Wastewater in cold climate experiences in the Andes

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VALE DO JAVARI


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VALE DO JAVARI


Baeza
Cosanga
Loreto
Orellana
Cotundo
Archidona
Tena
Puerto Misahuallí
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Reserva Biológica Colonso Chalupas
93.246 has de laboratorio vivo


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Indigenous nationality Kichwa Napo Runa

Tenerife ITER. Spain 2001. 10 meters altitude









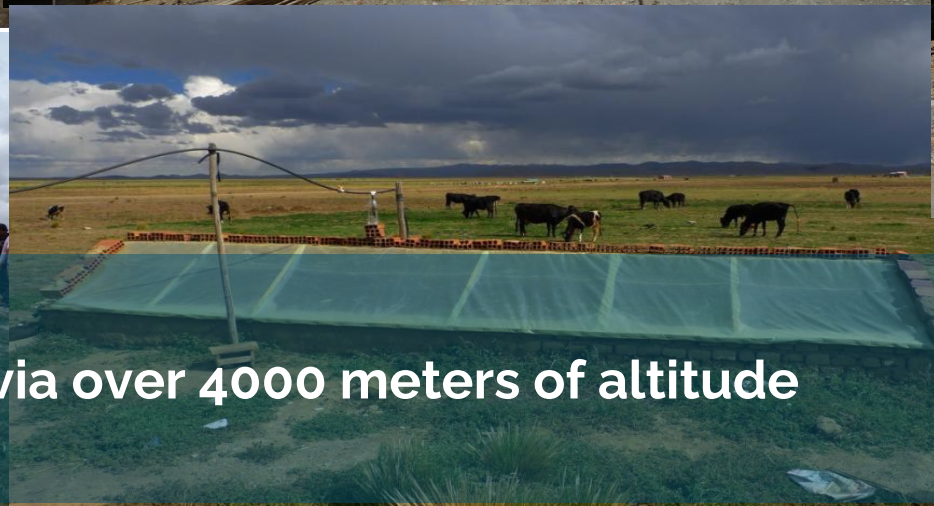



Bolivia Around 2500 meters of altitude








Bolivia over 4000 meters of altitude


Bolivia over 5000 meters of altitude
Refuge Las Rocas 5130 msnm
Huayna Potosi 6088 msnm

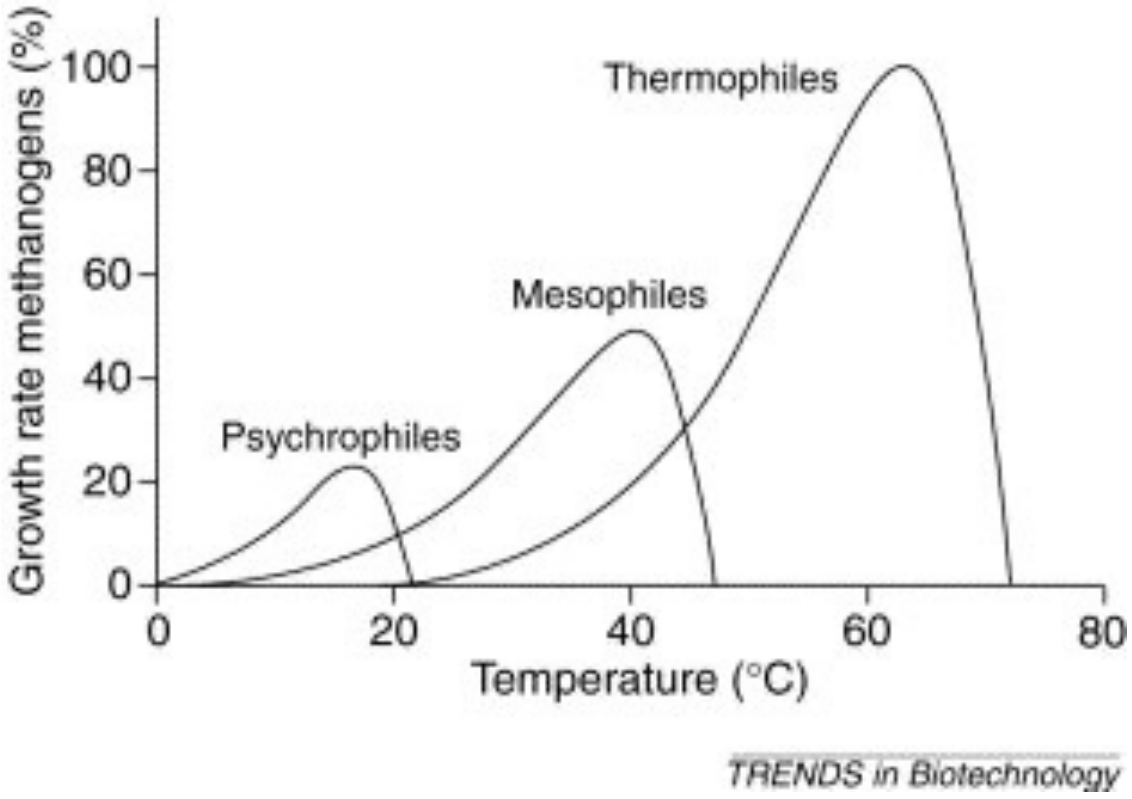
Low-cost digestors

Tenerife ITER. Spain 2001. 10 meters altitude

Santa Rosa, G. Parra Ecuador, 2015

Santander, Finca TOSOLY, Colombia, 2015

How Digestors Work



Lettinga, G., Rebac, S., & Zeeman, G. (2001). Challenge of psychrophilic anaerobic wastewater treatment. TRENDS in Biotechnology, 19(9), 363-370.

Predicting methane production in simple and unheated biogas digesters at low temperatures

Cuong H. Pham, Jin M. Triolo *, Sven G. Sommer

University of Southern Denmark, Faculty of Engineering, Institute of Chemical Engineering, Bio- and Environmental Engineering, Campusvej 55, 5230 Odense M., Denmark

C.H. Pham et al. / Applied Energy 136 (2014) 1–6

Laboratory studies reported that bellow 20 ºC there are no (or very few) Anaerobic Digestion

The reference, at 36.5 ºC is 325 l/kgVS

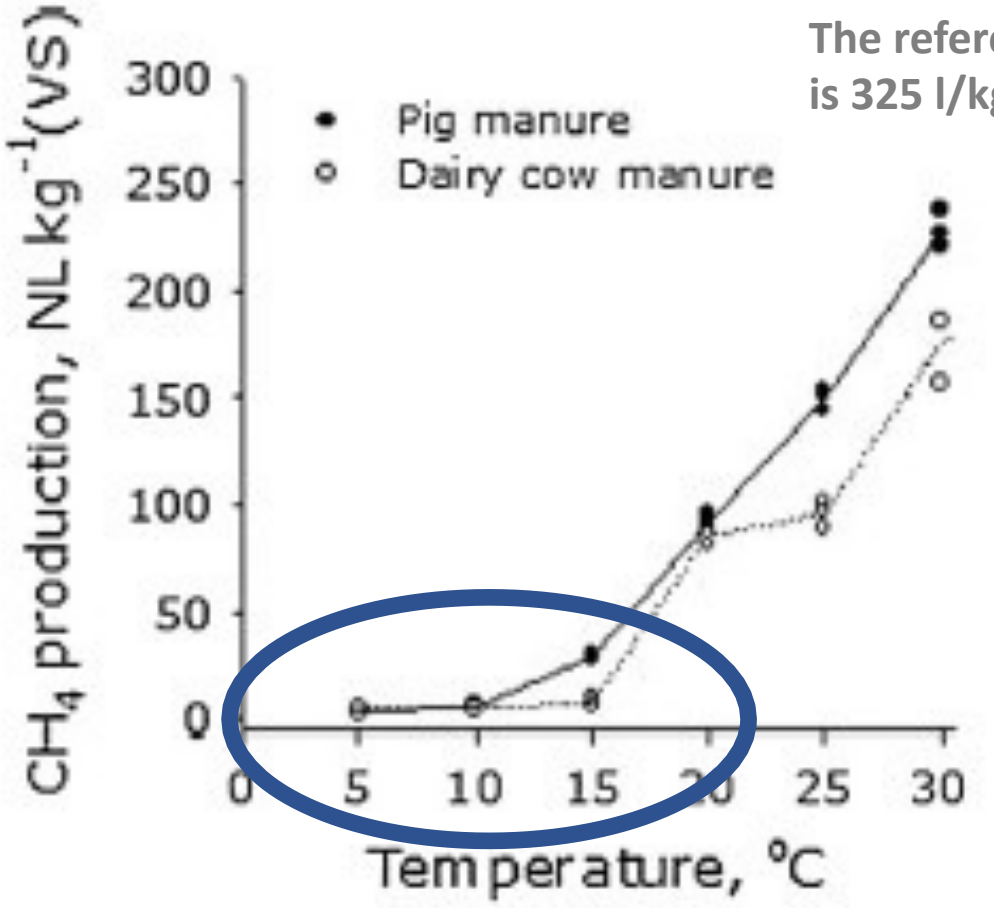


Fig. 2. Relationship between temperature (°C) and overall methane production (CH_4 NL kg VS^{-1}) from pig manure (solid line) and cow manure (dashed line).

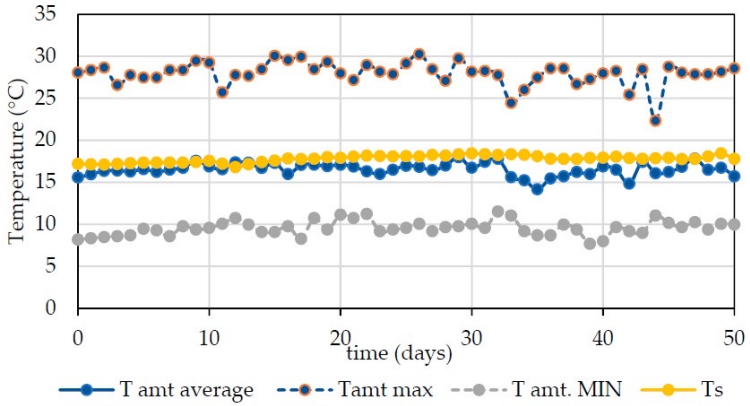
energies

MDPI

Article

Psychrophilic Full Scale Tubular Digester Operating over Eight Years: Complete Performance Evaluation and Microbiological Population

Jaime Jaimes-Estévez [1], German Zafra [2], Jaime Martí-Herrero [3,4,*], Guillermo Pelaz [5], Antonio Morán [5], Alejandra Puentes [1], Christian Gomez [1], Liliana del Pilar Castro [1] and Humberto Escalante Hernández [1]



Full scale, 8 years old digester, treating pig manure reporded 400 l/kgVS working at 17.7°C

But Pham et al 2014 said around 50 l/kgVS (17-18ºC)

The reference, at 36.5 ºC is 325 l/kgVS

Performance characterization

CH_4	%	63.1 ± 5.3
SMP	$Nm^3\ CH_4/kg\ VS$	0.40
MPR	$Nm^3\ CH_4/m^3_{digester}\ d$	0.21
COD reduction	%	66.7%
VS reduction	%	77.6%
Coliforms reduction	%	10.5%

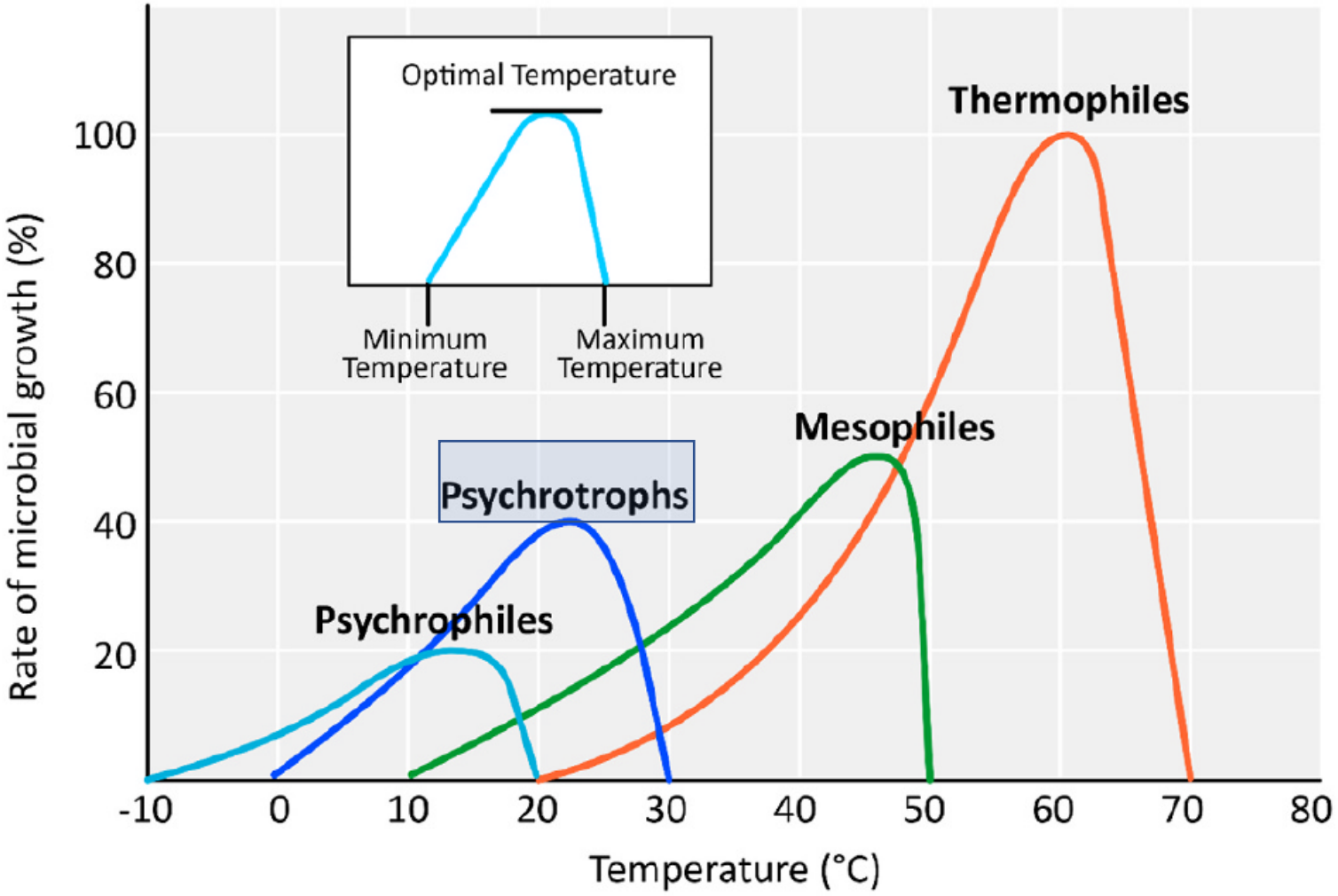


Fig. 1. The relative growth rate of psychrophilic, psychrotrophic, mesophilic and thermophilic microorganisms in response to temperature (adapted from Wiegel [24]).

Psychrophilic anaerobic digestion: A critical evaluation of microorganisms and enzymes to drive the process

Muyiwa Ajoke Akindolire[a], Haripriya Rama[a,b], Ashira Roopnarain[a,*]

Renewable and Sustainable Energy Reviews 161 (2022) 112394
ttps://doi.org/10.1016/j.rser.2022.112394

Bioresource Technology Reports 20 (2022) 101279

Contents lists available at ScienceDirect

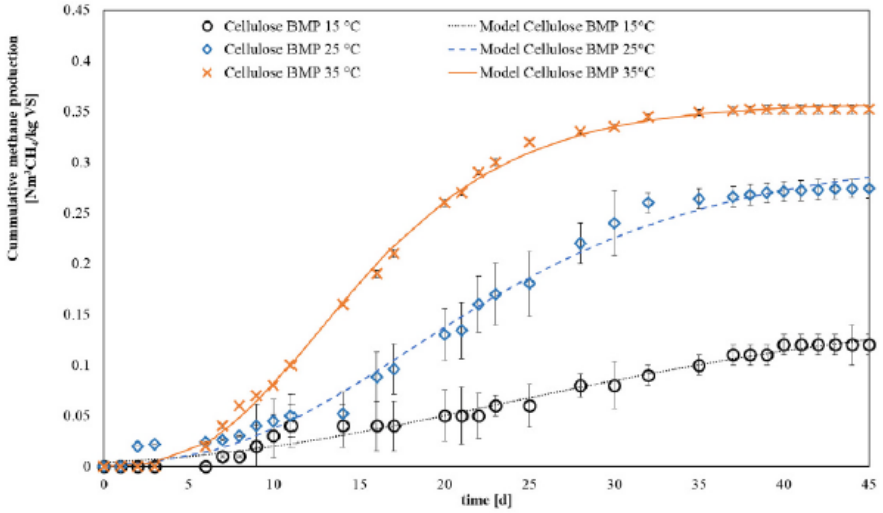
Bioresource Technology Reports

journal homepage: www.sciencedirect.com/journal/bioresource-technology-reports

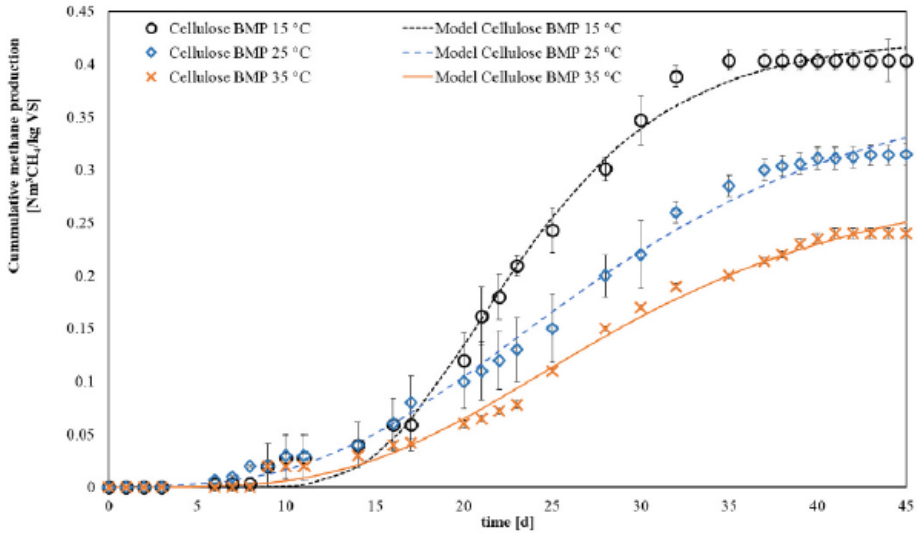
Biomethane potential test applied to psychrophilic conditions: Three issues about inoculum temperature adaptation

Jaime Martí-Herrero [a,b,*], Liliana Castro [c], Jaime Jaimes-Estévez [c], Mario Grijalva [d], Monica Gualatoña [d], María Belen Aldás [d], Humberto Escalante [c]

The history of the inoculum is the key



Mesophilic inoculum



Psychrophilic inoculum

Environmental Science
Water Research & Technology

PAPER

Cite this: *Environ. Sci.: Water Res. Technol.*, 2021, 7, 156

Sewage treatment at 4 °C in anaerobic upflow reactors with and without a membrane – performance, function and microbial diversity†

Evangelos Petropoulos, *[a] Burhan Shamurad,[a] Shamas Tabraiz,[a] Yongjie Yu,[a] Russell Davenport,[a] Thomas P. Curtis[a] and Jan Dolfing [ab]

In this study, we investigated the feasibility of anaerobic sewage treatment at extremely low temperatures (4 °C) using two reactor setups: upflow anaerobic sludge blanket reactors (UASB) without and with ($AnMBR_{UASB(UF)}$) a membrane. Both reactors were inoculated with seeds derived from sediments that were putatively acclimatized to low temperatures. A preliminary batch trial showed that treatment is feasible with the removal of carbon coupled to methane and sulphide production. The reactors operated for 180 days at a hydraulic retention time of 3 days. After 40 days acclimation, both systems met the EU chemical oxy-

methanogen was present but not abundant and largely confined to the biofilm. These observations suggest that at 4 °C methane can be produced not only through direct acetoclastic methanogenesis, but also through acetate oxidation coupled with hydrogenotrophic methanogenesis.

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Accepted 10th November 2020

DOI: 10.1039/d0ew00753f

rsc.li/es-water

methanogenic activities at 4 °C (<18 fmol CH_4 per $cell_{methanogen}$ per day) confirmed that acetoclastic methanogenesis is important in both setups and hydrogenotrophic methanogenesis was only unequivocally observed in the UASB reactors. The microbial diversity of the two systems was similar, and interestingly revealed several putatively hydrogenotrophic methanogens (*i.e.*, *Methanospirillum*, *Methanobrevibacter* and unassigned *Methanomassiliococeae*). *Methanosaeta*; the archetypal acetoclastic methanogen was present but not abundant and largely confined to the biofilm. These observations suggest that at 4 °C methane can be produced not only through direct acetoclastic methanogenesis, but also through acetate oxidation coupled with hydrogenotrophic methanogenesis.


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Image IBCAO


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus


Image Landsat / Copernicus
Goog


Digester inside a
compact greenhouse
Insulation in the trench
Viacha, La Paz, Bolivia. Endev-Bolivia-GTZ y CIMNE, 2011
At the begining
straw, but desapear
after 2 years

Viacha, La Paz, Bolivia. Endev-Bolivia-GTZ y CIMNE, 2011

CIB3:Centro de Investigación en Biodigestores, Biogás y Biol
(Research Center in Digesters, Biogas andBioslurry)

Experimental station
Choquenaira (UMSA)
Viacha, La Paz
3850 m.a.s.l.

gtz
COOPERACIÓN Bolivia Alemania
EnDev Acceso a Energía
Koninkrijk der Nederlanden
Hivos people unlimited
CIMNE
CPTS
CIPCA Centro de Investigación y Promoción del Campesinado
UNIVERSITAS MAJOR PACENSIS DIVI ANDREAE

CIB3:Centro de Investigación en Biodigestores, Biogás y Biol
(Research Center in Digesters, Biogas andBioslurry)

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PN16
m³

Bioresource Technology 167 (2014) 87–93

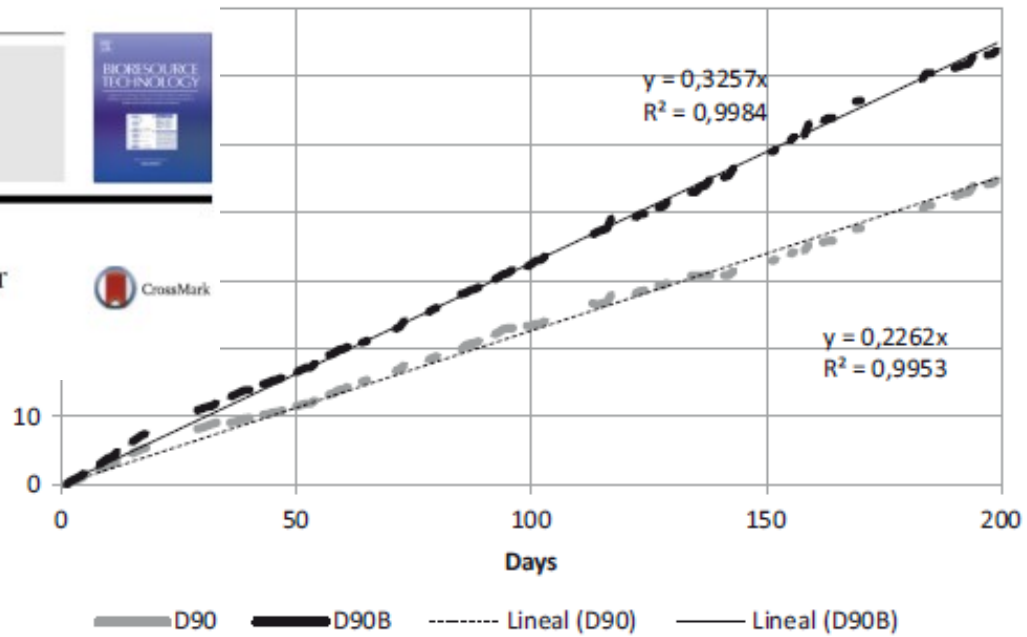
Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Improvement through low cost biofilm carrier in anaerobic tubular digestion in cold climate regions

J. Martí-Herrero [a,*], R. Alvarez [b], M.R. Rojas [b], L. Aliaga [c], R. Céspedes [d], J. Carbonell [a]




filter or biofilm?

Problems with the greenhouse plastic after two years

Viacha, La Paz, Bolivia. Endev-Bolivia-GTZ y CIMNE, 2014

Viacha, La Paz, Bolivia. Hivos and CIMNE, 2014

Viacha, La Paz, Bolivia. Hivos and CIMNE, 2014

And change the Straw insulation by polystyrene foam

Viacha, La Paz, Bolivia. Hivos and CIMNE, 2014

Viacha, La Paz, Bolivia. Hivos and CIMNE, 2015

…but we failed.
To much heat!

Viacha, La Paz, Bolivia. Hivos and CIMNE, 2015

Viacha, La Paz, Bolivia. Hivos and CIMNE, 2015

T. Perrigault et al. / Bioresource Technology 124 (2012) 259–268

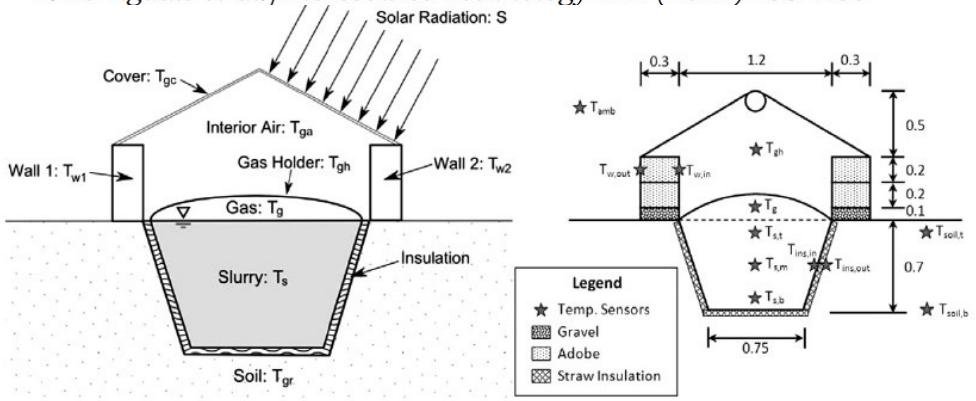


Fig. 1. General cross-section of the digester simulated in the 1-D thermal computer model and locations of the temperature sensors in and around the experimental digester. Length measurements are in meters.

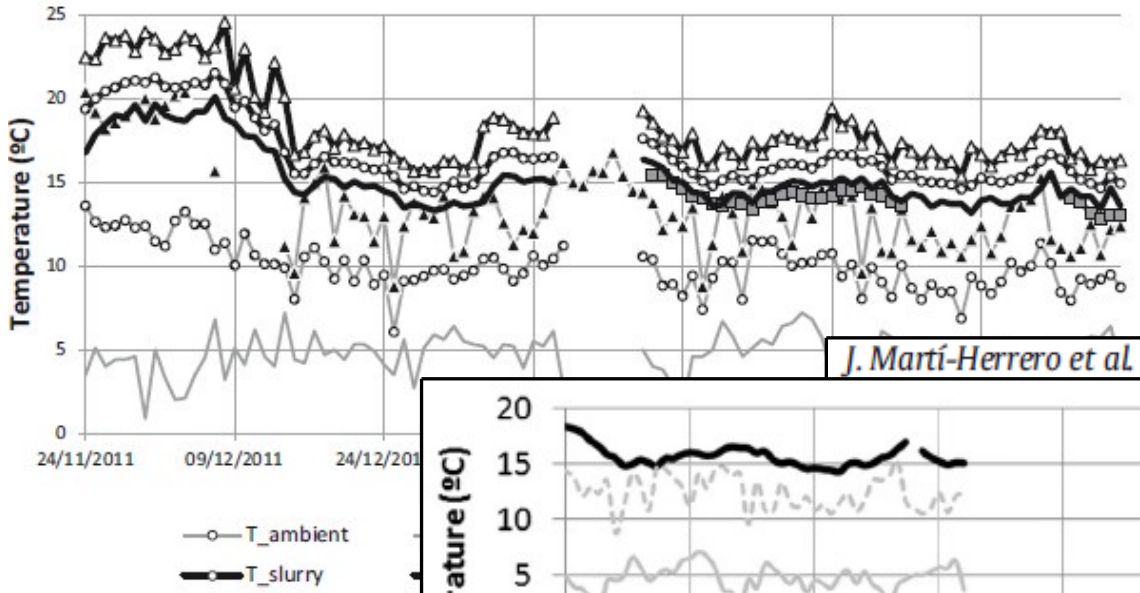
We focused on solar passive design with differents papers published:

The conclusions?

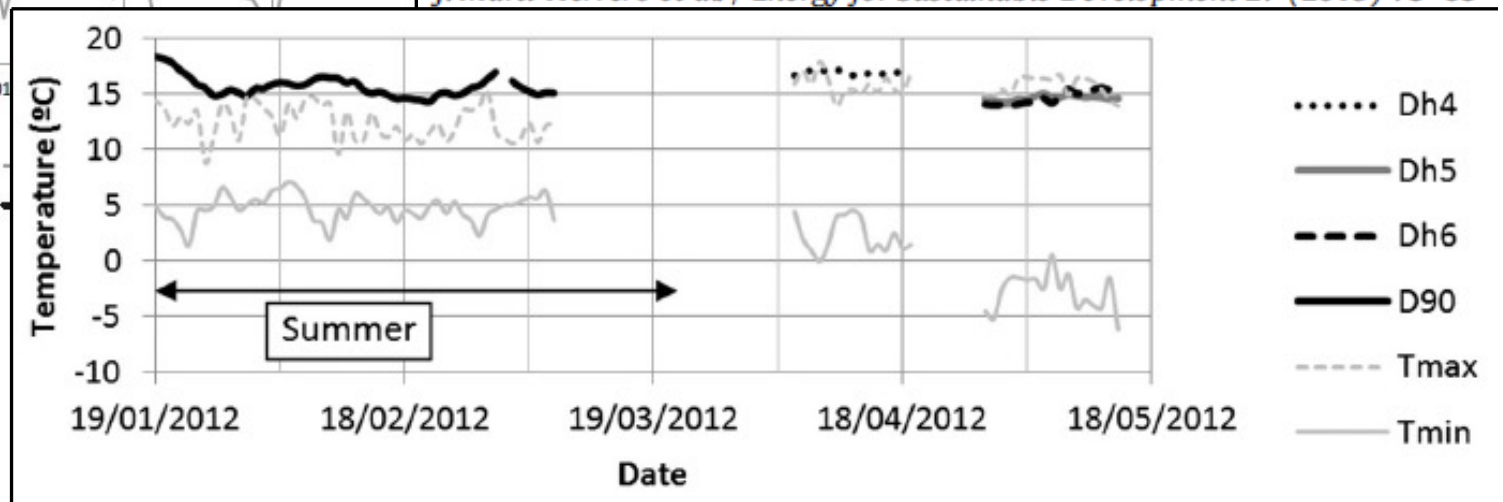
We can reach a slurry temperature similar to the maximum ambient temperature

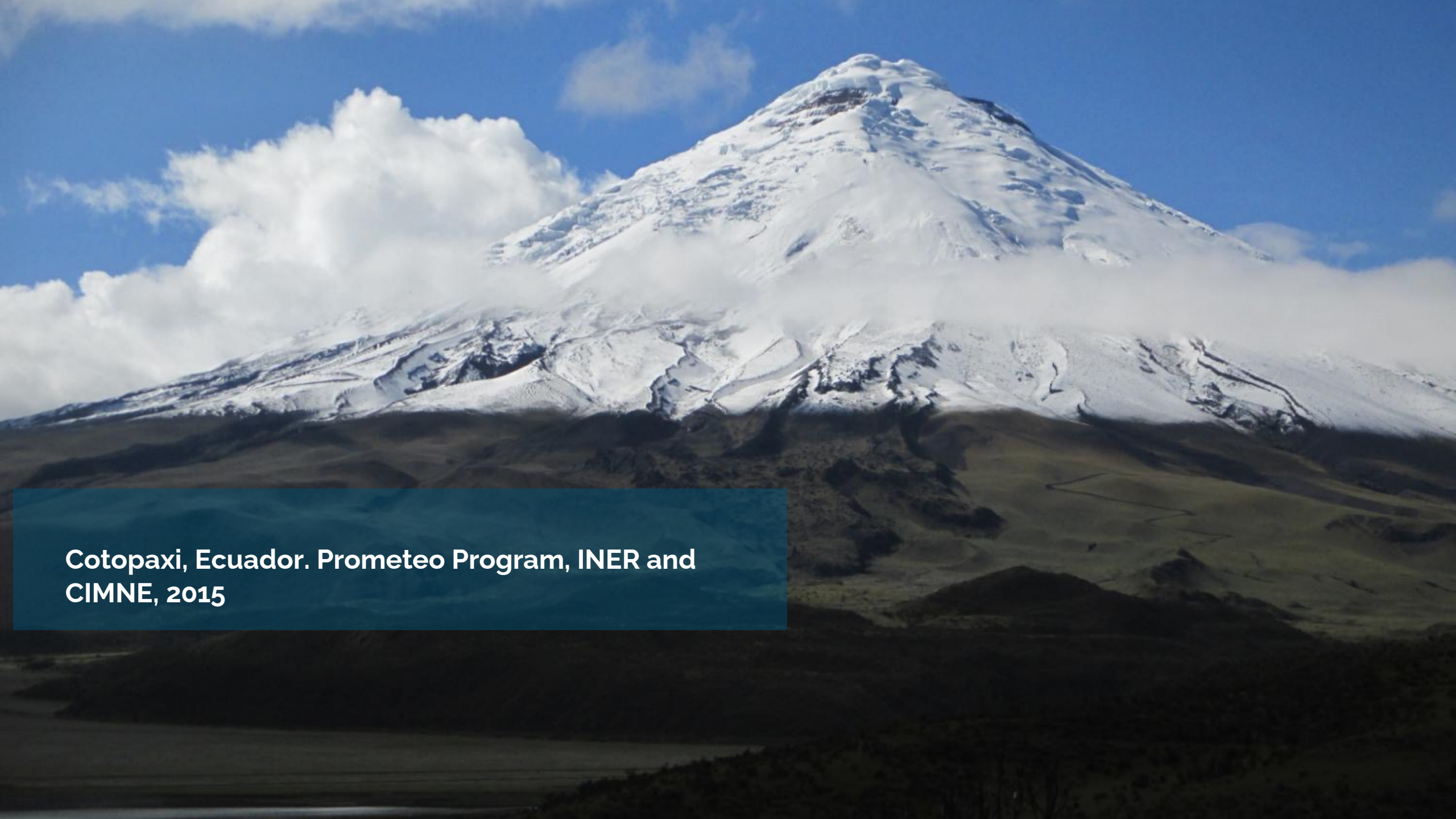
Without active heating, just taking advantege of solar passive design

J. Martí-Herrero et al. / Bioresource Technology 167 (2014) 87–93



J. Martí-Herrero et al. / Energy for Sustainable Development 27 (2015) 73–83





Cotopaxi, Ecuador. Prometeo Program, INER and CIMNE, 2015

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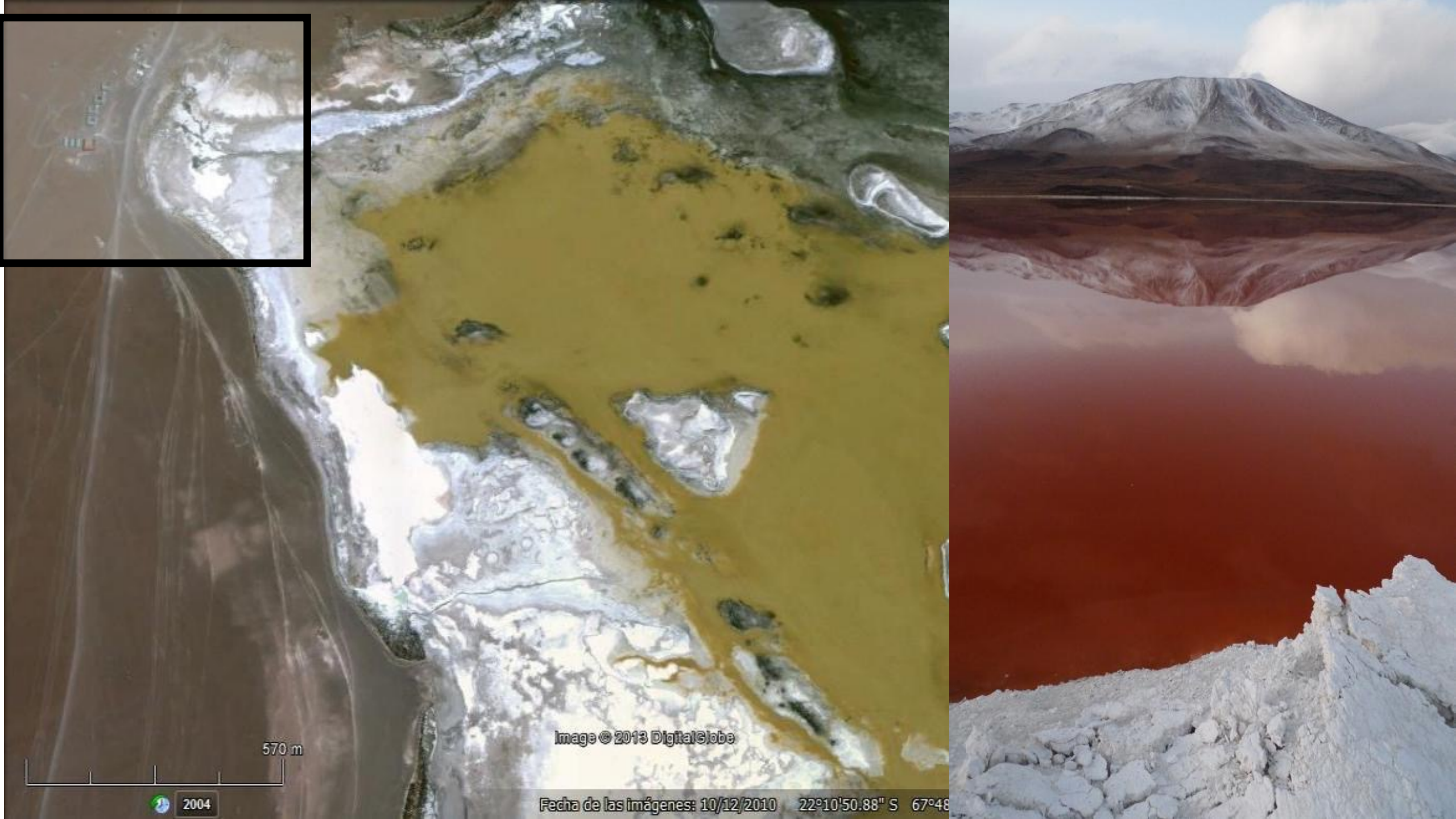
Cotopaxi, Ecuador. Prometeo Program, INER and CIMNE, 2015

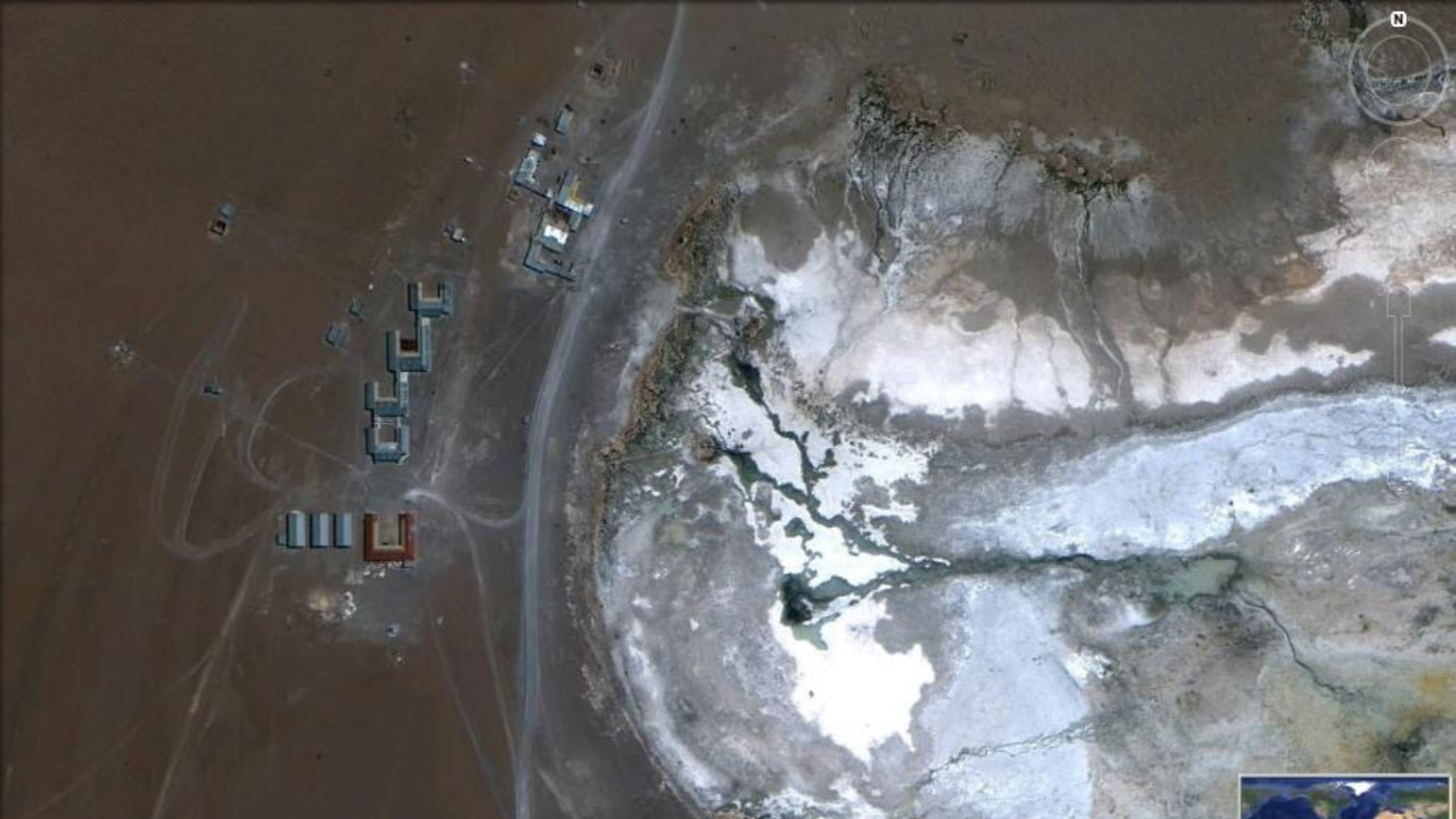
Cotopaxi, Ecuador, FONAG-INER 2015

Cotopaxi, Ecuador. Prometeo Program, INER and CIMNE, 2015

Cotopaxi, Ecuador, FONAG-INER 2015


Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
133 km
Google earth


570 m
2004
Image © 2013 DigitalGlobe
Fecha de las imágenes: 10/12/2010 22°10'50.88" S 67°48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Laguna Colorada, Bolivia CIMNE, 2014

300 cutted bottles per digerter

3 digester in serie

Black water separated of the grey water

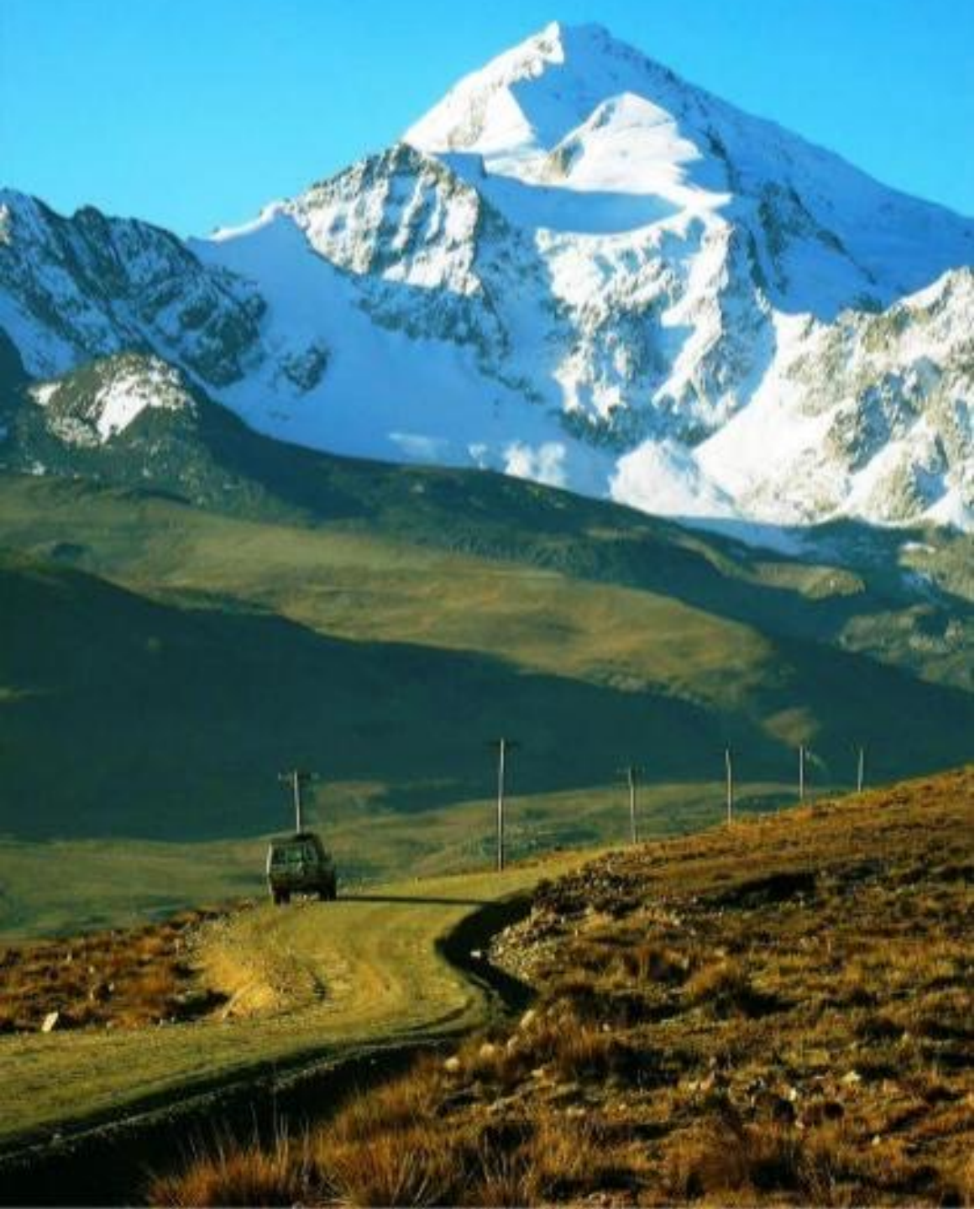
Laguna Colorada, Bolivia CIMNE, 2014

Laguna Colorada, Bolivia CIMNE, 2014

Ventilated Wetland with subsuperficial flux

Laguna Colorada, Bolivia CIMNE, 2014

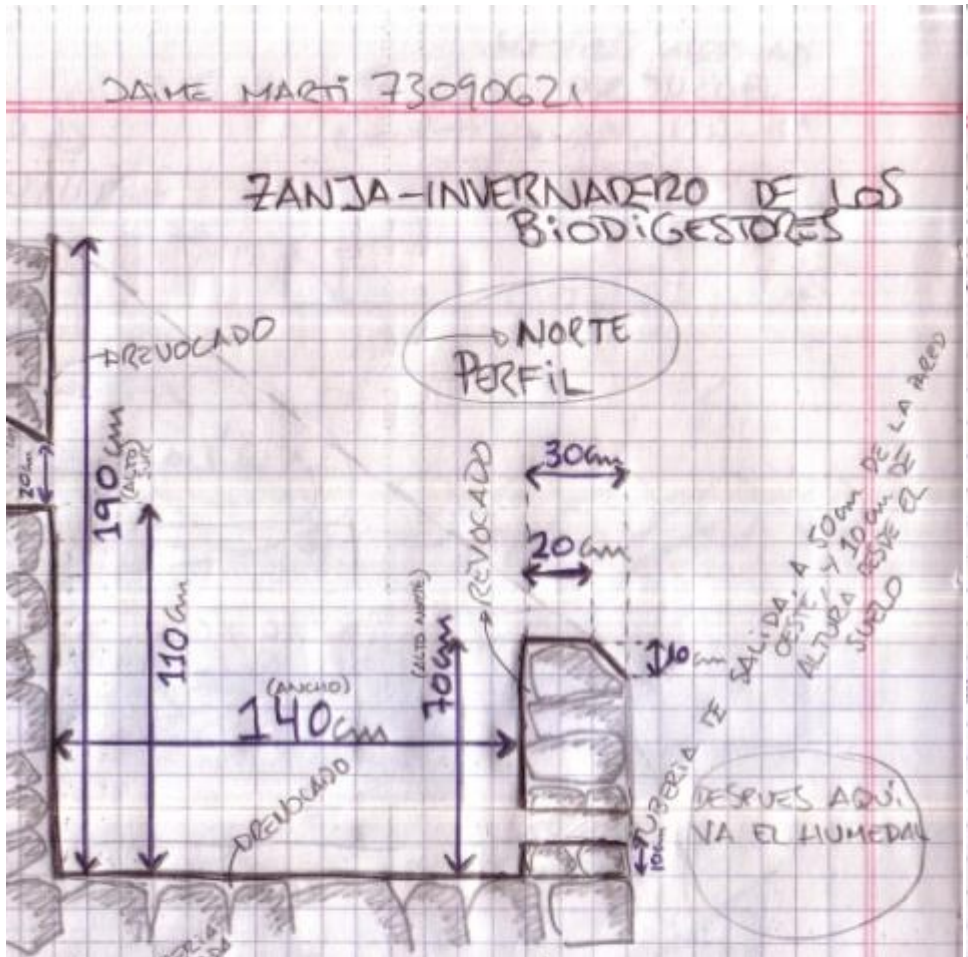
Laguna Colorada, Bolivia CIMNE, 2014

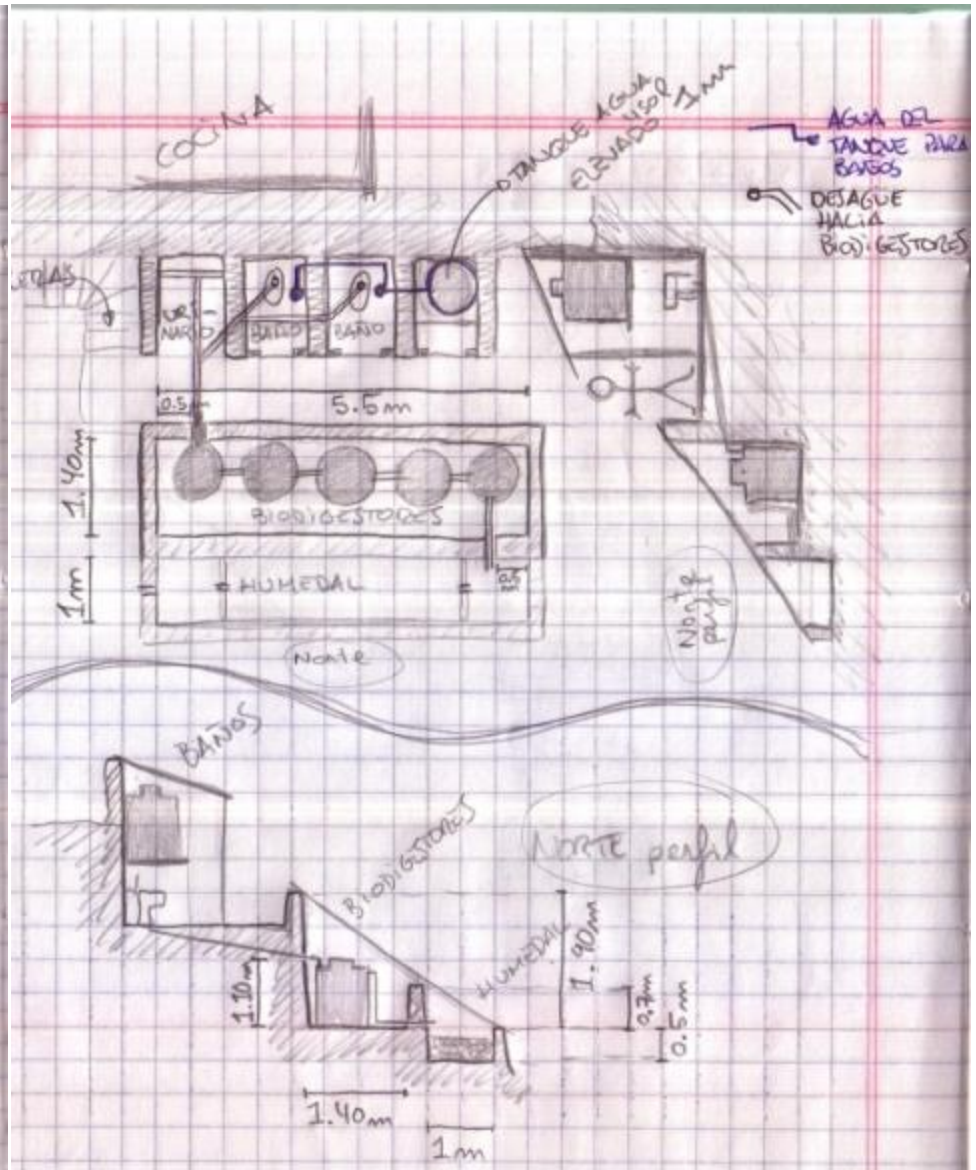



ROCK CAMP
CAMPO·ALTO ROCA·
5130masl

JAIME MARTI 73090621

ZANJA-INVERNADERO DE LOS BIODIGESTORES





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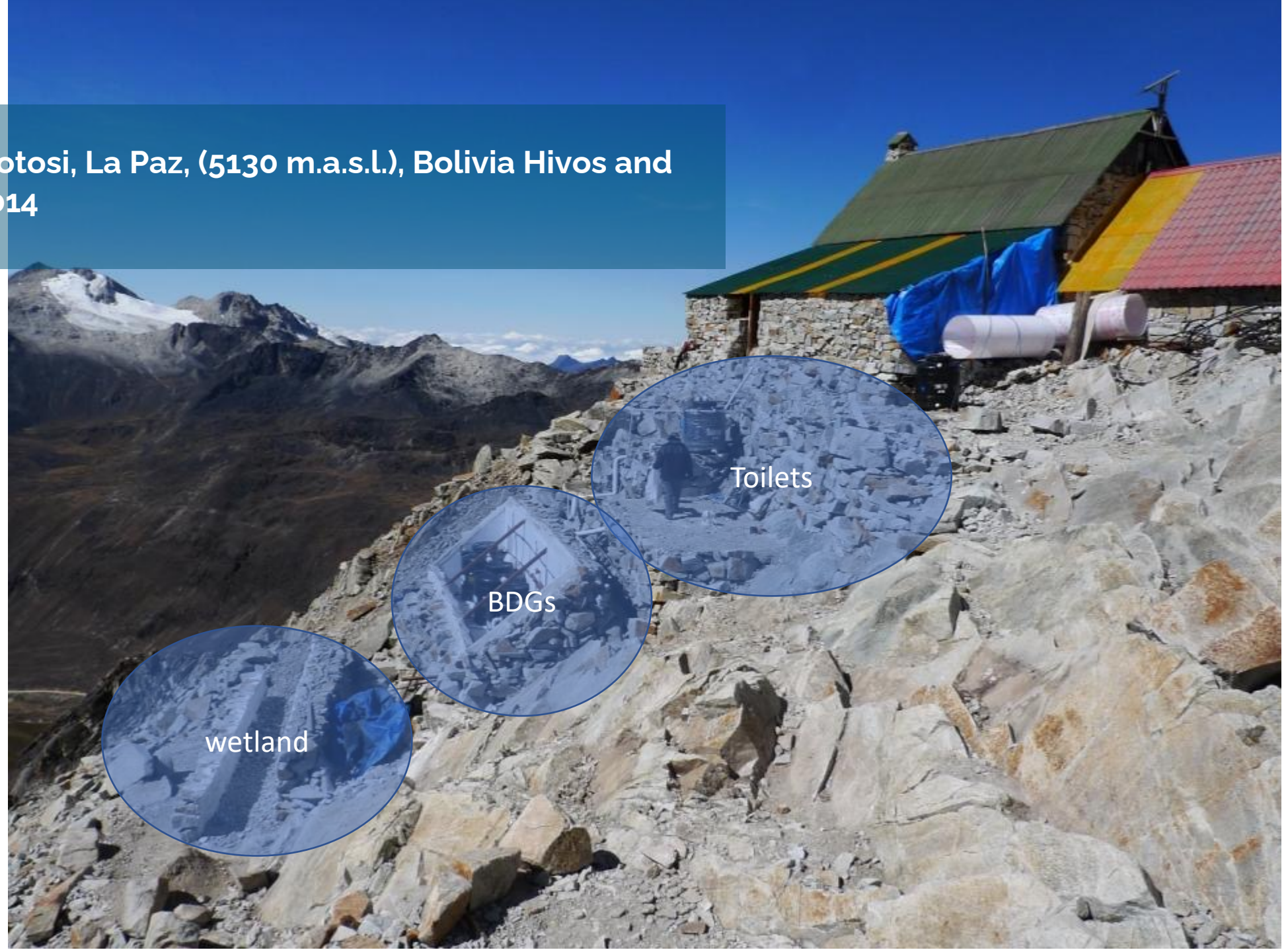


Huayna Potosi, La Paz, (5130 m.a.s.l.), Bolivia Hivos and CIMNE, 2014

- 4 tanks 600l (total 2.4m3)
- Inside a insulated greenhouse
- Full of soda bottels

Huayna Potosi, La Paz, (5130 m.a.s.l.), Bolivia Hivos and CIMNE, 2014

- Wetland full of small sotones
- Cover and ventilated
- 1m2/5p (total 5.5m2)

Huayna Potosi, La Paz, (5130 m.a.s.l.), Bolivia Hivos and CIMNE, 2014

Huayna Potosi, La Paz, (5130 m.a.s.l.), Bolivia Hivos and CIMNE, 2014

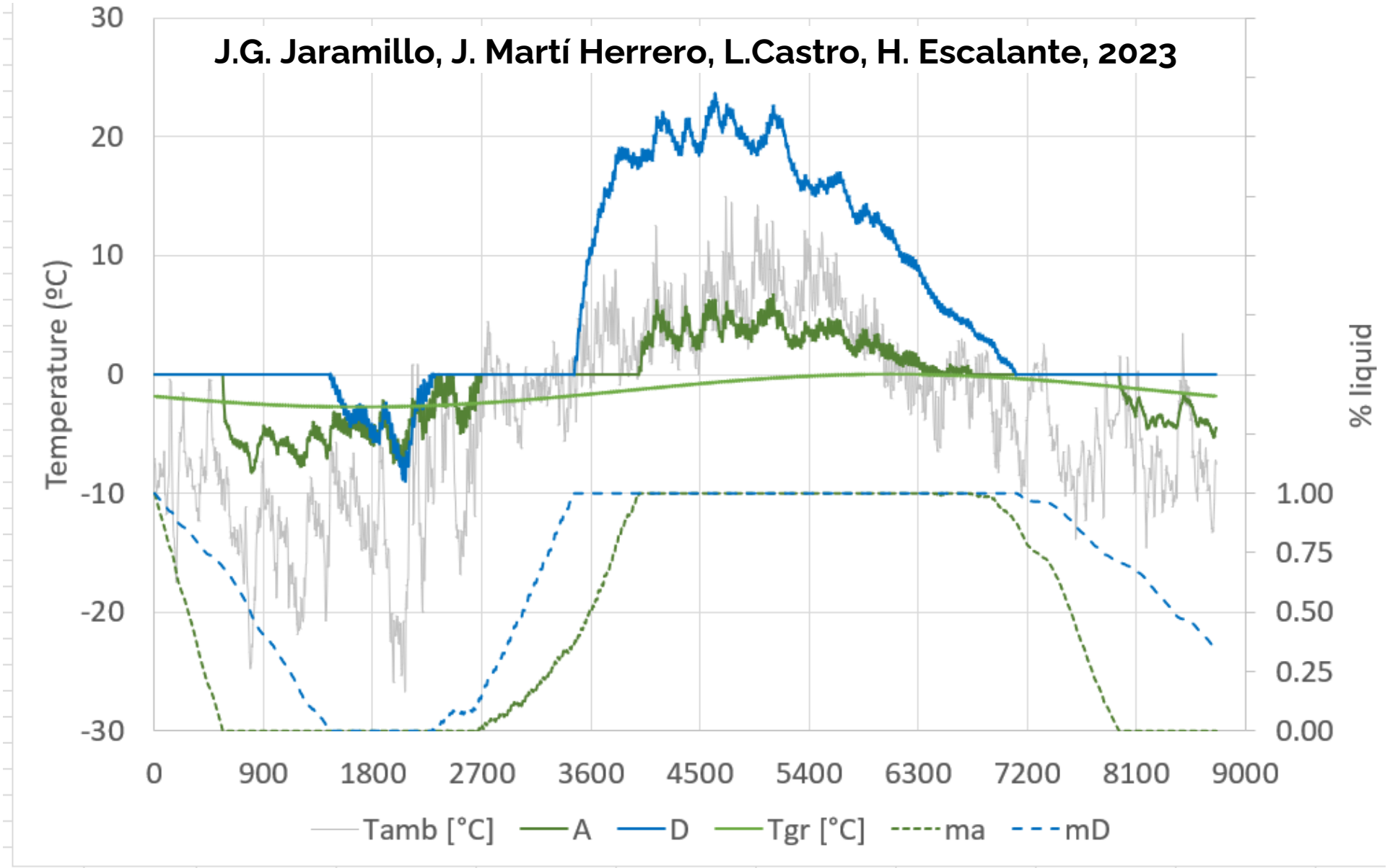
Huayna Potosi, La Paz, (5130 m.a.s.l.), Bolivia Hivos and CIMNE, 2014

Huayna Potosi, La Paz, (5130 m.a.s.l.), Bolivia Hivos and CIMNE, 2014

Jose Maria Saez, PUCE


PLASTIGAMA


PLASTIGAMA



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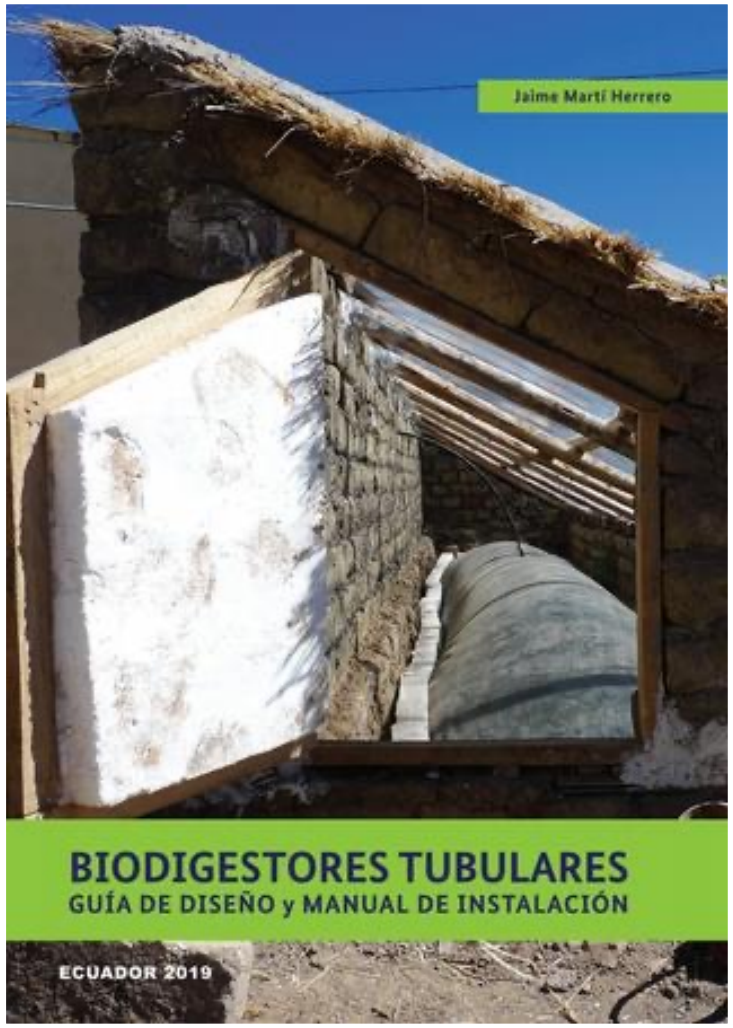
EXCELENCIA SEVERO OCHOA

- We can adapt microorganisms to low temperatures (even use native!!)
- Solar radiation as heating source
- Soda bottles helps a lot
- Accept that is going to freez
- Make sure to use the right technology



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EXCELENCIA SEVERO OCHOA

Red Bio LAC

Red de Biodigestores para Latino América y el Caribe

Thank you!


Comunidades dispersas

Tena. Ecuador. 2020

Tena. Ecuador. 2020

green empowerment
Village Solutions for Global Change

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