



# **Climate, water and peloid of Pink Lagoon of Torrevieja (Alicante-Spain). Its potential use in thalassotherapy**

**José M. Carbajo<sup>1</sup>, Francisco Armijo<sup>1</sup>, María Lorena Vela<sup>1,2</sup>, José Antonio De Gracia<sup>1</sup>, Francisco Maraver<sup>1,3</sup>**

1. Medical Hydrology Group. Department of Radiology, Rehabilitation & Physiotherapy. Complutense University of Madrid, 28040 Madrid, Spain

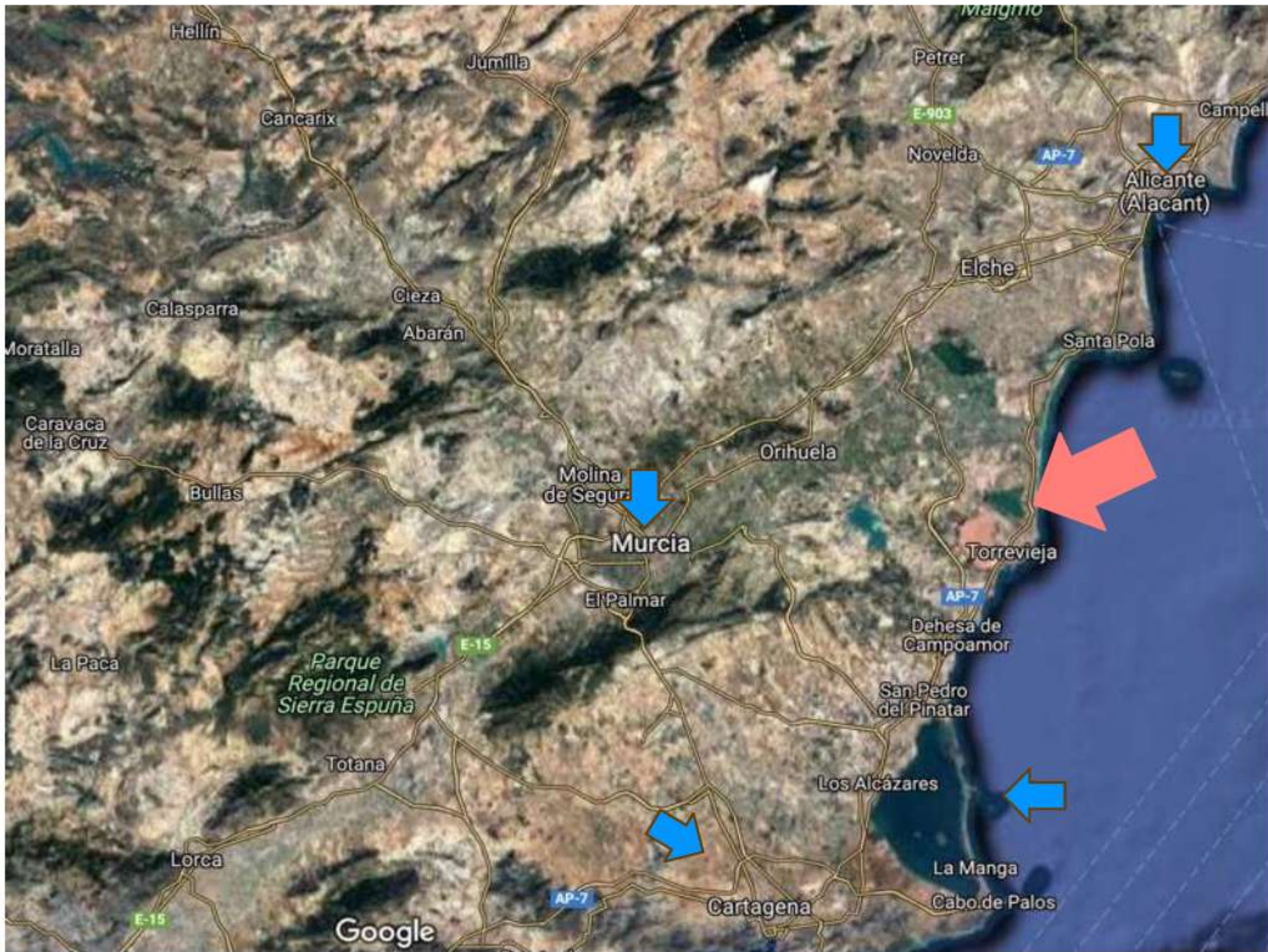
2. Health and Environment Sciences School. Comahue National University, 8300, Neuquen. Argentina

3. Professional School of Medical Hydrology. Faculty of Medicine. Complutense University of Madrid. Plaza Ramón y Cajal s/n, 28040 Madrid. Spain



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Hellín

Jumilla

Petrer

Cancarix

Novelda

Campell

Alicante  
(Alacant)

Calasparra

Cieza

Abarán

Elche

Santa Pola

Moratalla

Caravaca  
de la Cruz

Bullas

Molina  
de Segura

Orihuela

Murcia

Torrevieja

El Palmar

Dehesa de  
Campoamor

La Paca

Parque  
Regional de  
Sierra Espuña

San Pedro  
del Pinatar

Totana

Los Alcázares

Lorca

La Manga

Cartagena

Cabo de Palos

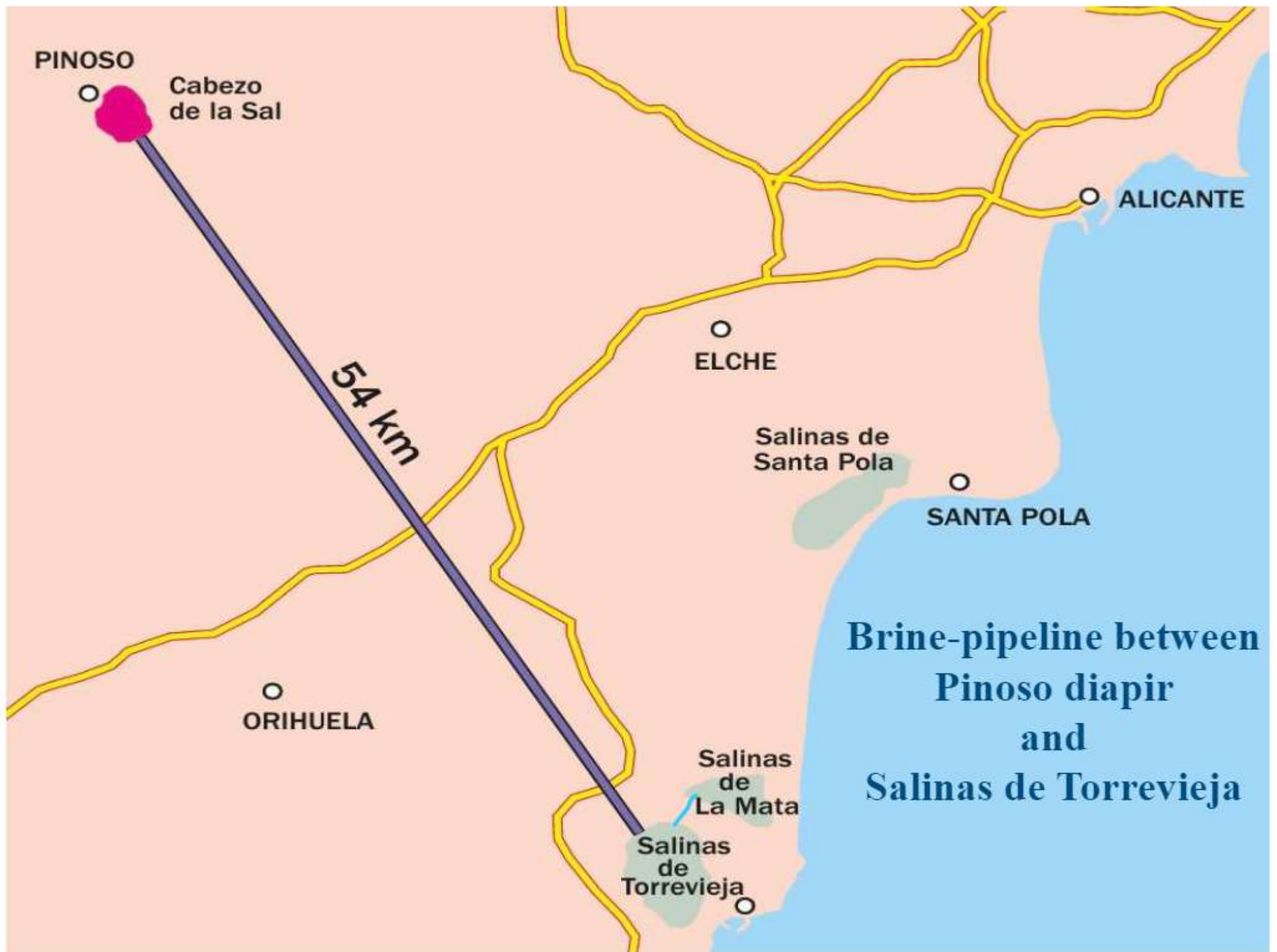
Google









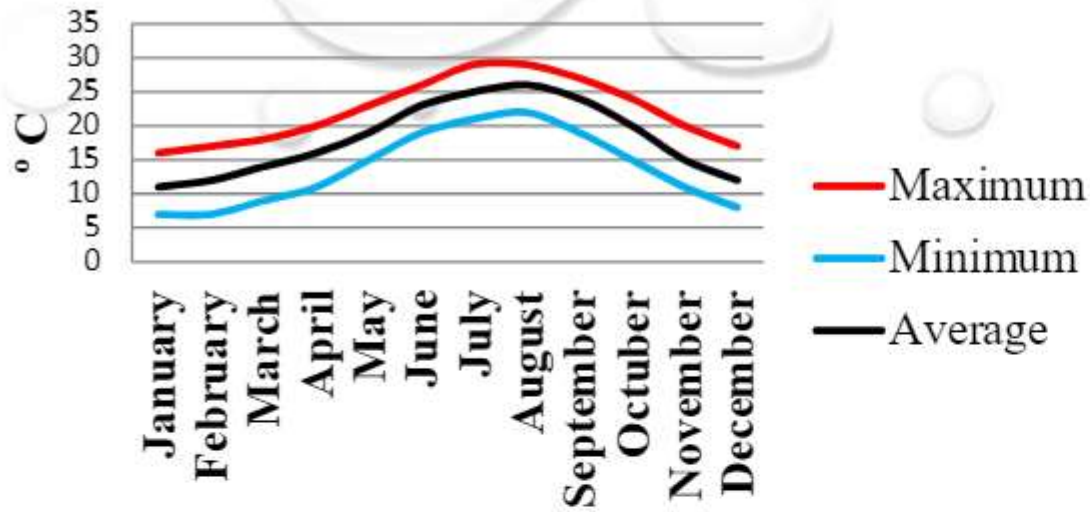




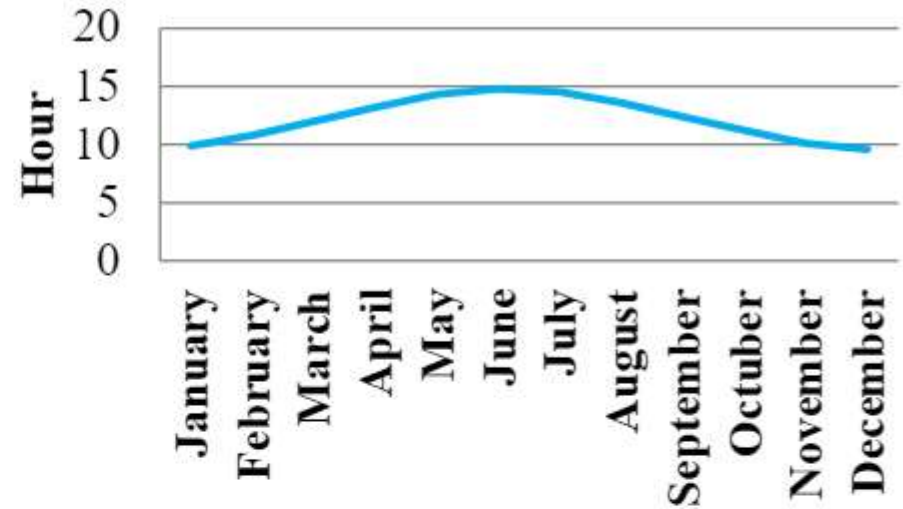




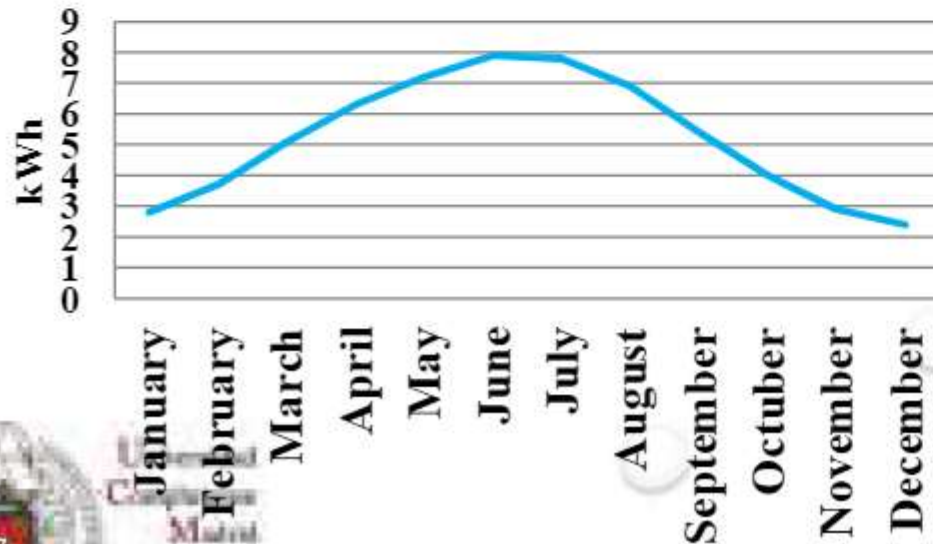
## Average, maximum and minimum temperature



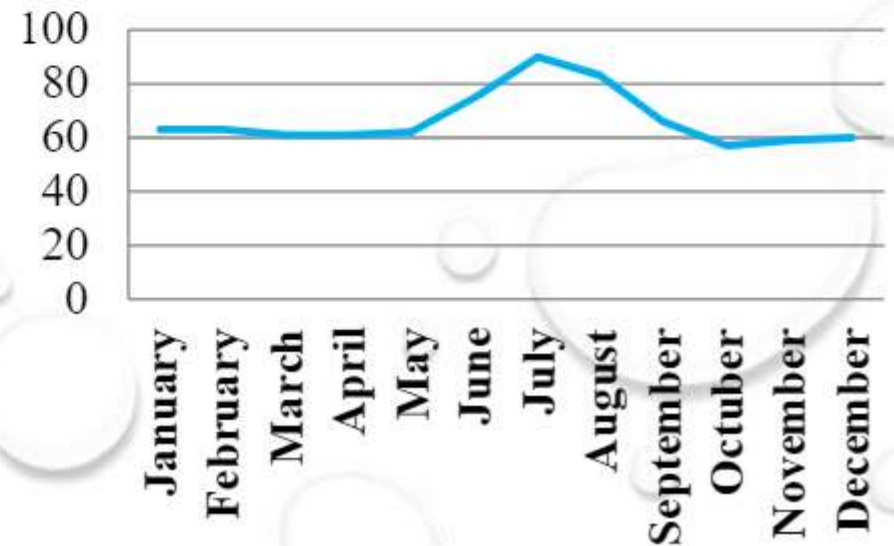
## Daylight hours



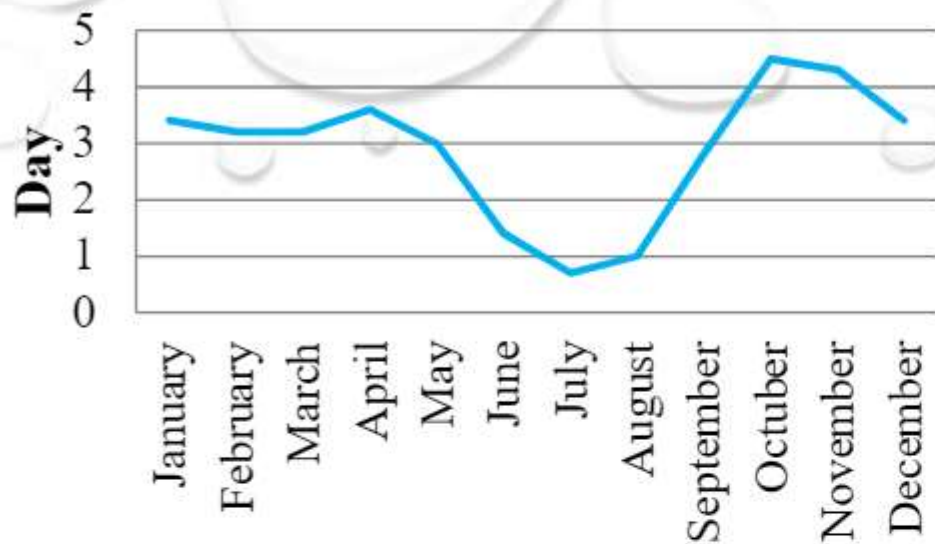
## Average daily incident shortwave solar energy



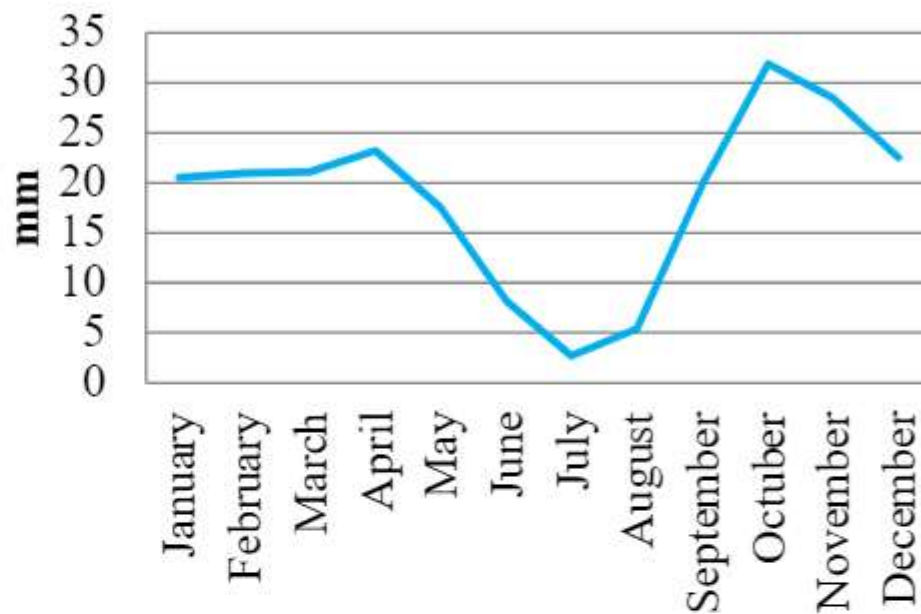
## Clear Sky percentage



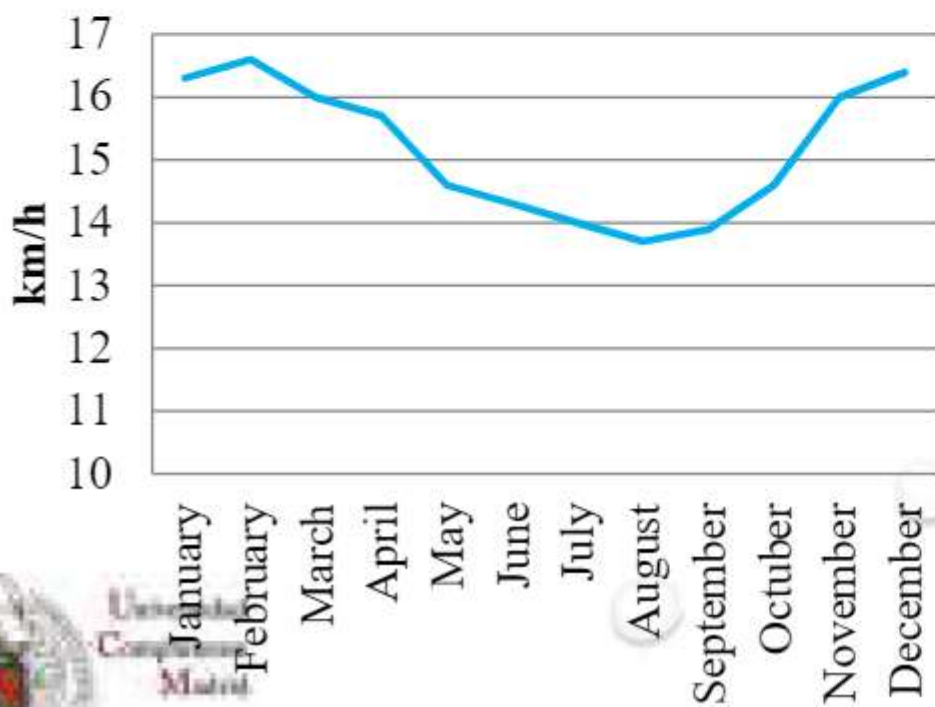
## Days of precipitation



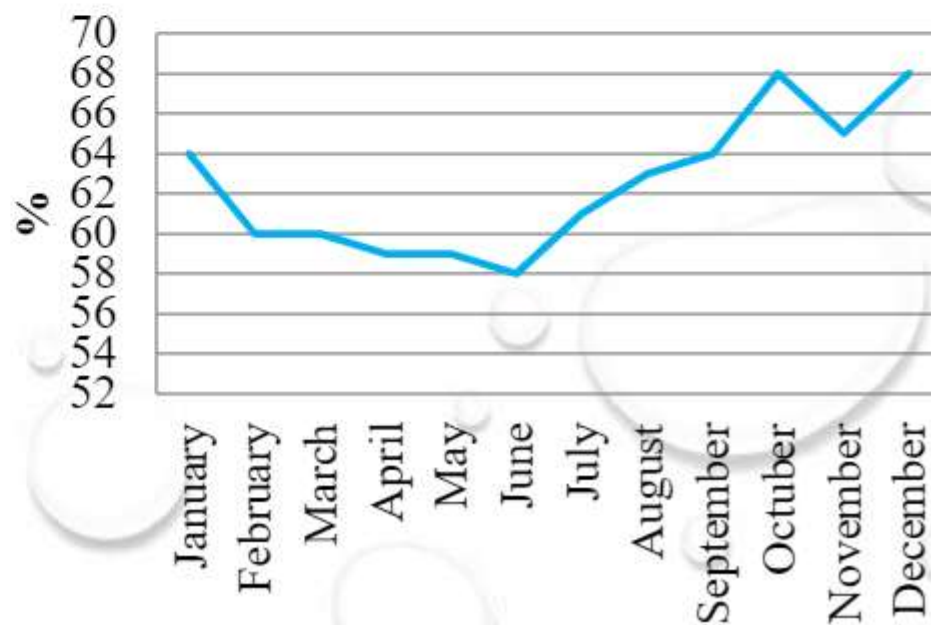
## Monthly amount rainfall



## Wind speed

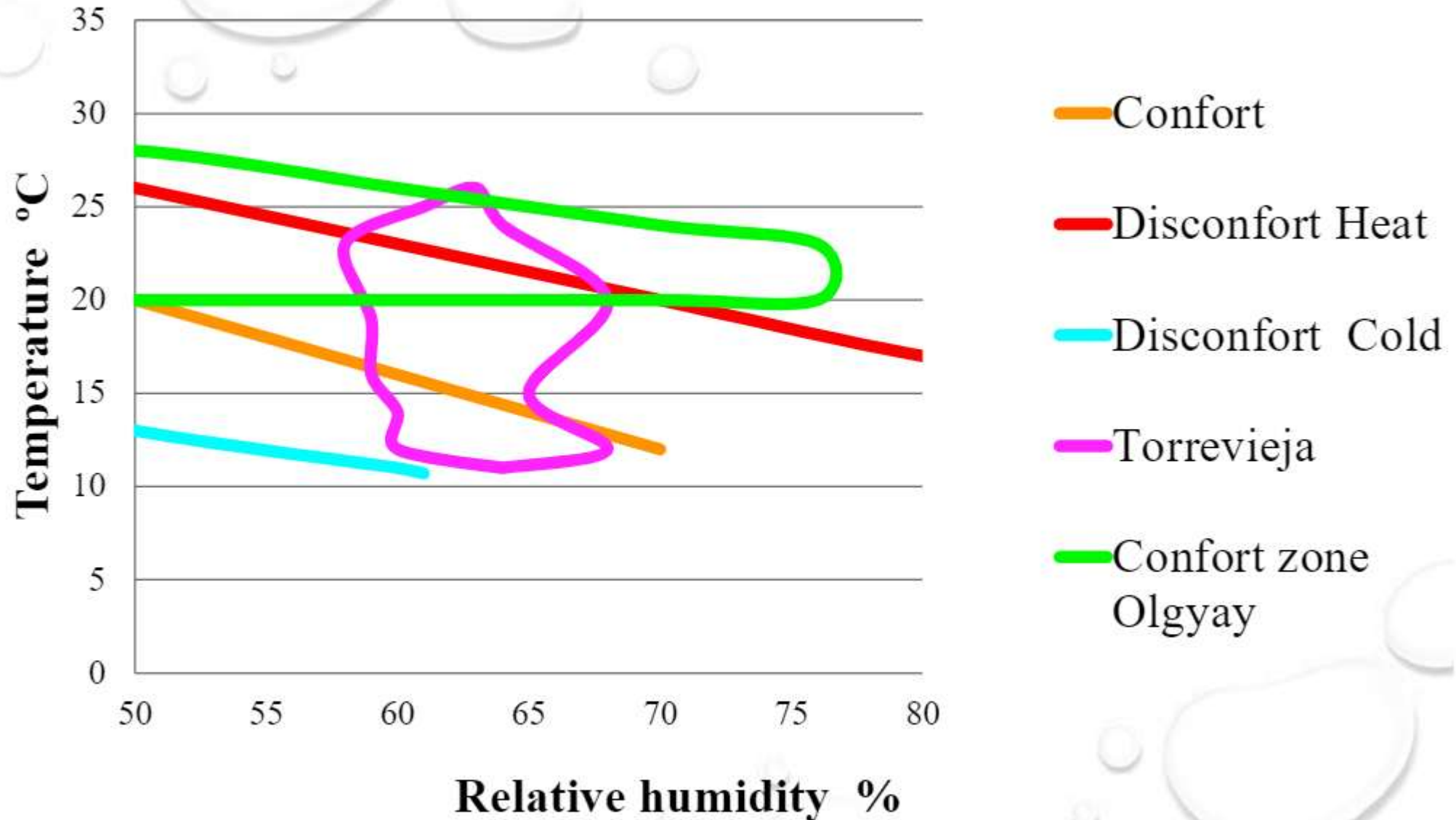


## Relative humidity





# Bioclimatic Diagram



Olgay, V. Design with Climate, Bioclimatic Approach and Architectural Regionalism, New Jersey **1963**: Princeton University Press.

Olgay V. Design with Climate: Bioclimatic Approach to Architectural Regionalism. New and expanded Edition. Princeton University Press; **2015**. ISBN: 9780691169736









# WATER COMPOSITION

Temperature and Density	26.3 °C – 1.23 g/L
Conductivity at 25°C	757.800 µS/cm
Dry residue at 180 °C	<b>389.720 g/L</b>
Smell	Marine
Colour	Colourless
Flavour	Salty

ANIONS	mg/L	% meq
Cl <sup>-</sup>	216.687.6	90.04
F <sup>-</sup>	12.3	0.01
Br <sup>-</sup>	1.018.8	0.19
HCO <sub>3</sub> <sup>-</sup>	434.8	0.10
NO <sub>3</sub> <sup>-</sup>	16.6	0.00
SO <sub>4</sub> <sup>2-</sup>	31.461.4	9.65
CATIONS	mg/L	% meq
Na <sup>+</sup>	106.467.8	69.55
K <sup>+</sup>	7.758.6	3.03
Li <sup>+</sup>	39.30	0.09
Ca <sup>2+</sup>	4.858.2	3.64
Mg <sup>2+</sup>	19.176.8	23.70

CO <sub>2</sub>	mg/L	17.8
Hardness	mg/L CaCO <sub>3</sub>	91.10
Alkalinity	mg/L CaCO <sub>3</sub>	356.4 (pH: 7.8)



# Pink lagoon and "evaporites"

## Mineral precipitation with evaporation from shallow salt flats:

- ⊙ **High solar radiation**
- ⊙ **High temperatura**
- ⊙ **High concentration of salts**
- ⊙ **pH close to neutral**
- ⊙ **Shallow water (thin layers)**





# Evaporites

A diagram illustrating the formation of evaporites. At the top, a white sky contains several pink lightning bolts and a white sun. Below the sky is a blue layer representing water. Underneath the water is a yellow layer, followed by a brown layer, a green layer, and finally a red layer at the bottom. The text is overlaid on the red layer.

**Chlorides: Halite [NaCl] and Magnesium chloride [MgCl<sub>2</sub>] >90% evaporation**

**Sulphates: Gypsum [CaSO<sub>4</sub>·1/2H<sub>2</sub>O] and Anhydrite [CaSO<sub>4</sub>] 80% evaporation**

**Carbonates: Calcite [CaCO<sub>3</sub>] and Dolomite [CaMg(CO<sub>3</sub>)<sub>2</sub>] 50% evaporation**



# Microorganisms found in saline environments

Archaea, Bacteria, Eukaryote & Halo-virus domains

- ⊙ **Conventional..... (>40-50 g/kg)**
- ⊙ **Hypersaline estuaries/lakes with halotolerant microorganisms:**
  - ⊙ **Moderately halophilic (>150 g/kg)**
  - ⊙ **Extremely halophilic (>250 g/kg)**



# Mains Microorganisms

## Archaea domain

(70-95%)

## Bacteria domain

(5-30%)

- **Generate to adapt to extreme conditions**
  - **Exopolysaccharides carotenoids and proteins**
  - **Red pigments much more active than beta-carotene (bacterioruberin, bacteriorhodopsin, etc.)**

- **Salinibacter ruber**
  - **Reddish coloration due to carotenoid pigments such as salinixanthin and retinal pigments like xanthorhodopsin**

Singh A, Singh AK. Haloarchaea: Worth exploring for their biotechnological potential. *Biotechnol. Lett.* **2017**. 39. 1793–1800. doi:10.1007/s10529-017-2434-y.

Martínez GM, Pire C, Martínez-Espinosa RM. Hypersaline environments as natural sources of microbes with potential applications in biotechnology: The case of solar evaporation systems to produce salt in Alicante County (Spain). *Curr Res Microb Sci.* **2022**; 3:100136. doi: 10.1016/j.crmicr.2022.100136.





# Mains Microorganisms

## Eukarya domain

## Halovirus domain

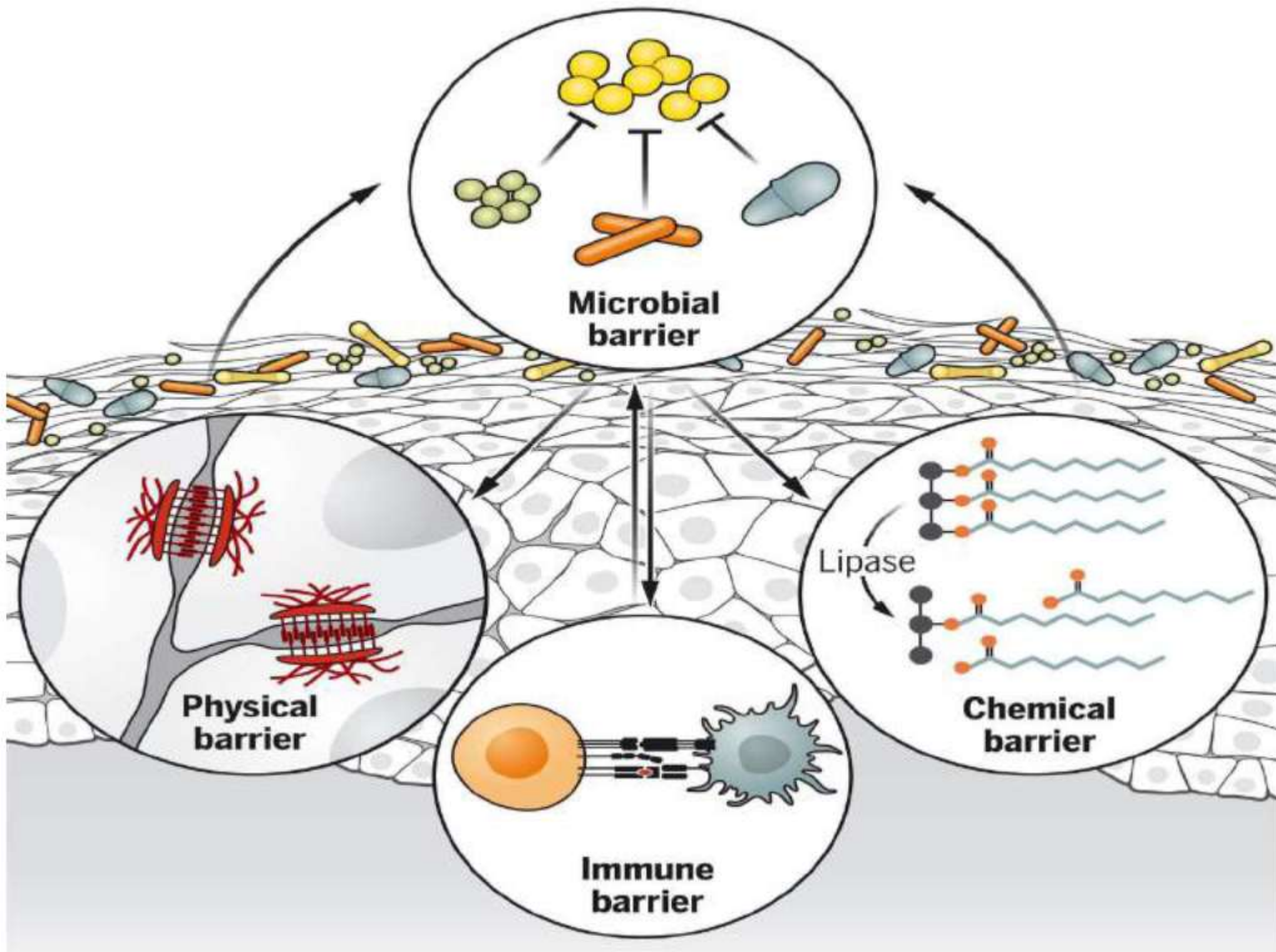
- ◉ ***Dunaliella spp.***
- ◉ **It produces polar lipids.**
- ◉ **Beta carotene, colorless carotenoids and Vitamin B12.**
- ◉ **Antimicrobial (Herrero et al. 2006) and antioxidants (Bahador et al. 2019) properties**

- ◉ **Nearly 100 viruses have been identified as predators of halophilic microorganisms, of which**
- ◉ **90% viruses infect haloarchaea**
- ◉ **10% infecting bacteria or eukaryotes**

Monte J. Ribeiro C. Parreira C. Costa L. Brive L. Casal S. Brazinha C. Crespo JG. Biorefinery of *Dunaliella salina*: sustainable recovery of carotenoids, polar lipids and glycerol. *Bioresource Technology*. **2020**; 297: 122509. doi: 10.1016/j.biortech.2019.122509

Martínez GM, Pire C, Martínez-Espinosa RM. Hypersaline environments as natural sources of microbes with potential applications in biotechnology: The case of solar evaporation systems to produce salt in Alicante County (Spain). *Curr Res Microb Sci*. **2022**; 3:100136. doi: 10.1016/j.crmicr.2022.100136.









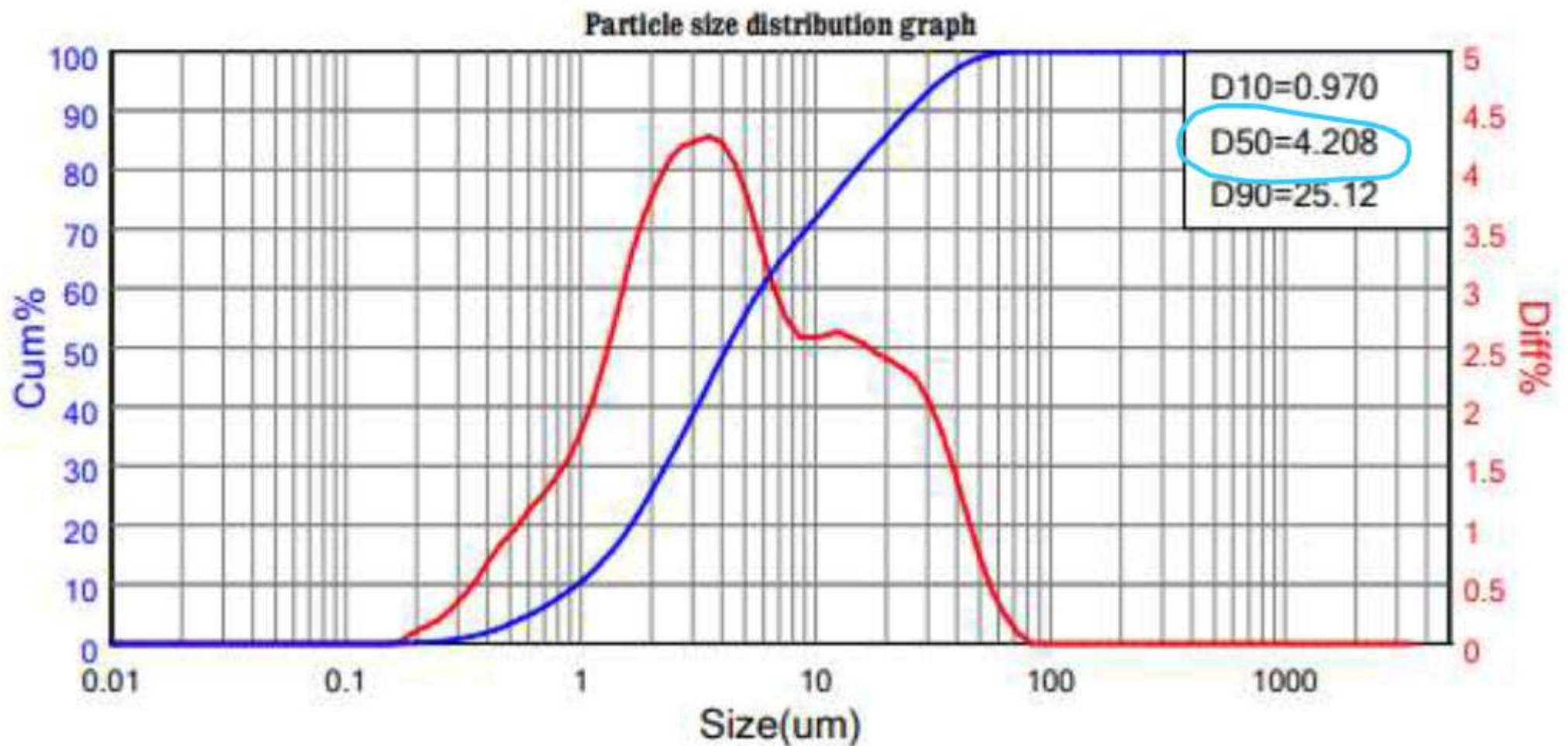


# Peloid/slime/silt Composition

Peloid	<b>Solids (S) (%)</b>	<b>78.17</b>	<b>Solids</b>
Torr	<b>Water (W) (%)</b>	<b>21.83</b>	<b>.74</b>
Hak	<b>Ashes (A) (%)</b>	<b>57.50</b>	<b>.99</b>
Inde	<b>Ash/Solids</b>	<b>0.74</b>	<b>.98</b>
Sork			<b>.96</b>
Dea			<b>.77</b>
<b>LoPagan</b>	<b>34.3</b>	<b>56.2</b>	<b>0.85</b>
<b>Aralsor</b>	<b>35.2</b>	<b>63.9</b>	<b>0.98</b>



# Histogram: particle size distribution curves





# Cooling Curve

## Thermal proprieties

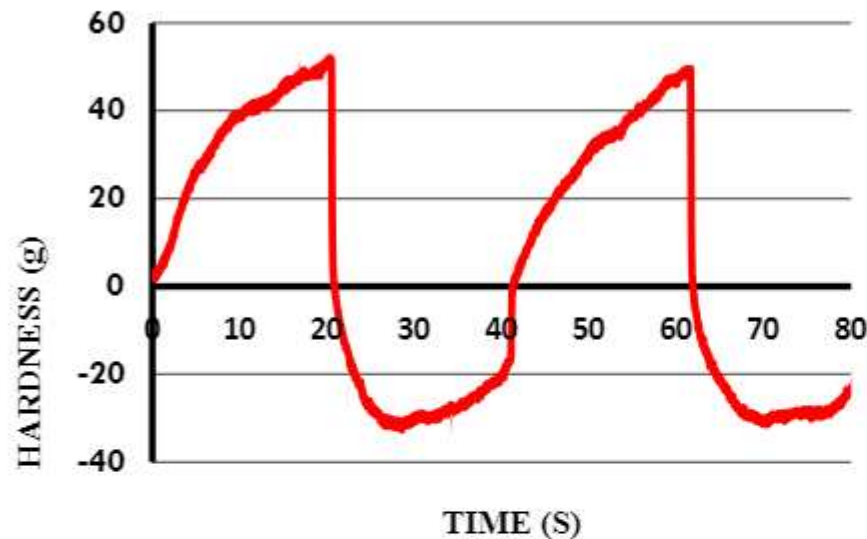
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Peloid	Heat capacity (J/g K)	Thermal conductivity (W/m K)	Thermal retentivity (s/m <sup>2</sup> )
Torrevieja	1.6	0.488	5.49
Hakisor	1.6	0.604	4.51
Sorkol	1.7	0.561	5.13
Inder	1.7	0.578	4.89
LoPagan	2.0	0.489	6.21
Aralsor	2.0	0.529	5.81
<b>Relaxation Time (sec.)</b>		<b>330 (5.5 min)</b>	





# Instrumental Texture



Hardness Profile

<b>Hardness (g)</b>	52.2
<b>Cohesiveness</b>	0.88
<b>Adhesiveness (g.s)</b>	-511.56

# Conclusions (I)

## Mineral Water

- ◉ It has a therapeutic potential like Ursu (Romania), Saleis de Béarn (France), Kreuznach Salinen (Germany), Droitwich (England), Salies du Salat (France), the Dead Sea (Israel), the Elgorriaga (Spain) and Elton (Russia).

## Peloid

- ◉ Due to its low water content, hardness and low adhesiveness, it should be applied with a brush (Egyptian style) or with a massage.
- ◉ Due to composition and microbial load, excellent antiseptic and antioxidant properties



# Therapeutic possibilities

- ⊙ **Dermatology & skin:** psoriasis, atopic dermatitis, lichen planus and other neuro dermatitis.
- ⊙ **Oral mucosa lesions:** alkalization and abiotic factors of the marine environment.
- ⊙ **Rheumatic processes:** chlorinated waters have always been prescribed, understood as pathologies related to the musculoskeletal system.



# Conclusions (II)

- ◉ **Climate, water and its peloid make the Pink Lagoon a perfect place for a thalassotherapeutic center.**
- ◉ **The therapeutic properties of its elements must be verified with the corresponding clinical studies.**





