully produce enough potable water per day to meet one family's daily drinking water needs.

The solar desalinator will:

- Meet the functional requirements of the harsh environmental conditions of Likotuden;
- Produce water fit for drinking according to the standard of fresh water quality by Indonesia’s Department of Health and the World Health Organization (WHO).

METHODOLOGY

Kopernik rapidly tests innovative solutions in last mile contexts in order to determine their potential to reduce poverty effectively. In our experiments Kopernik adopts a lean approach, collecting and analysing small-scale data to learn the effectiveness of the solutions.

In this project, Kopernik observed the performance and functionality of the solar desalination technology over five months. Kopernik collected water quality data using measuring tools such as a pH meter, a TDS meter, and a salinity meter. To ensure accuracy, each desalination measurement was taken multiple times. The results were then calculated and averaged. Kopernik also engaged the Department of Health in Larantuka and Kupang to conduct a fresh water quality test. The volume of water produced was measured by weight and converted from kilograms to liters.

FINDINGS

Environmental Appropriateness

The conditions of Likotuden are a true last mile community where access is difficult and infrastructure and services are limited. The location for this experiment was not ideal in terms of proximity to the sea water source but it was ideal in terms of mirroring similar communities where access to fresh water is difficult. The setup of the desalinator required the establishment of an 80 liter static water tank filled by seawater from a 130 meter pipe and pump system which relied on gravity pressure to fill the desalinator.

The family testing the technology reported that the pipe and pump system was precarious and required repair on one occasion. They reported that the desalinator itself was easy to use but at one point they shifted the machine, upsetting the angle and causing the brine (the salty water separated from the fresh water through the filtration process) and the fresh water to mix and become contaminated after filtration. Using a split level solved this problem quickly.

Unsurprisingly, the brine was particularly corrosive and the metal frame became rusty (image 1). After three months’ use, the panel cloth inside the machine had also disintegrated in parts (image 2). Upon receiving photos of the damage to the cloth, FCubed, the manufacturer, determined that the fabric was not worn all the way through and the damage was therefore primarily cosmetic and should not affect the desalinator's operation. The metal corrosion also had no affect on the machine's functionality.

The panel cloth required washing with fresh water every two months so the crystals from the salt water outlet did not reach the fresh water channels. This was not a difficult process but it did consume a portion of the filtered fresh water making it unavailable for the family to drink.

Image 1

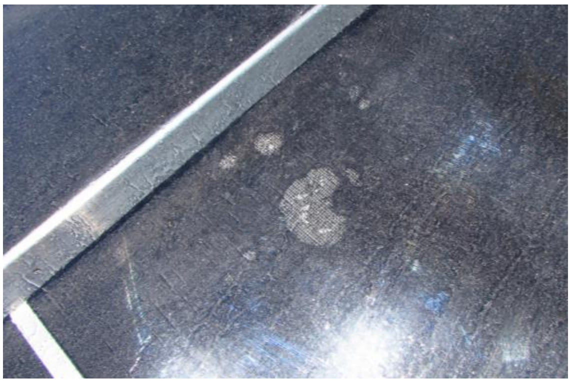

Image 2

Potability

Fresh water can be defined as water with less than 500 parts per million (ppm) or 0.05% of dissolved salts.[1] According to the World Health Organization (WHO)'s "Guidelines for Drinking Water Quality 2017", water with a TDS level of less than 600 miligram/liter is considered to be good. Using a salinity meter, Kopernik tested the salinity level of the seawater before it entered the desalinator where it was at a level of 3.0% (Image 3), and then after filtration where it was recorded as 0.0% (Image 4) proving that the water was potable.

[1] *https://en.wikipedia.org/wiki/Fresh_water#cite_note-5*

Image 3

Image 4

Kopernik also tested the filtered water in government laboratories. The results from the Department of Health in Kupang demonstrated zero presence of E.Coli bacteria (Image 5), and the Department of Health in Larantuka deemed the water fit for drinking in terms of smell, color and taste as well as chemical elements (Image 6). This is in line with the Indonesian Ministry of Health's regulation number 492/MENKES/PER/IV/2010.[2] While this is not a measure of the desalinator's performance, it does show that the water is fit for drinking.

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KUPANG – NTT

Telah terakreditasi penuh oleh Komisi Akreditasi Laboratorium Kesehatan Nasional
Sertifikat Akreditasi Laboratorium Kesehatan Nomor : 17/ S / KALK-P / XII / 2013
Dokter Penanggung Jawab : dr. Hermi Indita Malewa, SpPK

HASIL PEMERIKSAAN BAKTERIOLOGI AIR

PENGIRIM : YAYASAN KOPERNIK LARANTUKA
TANGGAL KIRIM : 01 AGUSTUS 2017
JENIS SAMPEL : AIR BERSIH
JENIS PEMERIKSAAN : E. COLI DAN TOTAL COLIFORM

NO	KODE SAMPEL	JENIS PEMERIKSAAN		PERMENKES NO. 416/MENKES/PER/IX/1990 TENTANG PERSYARATAN KUALITAS AIR BERSIH
		E. COLI	TOTAL COLIFORM	
1	01	0	0	Bukan air perpipaan : *E. Coli* : - *Total Coliform : 50/100 mL*
2	02	0	0	Air perpipaan : *E. Coli* : - *Total Coliform : 10/100 mL*

Catatan : Hasil hanya berlaku pada sampel yang diperiksa

Kupang, 15 Agustus 2017

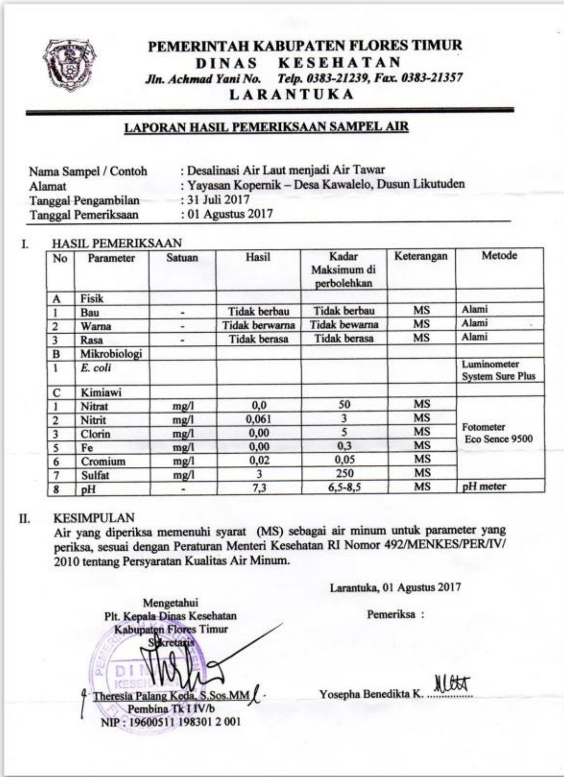
Mengetahui,
Kepala UPT Laboratorium Kesehatan
pada Dinas Kesehatan Provinsi NTT

Drs. Agustinus Salu, Apt., MM
Pembina Tk I
NIP. 19660826 199303 1 012

Pemeriksa,

Dewi Santy E. O. Day, SKM
NIP. 19780428 200012 2 003

Image 5



PEMERINTAH KABUPATEN FLORES TIMUR
DINAS KESEHATAN
Jln. Achmad Yani No. Telp. 0383-21239, Fax. 0383-21357
LARANTUKA

LAPORAN HASIL PEMERIKSAAN SAMPEL AIR

Nama Sampel / Contoh : Desalinasi Air Laut menjadi Air Tawar
Alamat : Yayasan Kopernik – Desa Kawalelo, Dusun Likutuden
Tanggal Pengambilan : 31 Juli 2017
Tanggal Pemeriksaan : 01 Agustus 2017

I. HASIL PEMERIKSAAN

No	Parameter	Satuan	Hasil	Kadar Maksimum di perbolehkan	Keterangan	Metode
A	Fisik					
1	Bau	-	Tidak berbau	Tidak berbau	MS	Alami
2	Warna	-	Tidak berwarna	Tidak bewarna	MS	Alami
3	Rasa	-	Tidak berasa	Tidak berasa	MS	Alami
B	Mikrobiologi					
1	*E. coli*					Luminometer System Sure Plus
C	Kimiawi					
1	Nitrat	mg/l	0,0	50	MS	Fotometer Eco Sence 9500
2	Nitrit	mg/l	0,061	3	MS	
3	Clorin	mg/l	0,00	5	MS	
5	Fe	mg/l	0,00	0,3	MS	
6	Cromium	mg/l	0,02	0,05	MS	
7	Sulfat	mg/l	3	250	MS	
8	pH	-	7,3	6,5-8,5	MS	pH meter

II. KESIMPULAN
Air yang diperiksa memenuhi syarat (MS) sebagai air minum untuk parameter yang periksa, sesuai dengan Peraturan Menteri Kesehatan RI Nomor 492/MENKES/PER/IV/ 2010 tentang Persyaratan Kualitas Air Minum.

Larantuka, 01 Agustus 2017

Mengetahui
Plt. Kepala Dinas Kesehatan
Kabupaten Flores Timur
Sekretaris

Theresia Palang Keda, S.Sos.MM
Pembina Tk I IV/b
NIP : 19600511 198301 2 001

Pemeriksa :

Yosepha Benedikta K. ....

Image 6

Water Volume

The solar desalination process is strongly influenced by weather and other environmental factors, in particular exposure to sunlight. When the exposure to sunlight is high the desalination performance will be maximized. During the experiments, Kopernik positioned the desalination machine under direct sunlight without any shade from buildings or trees. The volume of water is also be affected by the availability and capacity of the water pump. The further the distance between the water pump and the sea, the higher the capacity of pump is needed. Kopernik installed a 10 liters/minute capacity pump with a 130m pipe. This desalinator model can also be used without a pump, requiring the seawater tank which feeds the

[2] *The water test was conducted by Ferdinandus Mada, SKM and Yosepha Benedikta Kumanireng (Larantuka's Health Department staff)*

desalinator to be filled manually.

According to FCubed, the Carocell 3000 can produce 15 liters of fresh water from 30 liters of seawater per day with perfect conditions. Based on our results, the desalination tool in Likotuden produced an average of 10 liters of fresh water per day. On the first and fourth day, the desalinator produced an amount of fresh water that was consistent with the manufacturer's standards, however, on the third day, due to heavy rain, only 6.5 liters of fresh water was produced (Figure 1). It should be noted that during our monitoring and evaluation period, the weather in Likotuden was mostly cloudy.

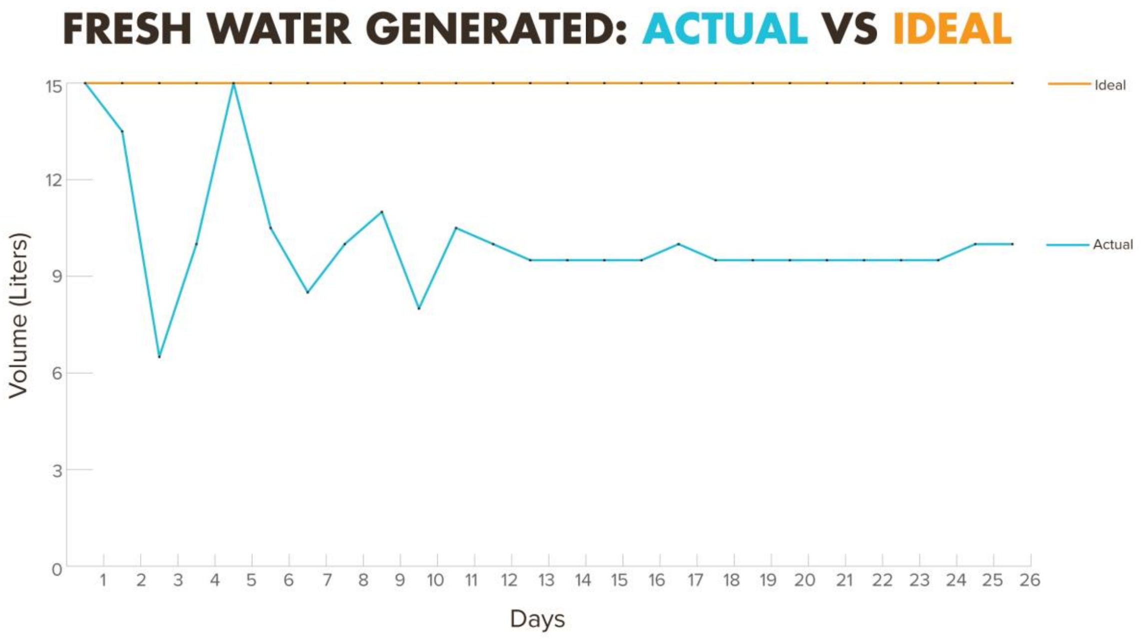


Figure 1. The amount of fresh water generated by the solar desalination tool

Another important factor that affected the desalination process was the sea's tidal patterns. Ideally, the water pump's hose collecting the seawater would be located from a jetty and would be submerged in water at all times. However, in Likotuden, the pump collected seawater from the shore and with the length of pipe used, Kopernik could only collect seawater at high tide. If the water pump was operated when the tide was low, the remaining water in the suction channel ran out causing cavitation in the pump. If this occurs on a regular basis, cavitation will likely damage the pump after just two years.

The water volume collected in Likotuden was also affected by the collection method. The family testing the technology collected the fresh water from the desalinator using an open bucket and then poured it into plastic drinking bottles for storage, resulting in some spillage.

While the analysis of the water volume was based on one family's average needs of 10 liters per day, Kopernik checked this against other families' needs in the community. Across four more families in Likotuden, Kopernik found that their consumption was similarly also averaging 10 liters for drinking per day. Kopernik found across the five families interviewed that families used an average of 200 liters of water for other daily household needs such as for showering and washing. Therefore while the desalinator did cover the family's drinking water needs, the technology would not be a viable solution to cover all household fresh water needs.

Affordability

While affordability was not the focus of this project phase, Kopernik conducted a calculation based on the 10 liters drinking water consumption of the five families in Likotuden. Assuming that the Leto Matan spring does not continue to meet the needs for all families in Likotuden and people had to start buying their drinking water from the small water truck operating in the area, the daily requirement of ten liters of water per day would cost around IDR2,000 (~US$0.15). Over one year, that equates to IDR730,000 (~US$54).

If a family did decide to invest in the Carocell 3000 desalinator, the cost of the machine would be more than US$250. This base cost does not include shipping and transport to the final installation location or installation materials and labour, pipe and pump (if required) or water collection and storage containers. Based on the three year lifetime of the product, the desalinated water would therefore cost a minimum of US$83/year (US$250/3 years), 65 percent more expensive than buying the equivalent volume of gallon water in this area at US$54.

CONCLUSION

The Carocell 3000 desalination machine installed in Likotuden did meet households' daily drinking water needs. Our hypothesis was proven correct, as the desalinator produced an average of 10 liters of fresh water per day exactly meeting the household's average 10 liter drinking water requirements. The water quality also met the Indonesian Government and WHO standards, with a salinity level under 0.05%. The functionality of the desalination technology met the requirements needed in a last mile environment.

Kopernik believes the performance of the Carocell 3000 can be better and meet the manufacturers claims of 15 liters per day if the desalinator was operating in a more ideal location than Likotuden, avoiding the complications of the far distance from the shore and the tidal influences. Kopernik suggests a more efficient water collection method could be adopted which would reduce spillage.

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TESTIMONIAL :

The water produced by the by the desalination tool is the same quality as the fresh water from the mountain in Kawalelo Village- Ibu Maria Loretha, Likotuden, East Flores

RECOMMENDATIONS

Based on the data collected, Kopernik recommends that:

1. Organisations working with this technology locate the machine near the sea or a sea water well with a submerged pipe to minimize complications due to precarious pipes and pumps and tidal fluctuations.
2. Kopernik tests this technology again to see if a more ideal location and better collection methods will meet the manufacturer's claim of a 15 liters per day production capacity.
3. Kopernik tests other desalination tools to see if there is in fact a system that produces a larger capacity, meeting the full household water requirements at a viable price point (a cheaper alternative to purchasing water).

LEARN MORE

1. Kopernik's Director of Strategic Initiatives, Anna Baranova's Kopernik Insight investigated the functionality versus return on investment for the Carocell 3000 Water Purifier.
2. We shared this report to the Carocell3000 Water Purifier manufacturer, FCUBED. Learn more about their detailed response and feedback.