

Projeto bioclimático nos Açores: da teoria à prática, para arquitetos.

2.5h



16.11.2023

Capa da revista “The Unesco Courier”. (1973)

Ph.D. Arch. Nadir Bonaccorso

Sinopse da sessão

As estratégias bioclimáticas permitem, de forma eficiente, aproximar, de forma passiva, as temperaturas internas da construção às necessidades fisiológicas do Homem. A integração destas estratégias precisam de ser tomadas em consideração na primeira fase de conceção do projeto de arquitetura. **Objetivo** desta sessão é entender os conceitos ligados à bioclimática e enquadrar as estratégias mais importantes a utilizar no desenho de um projeto no conjunto insular açoriano, usando ferramentas digitais para arquitetos, para determinação das variáveis climáticas e das estratégias a implementar no projeto.

Índice da sessão

1. Apresentação.
2. Introdução às avarias do planeta Terra
(*Spaceship Earth*).
3. Desenhar com o clima utilizando ferramentas digitais
open source
 - 3.1 a génese da bioclimática
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5. Pre-Design e Sefaira (software ligado ao Sketchup
Pro)
6. Conclusões e Discussão.



International competition - Auchan *(it)* 2001



Competition for a Youth Hostel
Alijó *(pt)* 2001



1st prize -not built
International competition - European-Polis.
Environmental monitoring centre, Gaia *(pt)* 2001

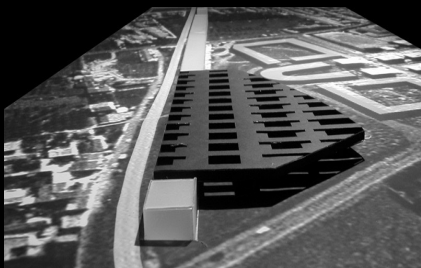


Honorable Mention
International competition - European-Polis.
Environmental monitoring centre, Guarda *(pt)* 2001

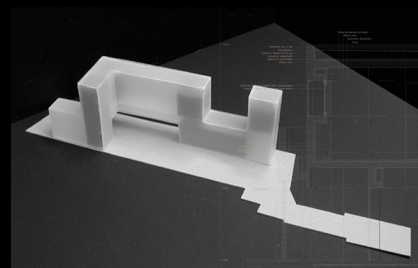


1st prize -built

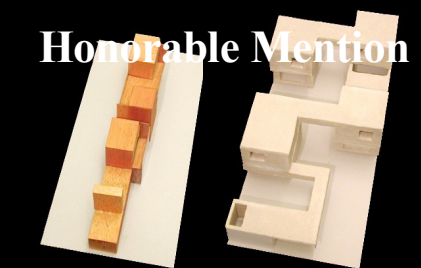
Competition by invitation - Cacém-Polis
Popular kindergarten, Cacém *(pt)* 2002



International competition - EUROPAN 7
Housing for Évora *(pt)* 2003

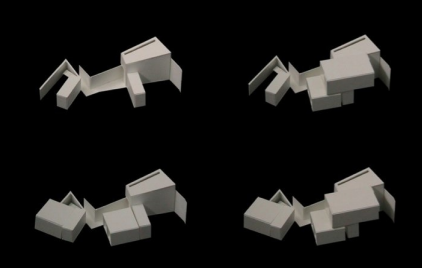


Competition for the Headquarters of the
Chamber of Portuguese architects, Faro *(pt)* 2003

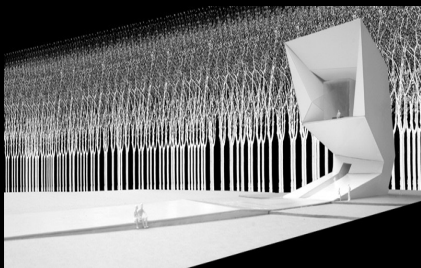


Honorable Mention

International competition - Saudi house,
Affordability and sustainability, Riyadh *(sa)*
2003



Competition by invitation
6 houses for 6 brothers, Bordeira *(pt)* 2004

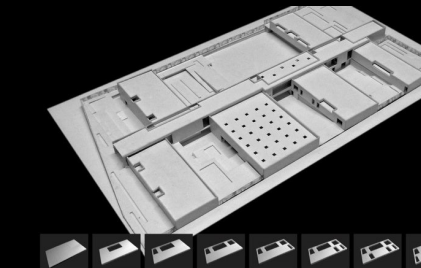


International competition. Monument for the
Tsunami victims, Oslo *(n)* 2006

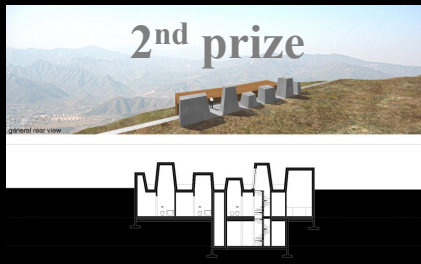


1st prize -not built

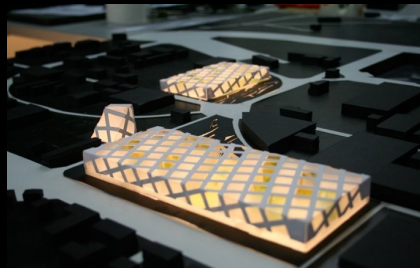
Competition by invitation. Outeiro da vela Park
Cascais *(pt)* 2005



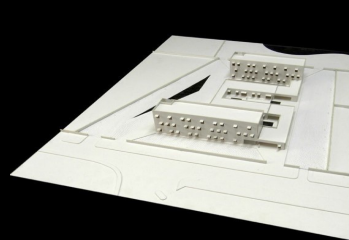
Competition – School buildings,
Amadora *(pt)* 2006



International Solar Building Design Competition,
Beijing, China, 2007



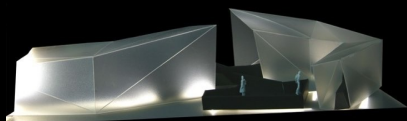
Competition by invitation. Urban requalification,
Marghera (it) 2007



Competition. Office Headquarters for Interminho
(pt) 2007



Competition by invitation. Call Center for
S.I.B.S., Lisbon (pt) 2008



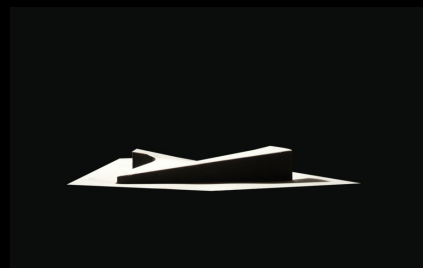
Competition by invitation. Portugal Pavillon for
EXPO 2008, Sevilha (es) 2007



International competition.
Pedestrian bridge GALP, Lisboa (pt) 2009



Study for an Sustainable Evolutive Residence
S.E.R. 2009



Competition by invitation. House.
Carcavelos (pt) 2009



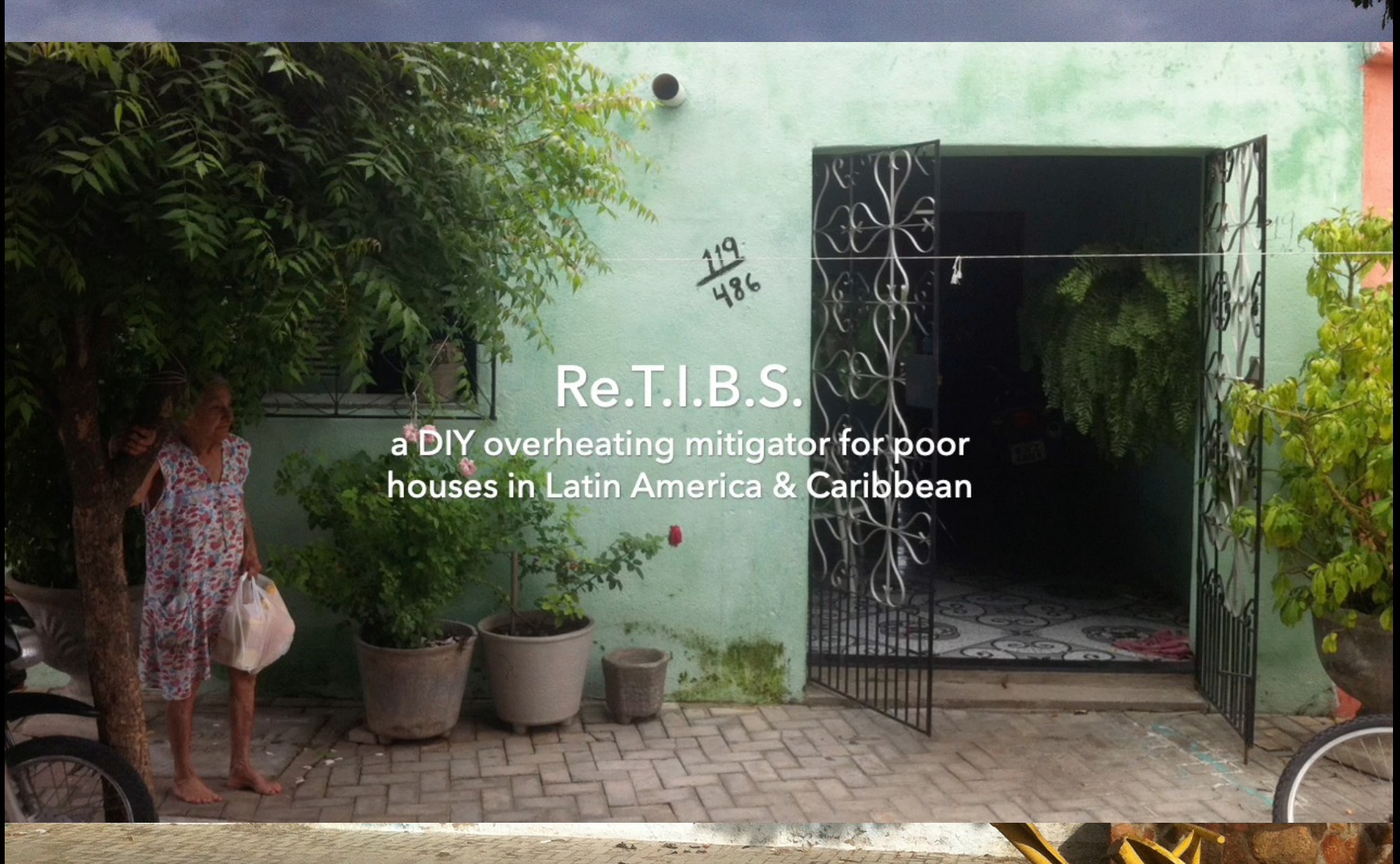
Competition. Eposition project for the 2nd Trienal
de Arquitectura de Lisboa, Lisbon (pt) 2009



Competition. House in Luanda
(pt) 2010



Ph.D. Low-cost passive strategies for poor houses
in Brazil. (pt-br) 2013-2023



Re.T.I.B.S.

a DIY overheating mitigator for poor houses in Latin America & Caribbean

Qual a área em que @formand@
trabalha?

Ateliê

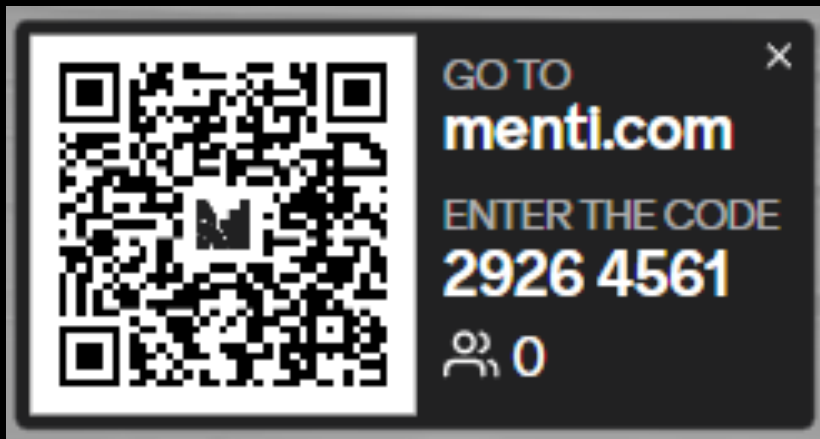
Função pública

Investigação

Ensino

Outra

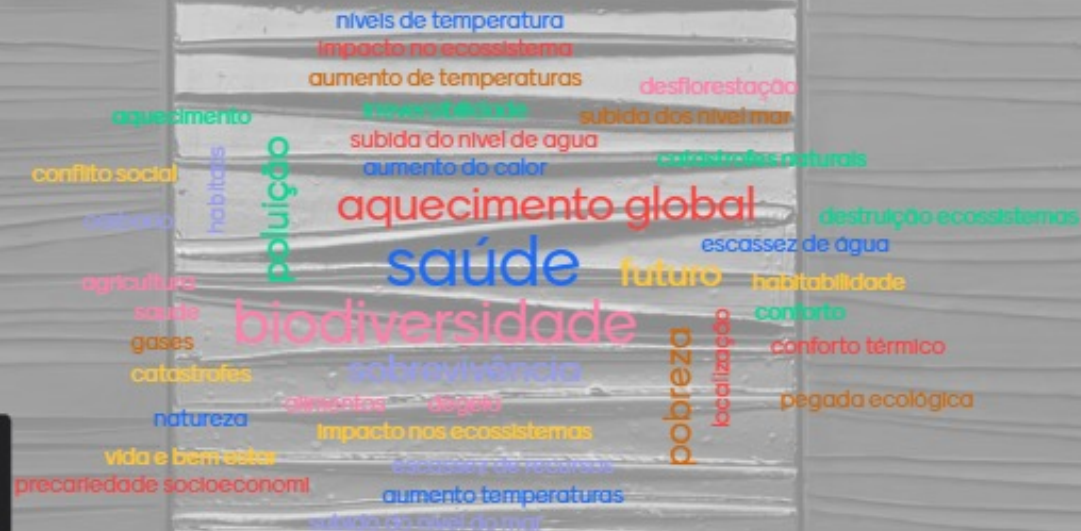
Quais às 3 principais consequências que @ preocupam quando pensa em alterações climáticas?



Join at menti.com use code 2926 4561

Mentimeter

Escreva as três principais razões que @ preocupam relativamente às alterações climáticas
56 responses



GO TO
menti.com
ENTER THE CODE
2926 4561
0

20

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Arquitetura Bioclimática e Eficiência Energética nos Açores [ABEEAZO]. Sessão 06

Projeto bioclimático nos Açores: da teoria à prática, para arquitetos.

Formador: Ph.D. Arq. Nadir Bonaccorso



Earth , from Apollo 8 on 24th of
December, 1968.
Photo by Bill Anders



Kuwait, a desert on fire, 1991
Photo by Sebastião Salgado



Paraisopolis, 2018
Photo by Paralaxis



Aleppo, Syria, 2017
Photo by Joseph Eid

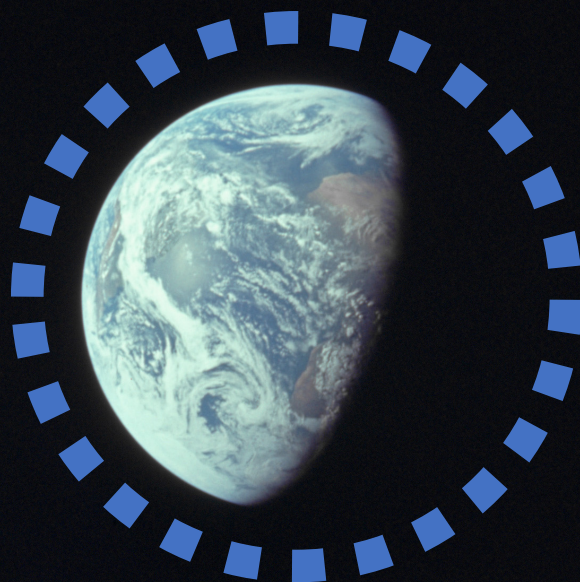
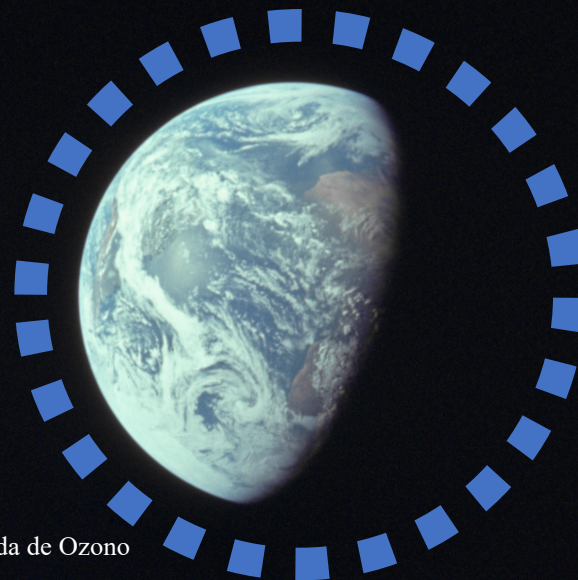
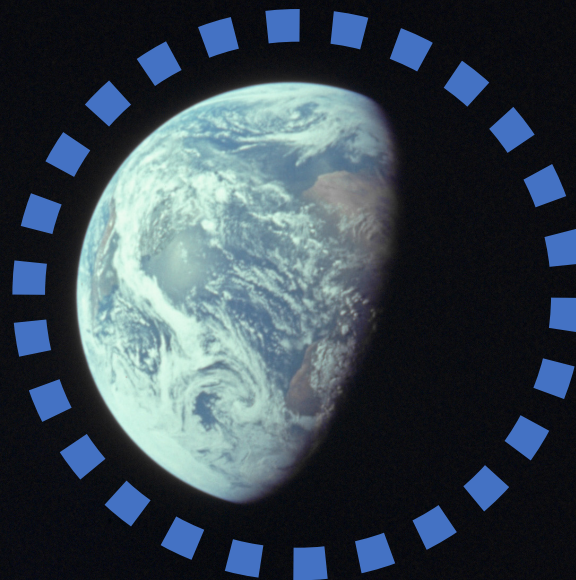
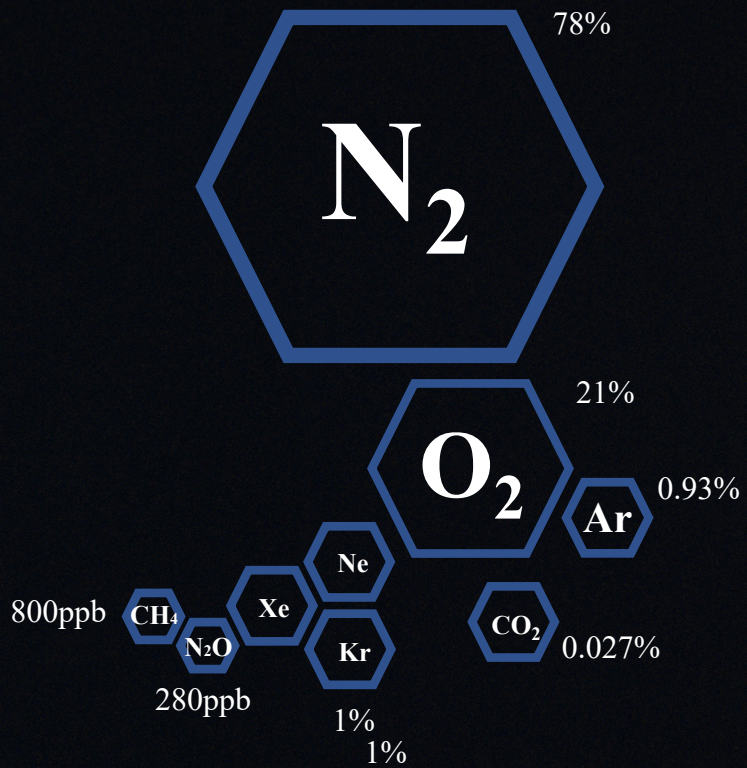


Imagem da missão Apollo 8, tirada em 24 de Dezembro de 1968 [NASA].



Camada de Ozono







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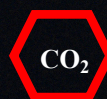
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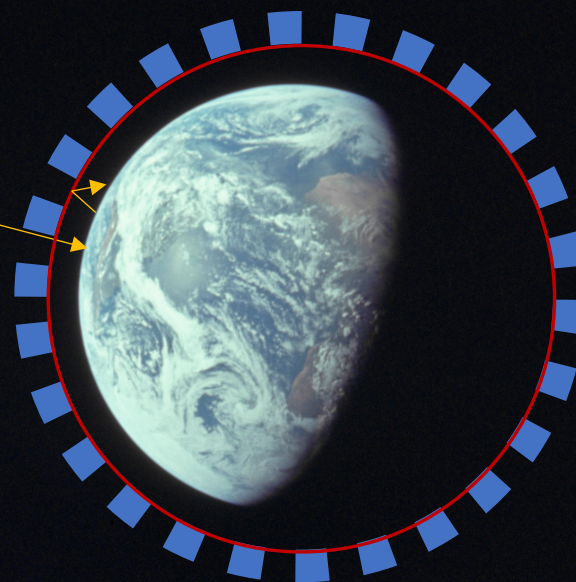
332ppb



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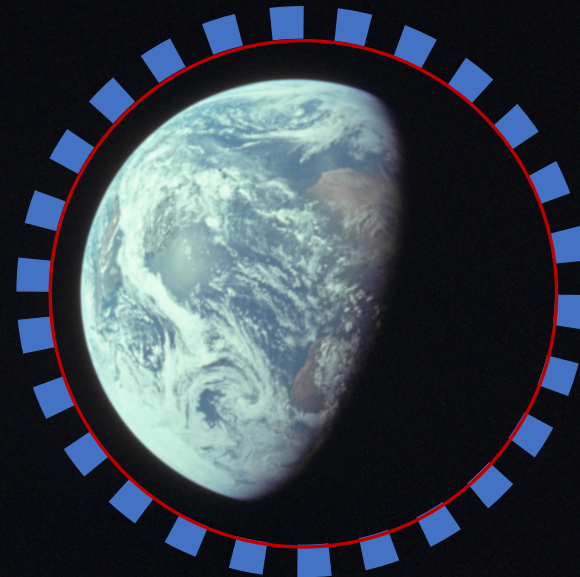
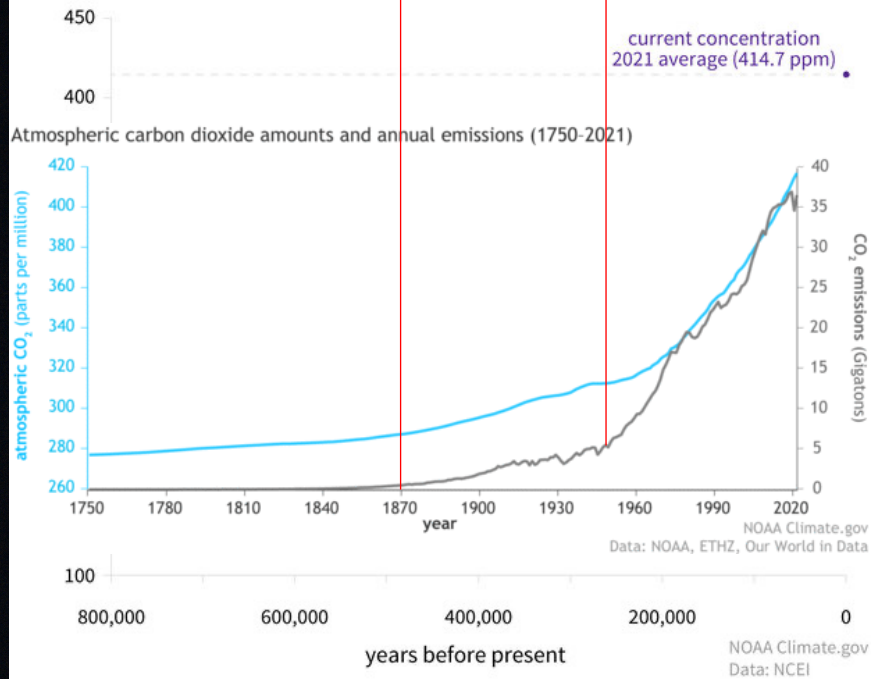
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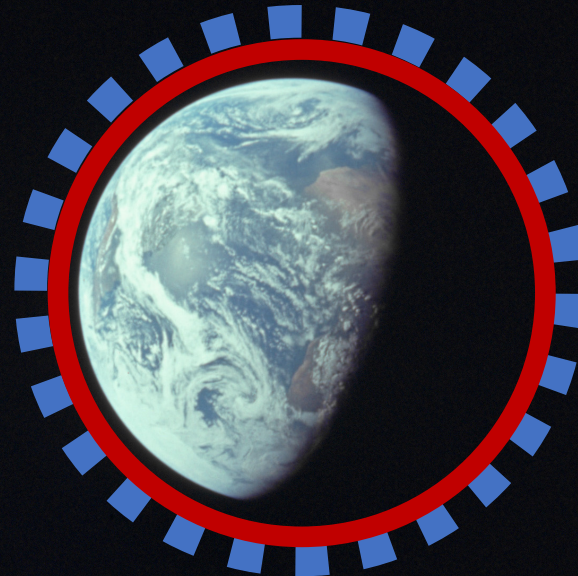
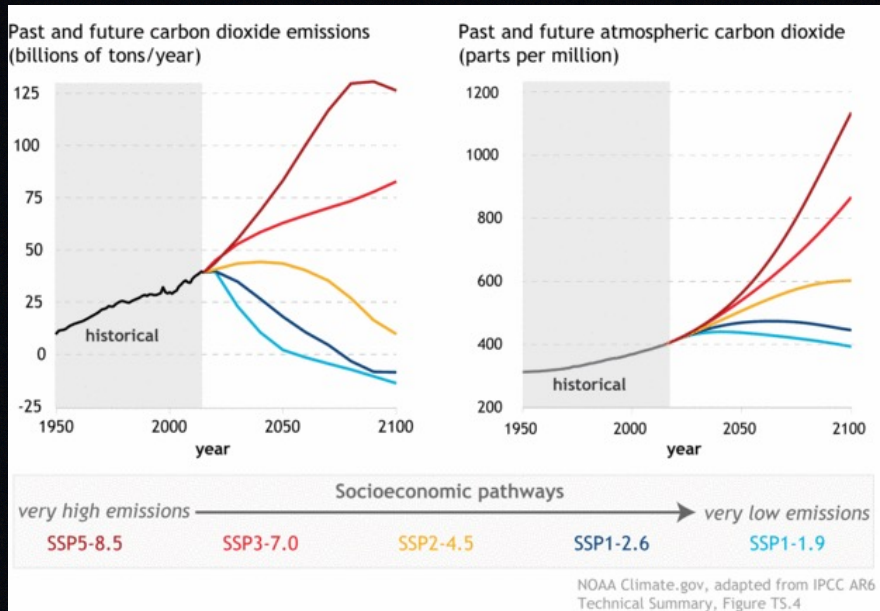
Antropoceno por Crutzen

Antropoceno por Anthropocene Working Group, Crawford Lake.

CARBON DIOXIDE OVER 800,000 YEARS



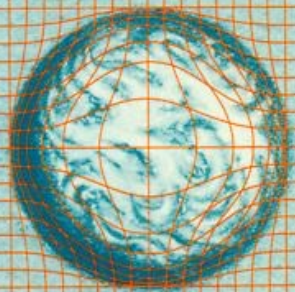
Lindsey, R. (2022) Climate Change: Atmospheric Carbon Dioxide Climate.gov



Lindsey, R. (2022) Climate Change: Atmospheric Carbon Dioxide Climate.gov

R. BUCKMINSTER FULLER

OPERATING MANUAL
FOR SPACESHIP EARTH



Future climate change is projected to increase the severity of impacts across natural and human systems and will increase regional differences. There are multiple opportunities for scaling up climate action.

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cli

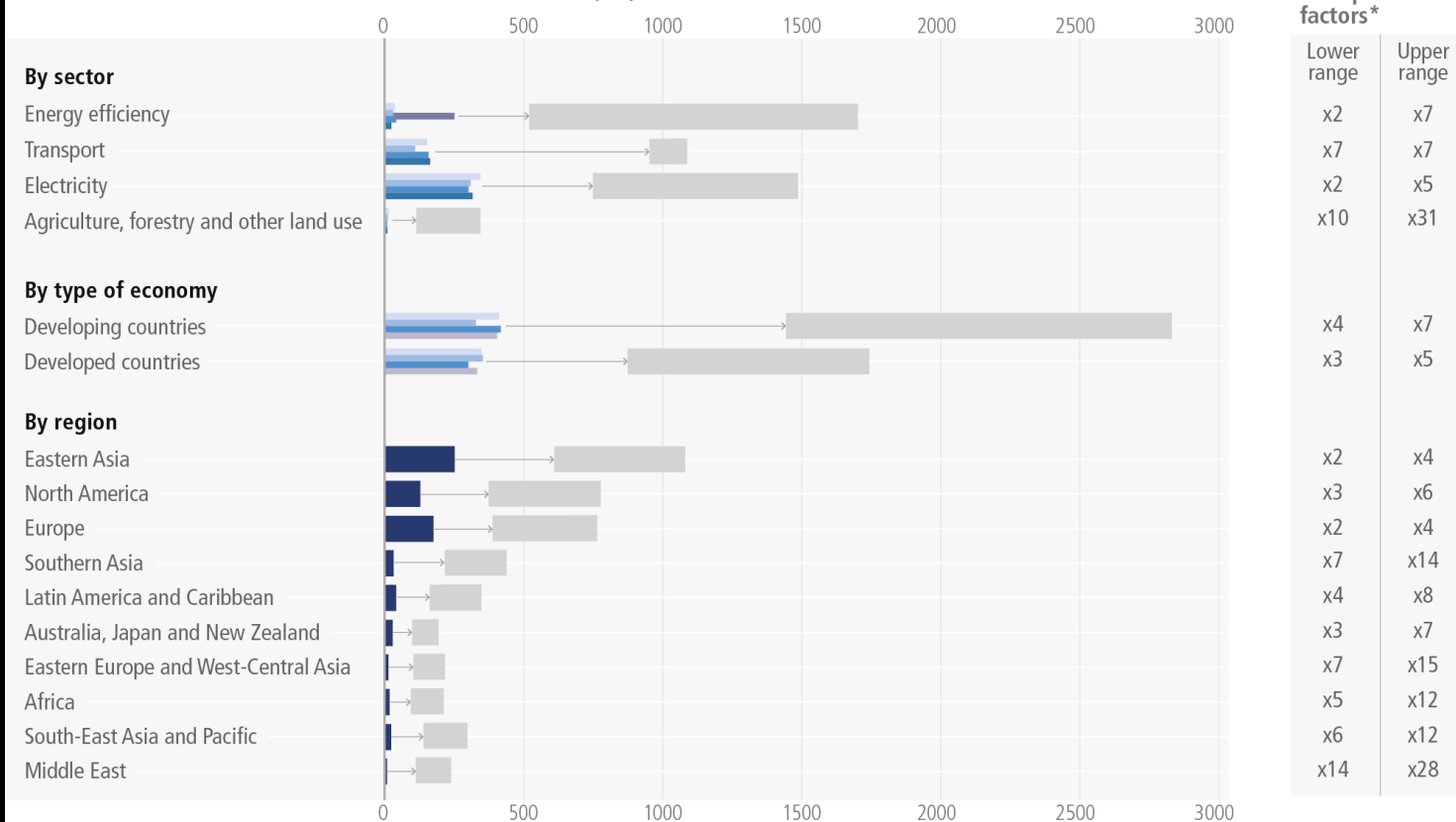
Examp

a) Feasibility of climate responses and adaptation, and potential of mitigation options in the near-term

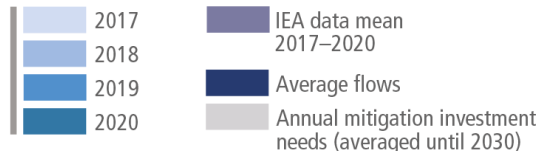
options costing 100 USD tCO₂-eq or less could realize almost one-third of the

Higher mitigation investment flows required for all sectors and regions to limit global warming

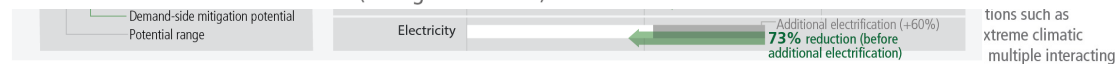
Actual yearly flows compared to average annual needs
in billions USD (2015) per year



Yearly mitigation investment flows (USD 2015/yr) in:



*Multiplication factors indicate the x-fold increase between yearly mitigation flows to average yearly mitigation investment needs. Globally, current mitigation financial flows are a factor of three to six below the average levels up to 2030.



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Article

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Received: 12 October 2

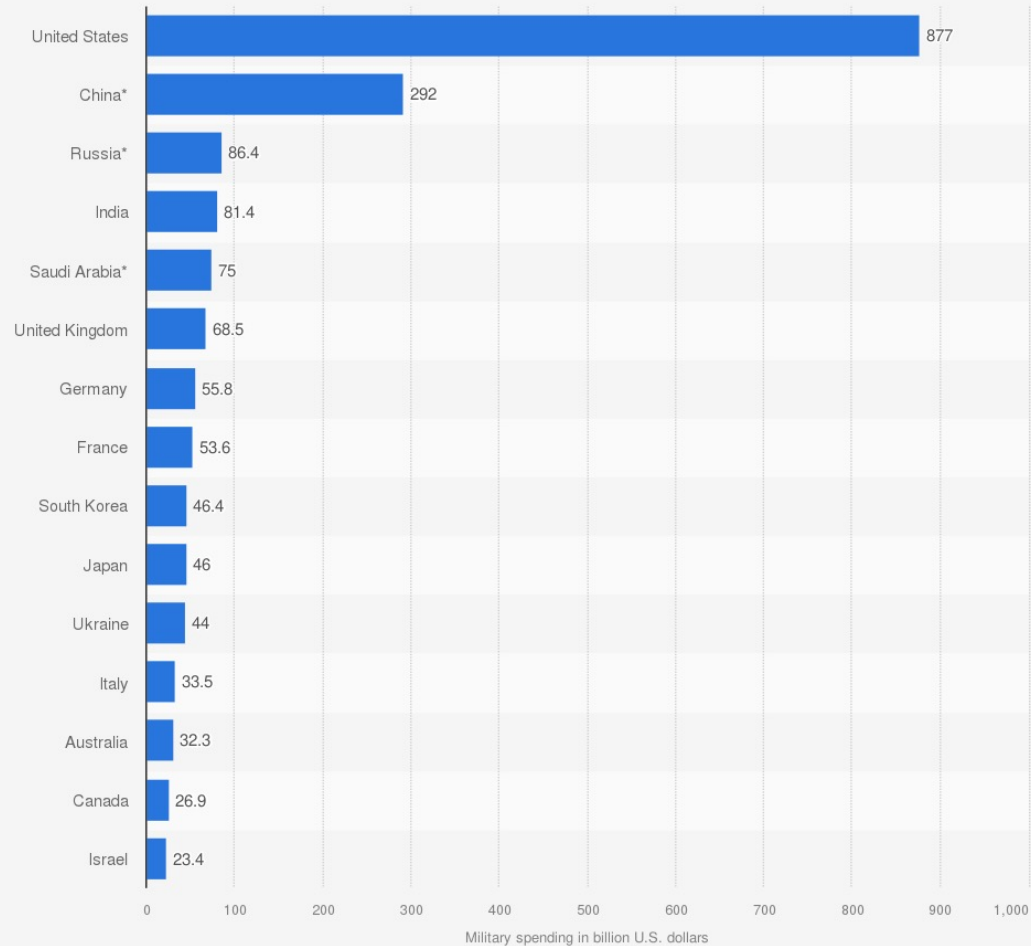
Accepted: 22 Septemb

Published online: 29 Septe



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Countries with the highest military spending worldwide in 2022 (in billion U.S. dollars)



Source
SIPRI
© Statista 2023

Additional Information:
Worldwide; 2022



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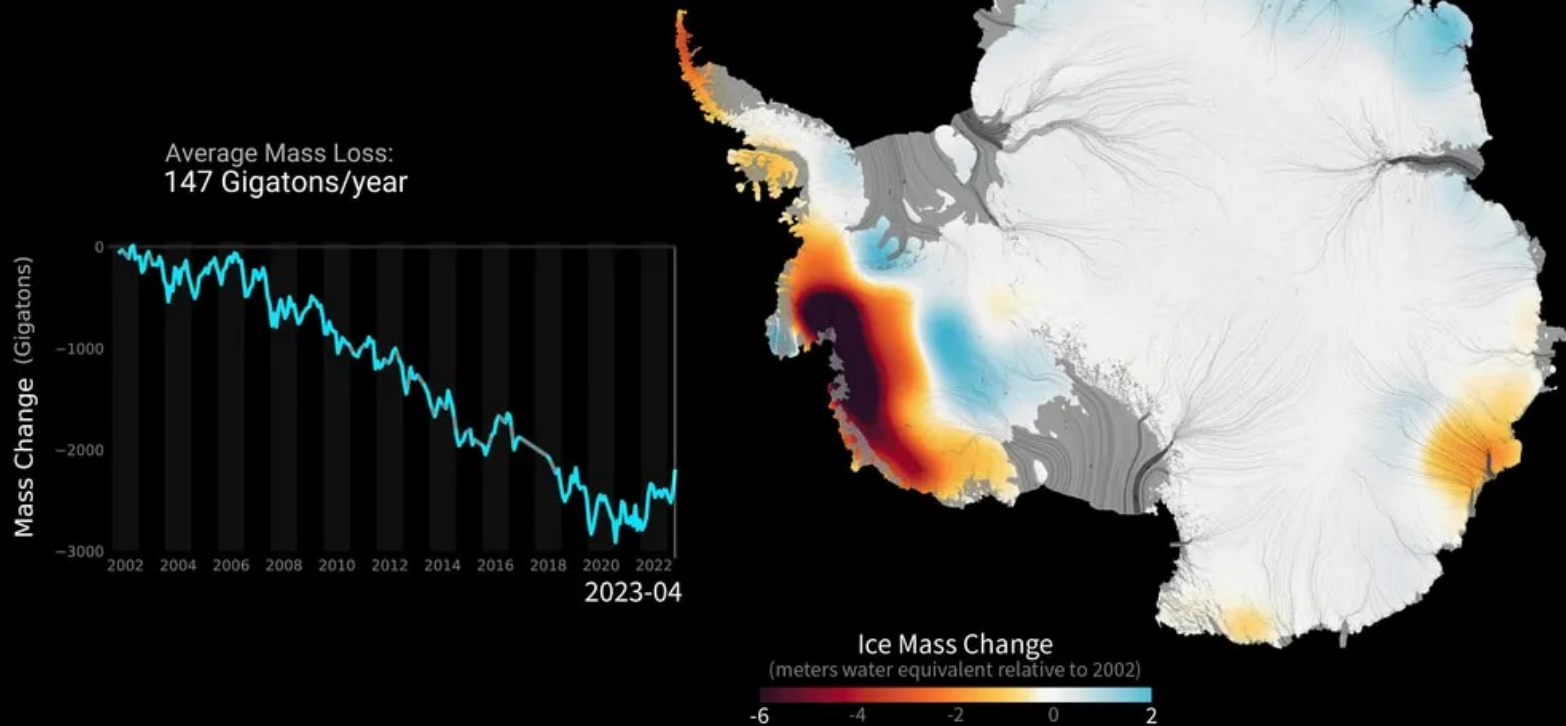
NEWS RELEASE 23-OCT-2023

Increased
melting

Sea Ice Extent, 10 Sep 2023

GRACE AND GRACE-FO Observations of Antarctic Land Ice Mass Changes

2023-04



Around the world, the impacts of climate change are being felt. The world's leading scientists are calling for urgent action to address the threat of climate change. Policymakers to plan ahead and adapt more readily.

Open Access Editor's Choice Review

The Role of the Energy Use in Buildings in Front of Climate Change: Reviewing a System's Challenging Future

by  George Ekonomou  and  Angeliki N. Menegaki * 

Department of Economic and Regional Development, Agricultural University of Athens, Amfissa Campus, 331 00 Amfissa, Greece

* Author to whom correspondence should be addressed.

Energies **2023**, *16*(17), 6308; <https://doi.org/10.3390/en16176308>

Received: 24 July 2023 / Revised: 26 August 2023 / Accepted: 26 August 2023 / Published: 30 August 2023

(This article belongs to the Special Issue Climate Changes and the Impacts on Power and Energy Systems)

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Versions Notes

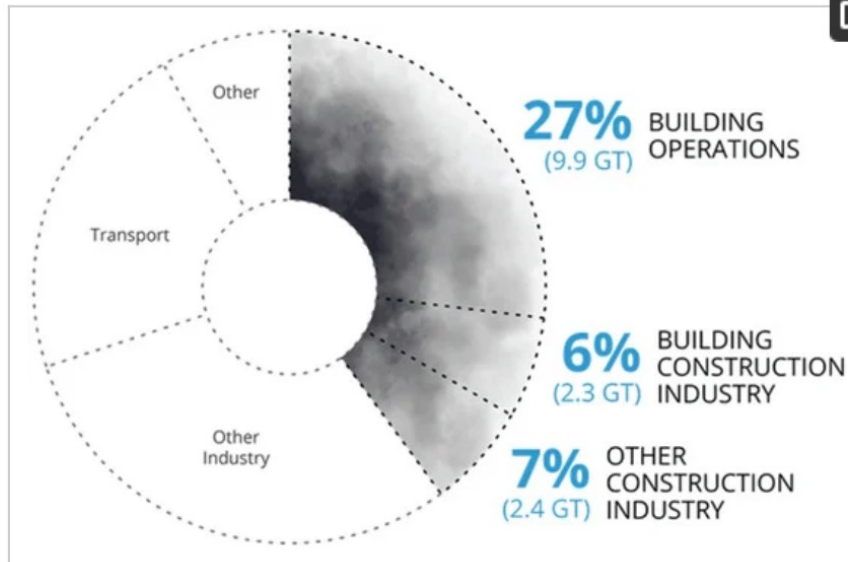
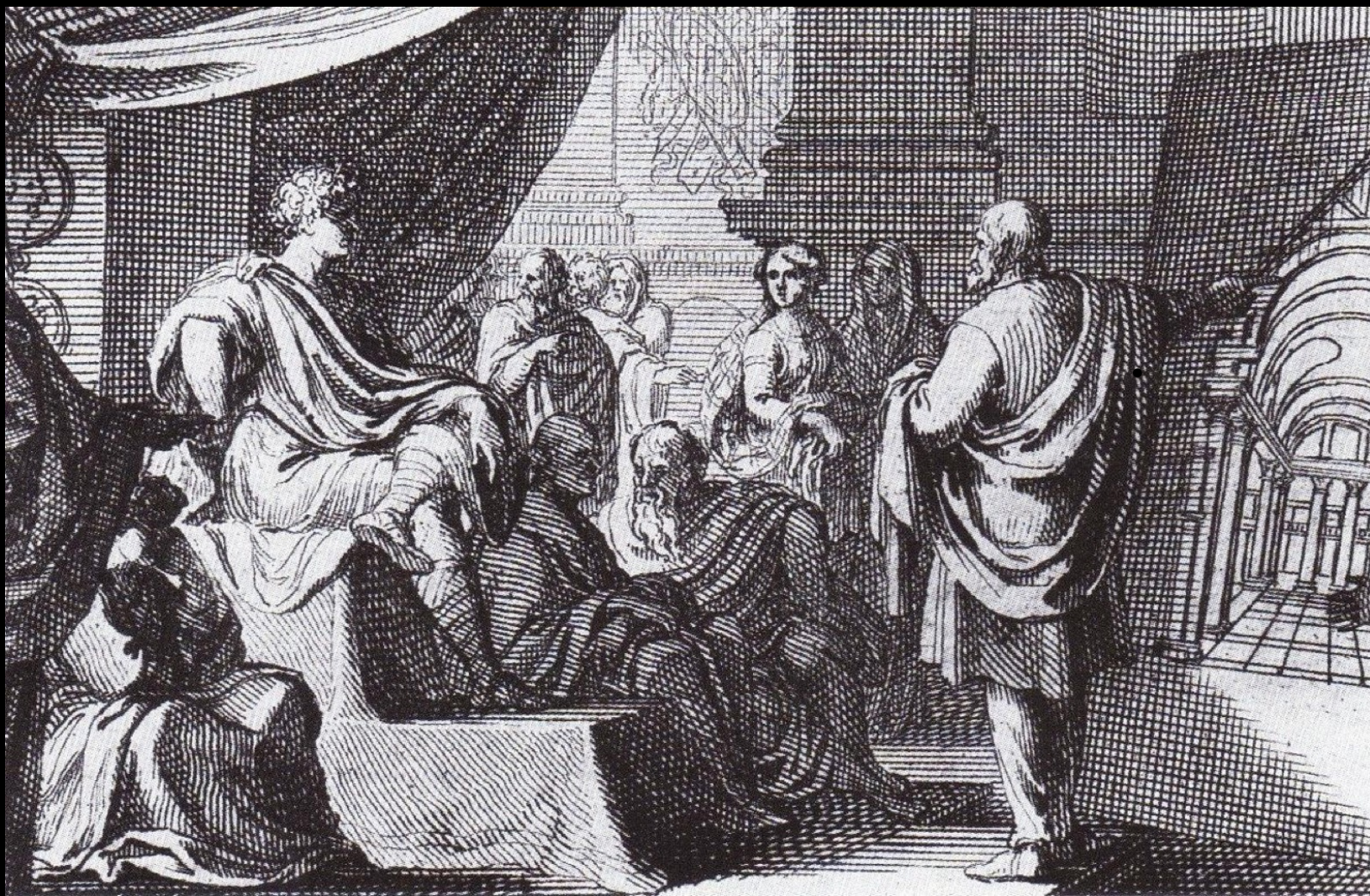


Figure 6. Global “CO₂” emissions, annually–globally [35].



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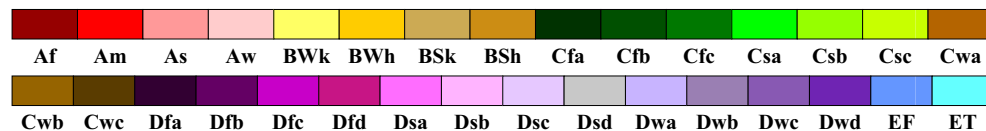
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Estampa de 1684. SMITH T.G., (2003) Vitruvius on Architecture, New York, Monacelli Press,.

World Map of Köppen–Geiger Climate Classification

updated with CRU TS 2.1 temperature and VASCLimO v1.1 precipitation data 1951 to 2000



Main climates

A: equatorial
B: arid
C: warm temperate
D: snow
E: polar

Precipitation

W: desert
S: steppe
f: fully humid
s: summer dry
w: winter dry
m: monsoonal

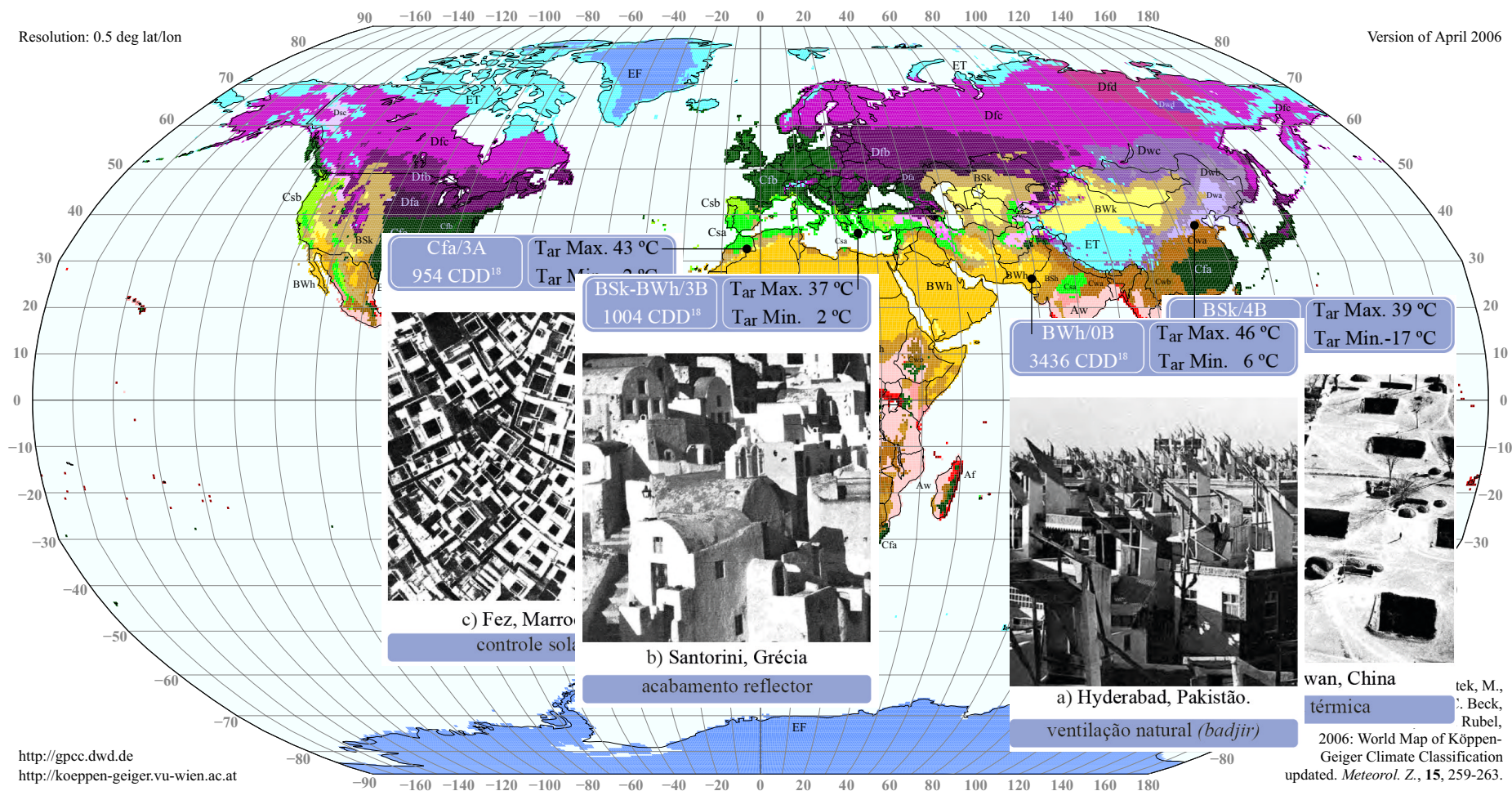
Temperature

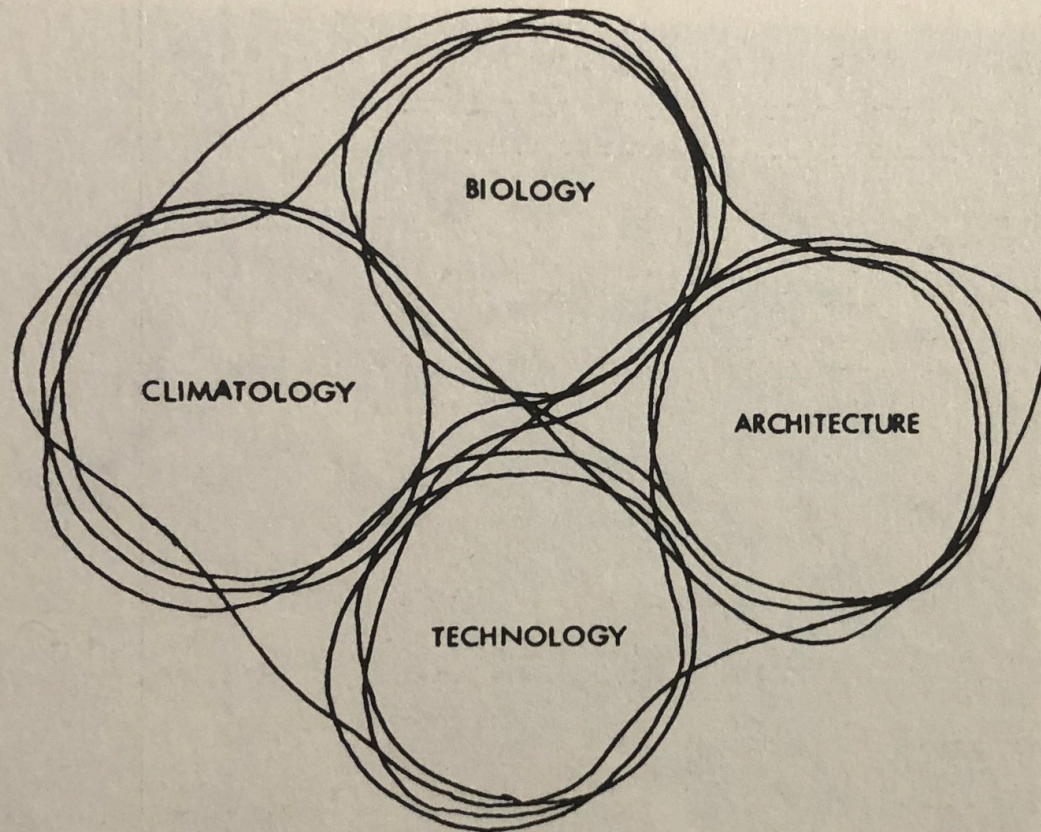
h: hot arid
k: cold arid
a: hot summer
b: warm summer
c: cool summer
d: extremely continental

F: polar frost
T: polar tundra

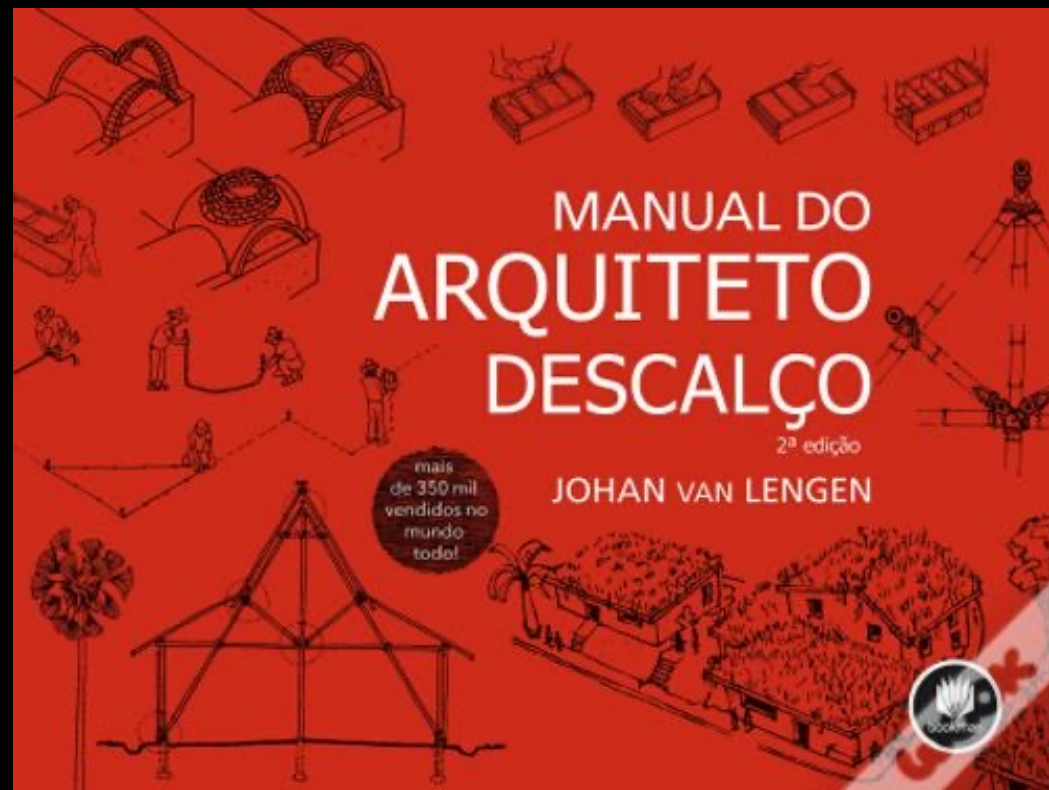
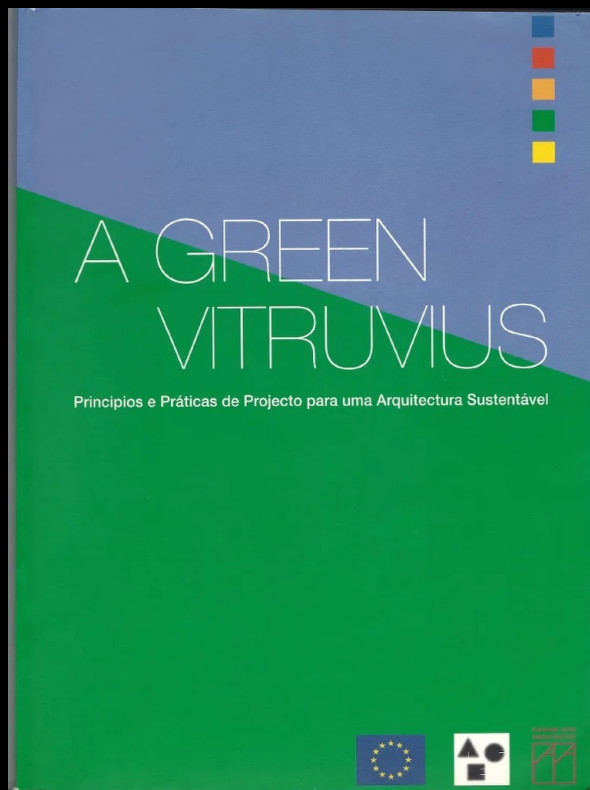
Resolution: 0.5 deg lat/lon

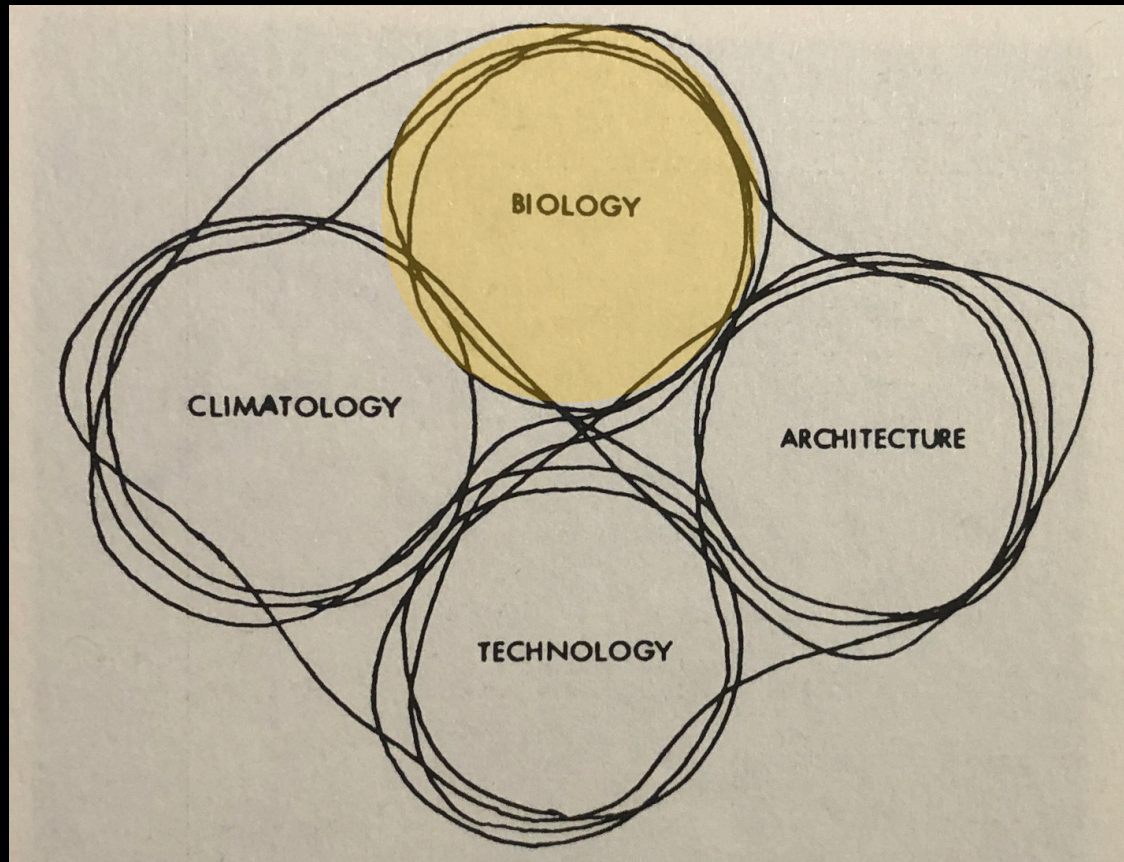
Version of April 2006

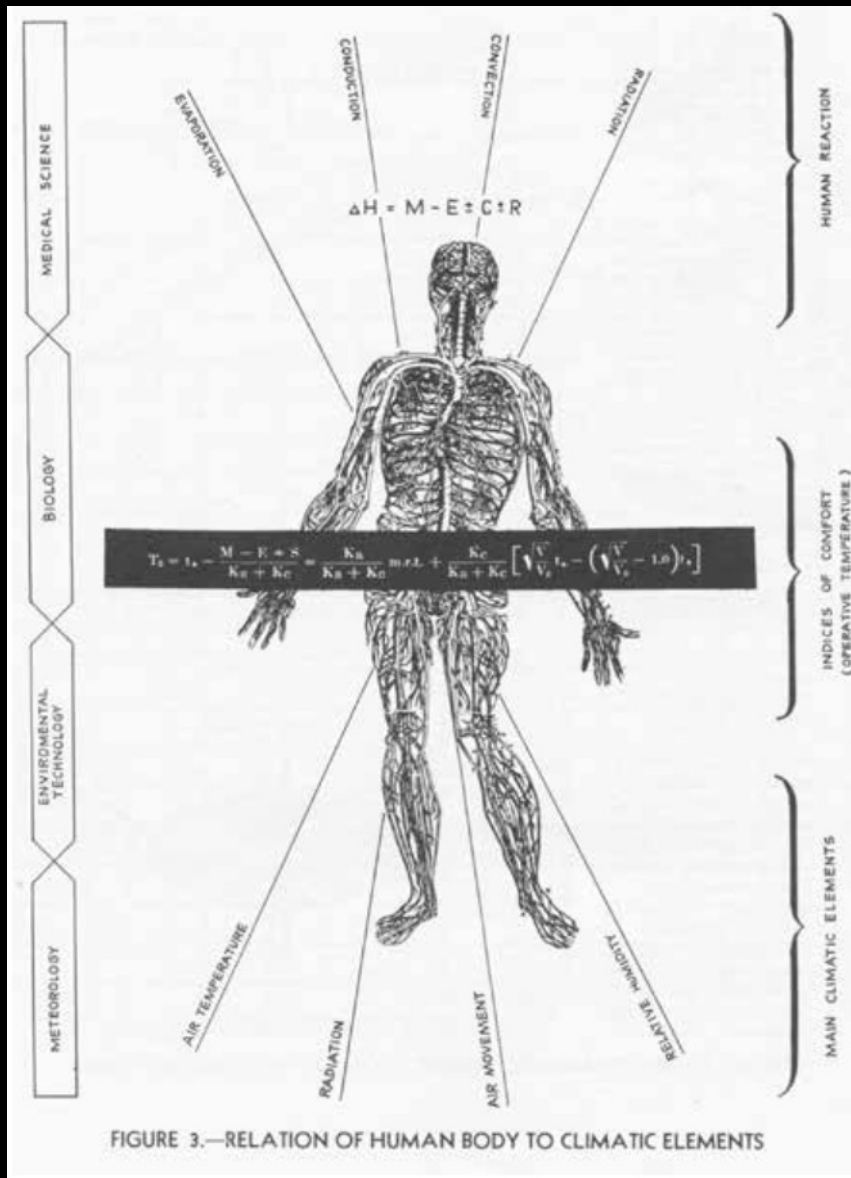




31. Interlocking fields of climate balance.





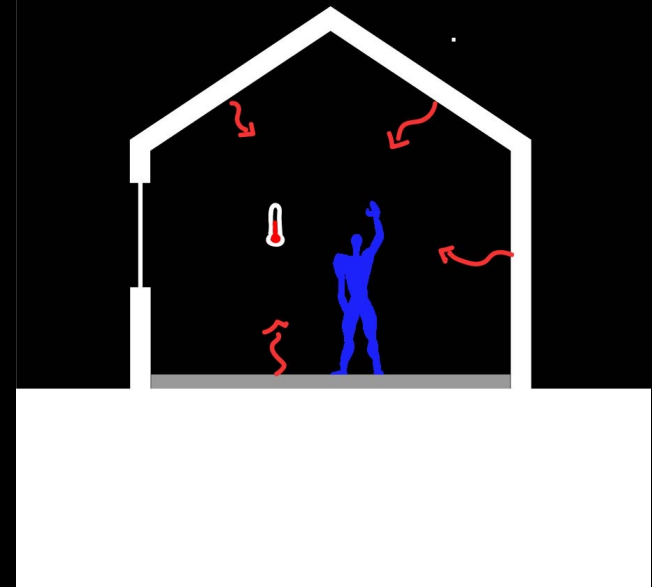


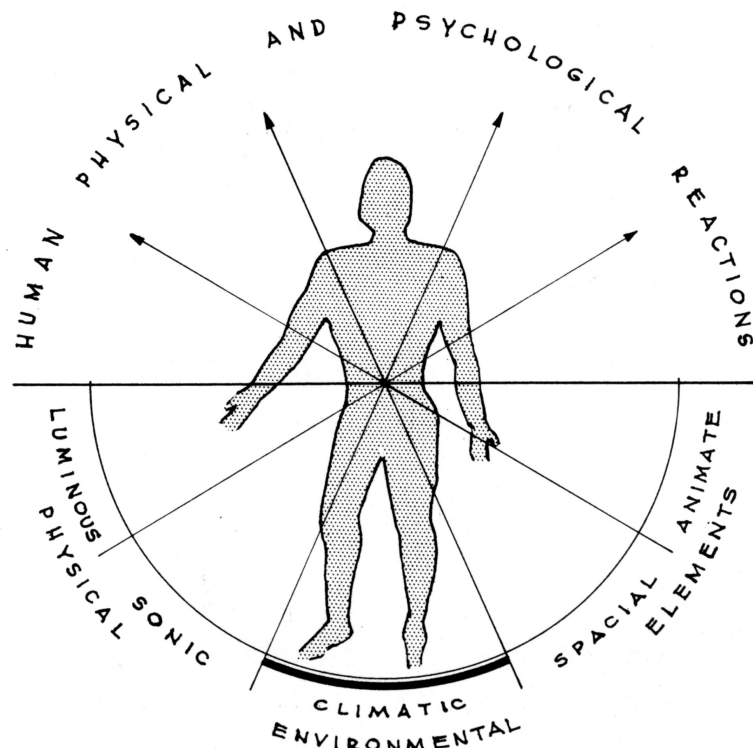
A FISIOLOGIA HUMANA

Os fatores ambientais que influem no metabolismo:

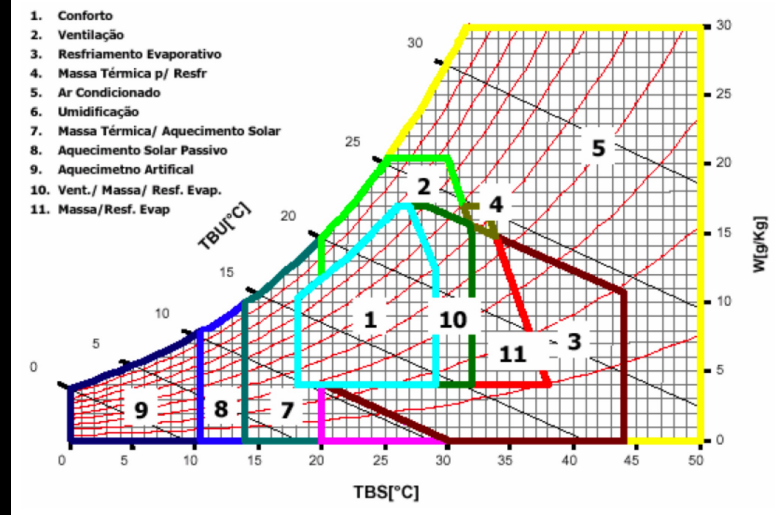
a Temperatura do ar | Temperatura
a Temperatura radiante | Operativa
a Velocidade do ar
a Humidade

o Vestuário



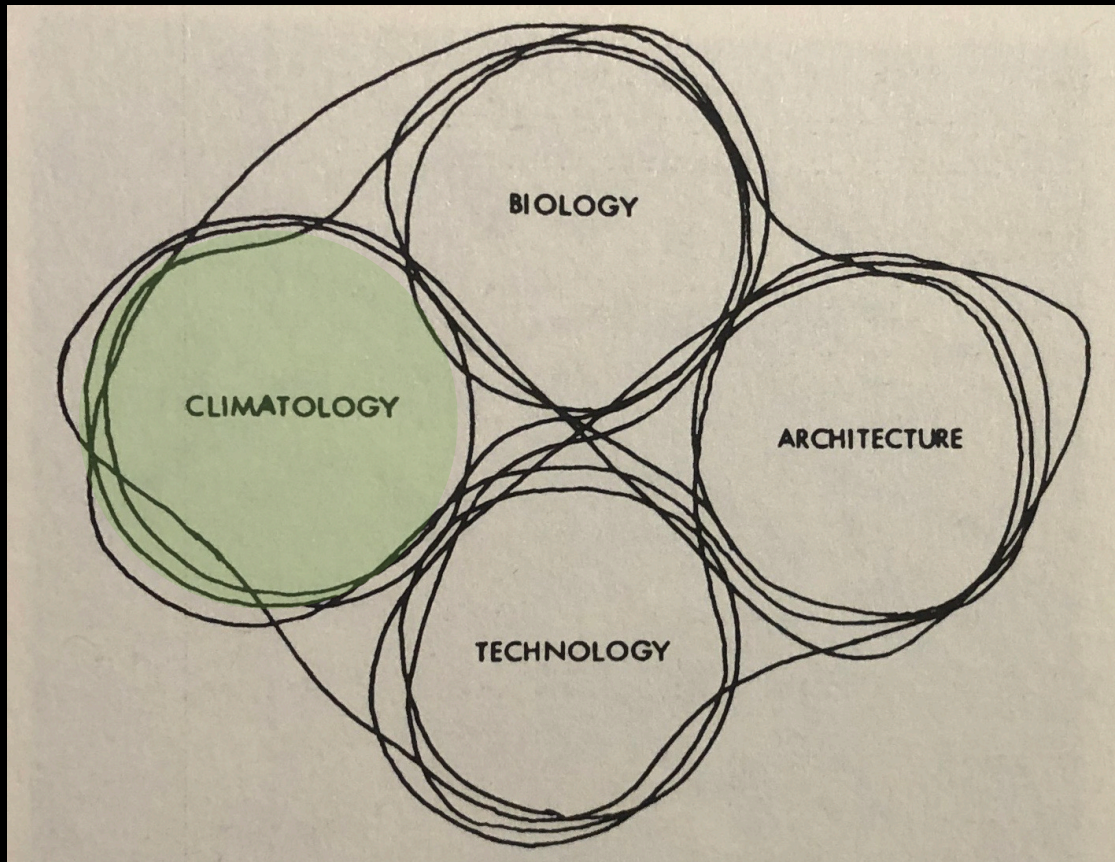


34. Man as the central measure in architecture.



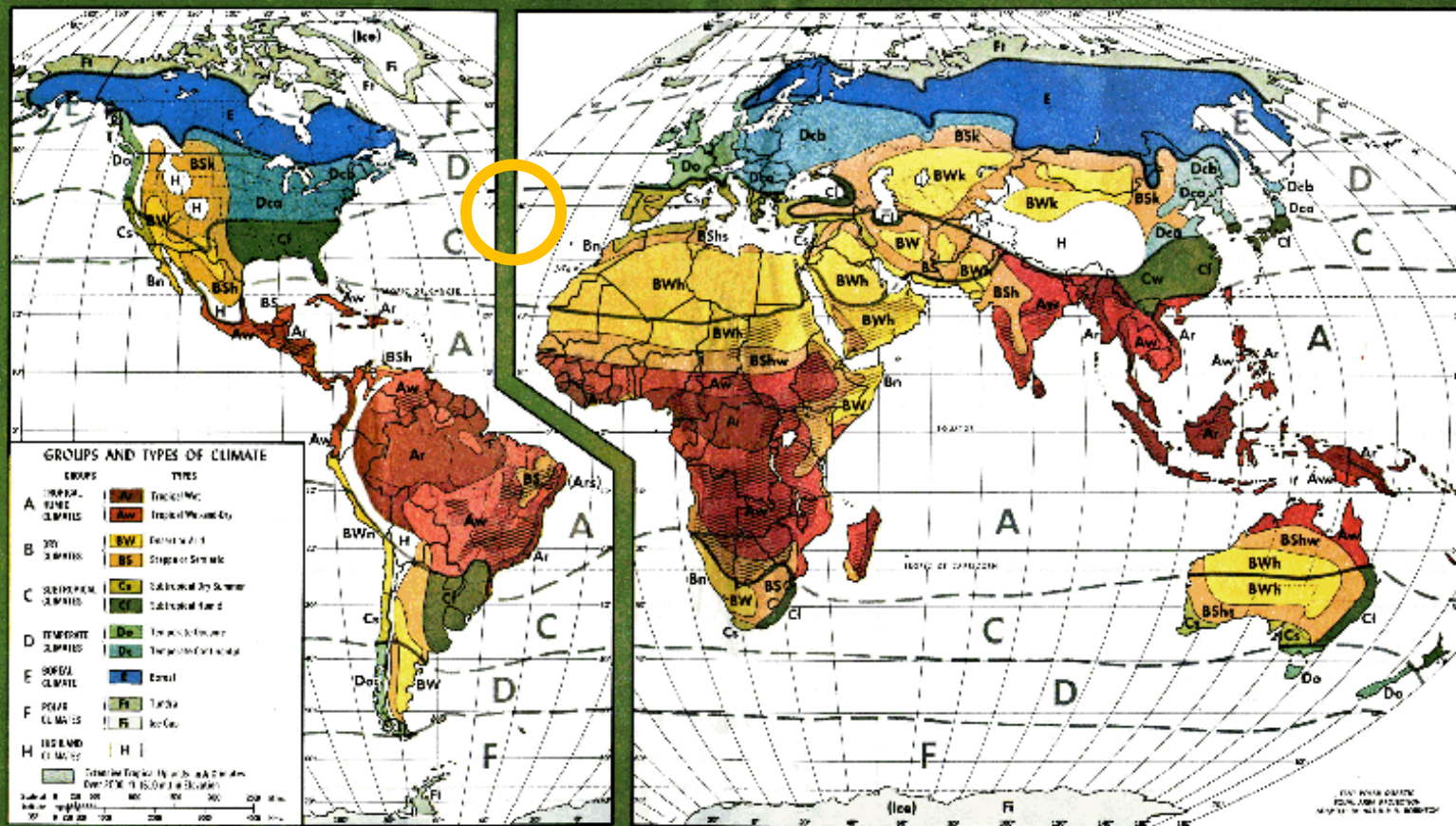
Carta de Givoni. Fonte: DOI: 10.14295/online.v15i55.3079

- 1 – Conforto
- 2 – Ventilação
- 3 – Arrefecimento evaporativo
- 4. Massa térmica para arrefecimento
- 5 – Ar condicionado
- 6 – Umidificação
- 7 – Massa Térmica para aquecimento solar
- 8 – Aquecimento solar passivo
- 9 – Aquecimento ativo
- 10- Ventilação / massa térmica e arrefecimento evaporativo
- 11- Massa térmica e arrefecimento evaporativo



Análise climática

1. Obtenção do ficheiro climático EPW
2. Análise com o software CBE Clima Tool
3. Verificação das estratégias a adotar, utilizando a carta Psicrométrica de Givoni

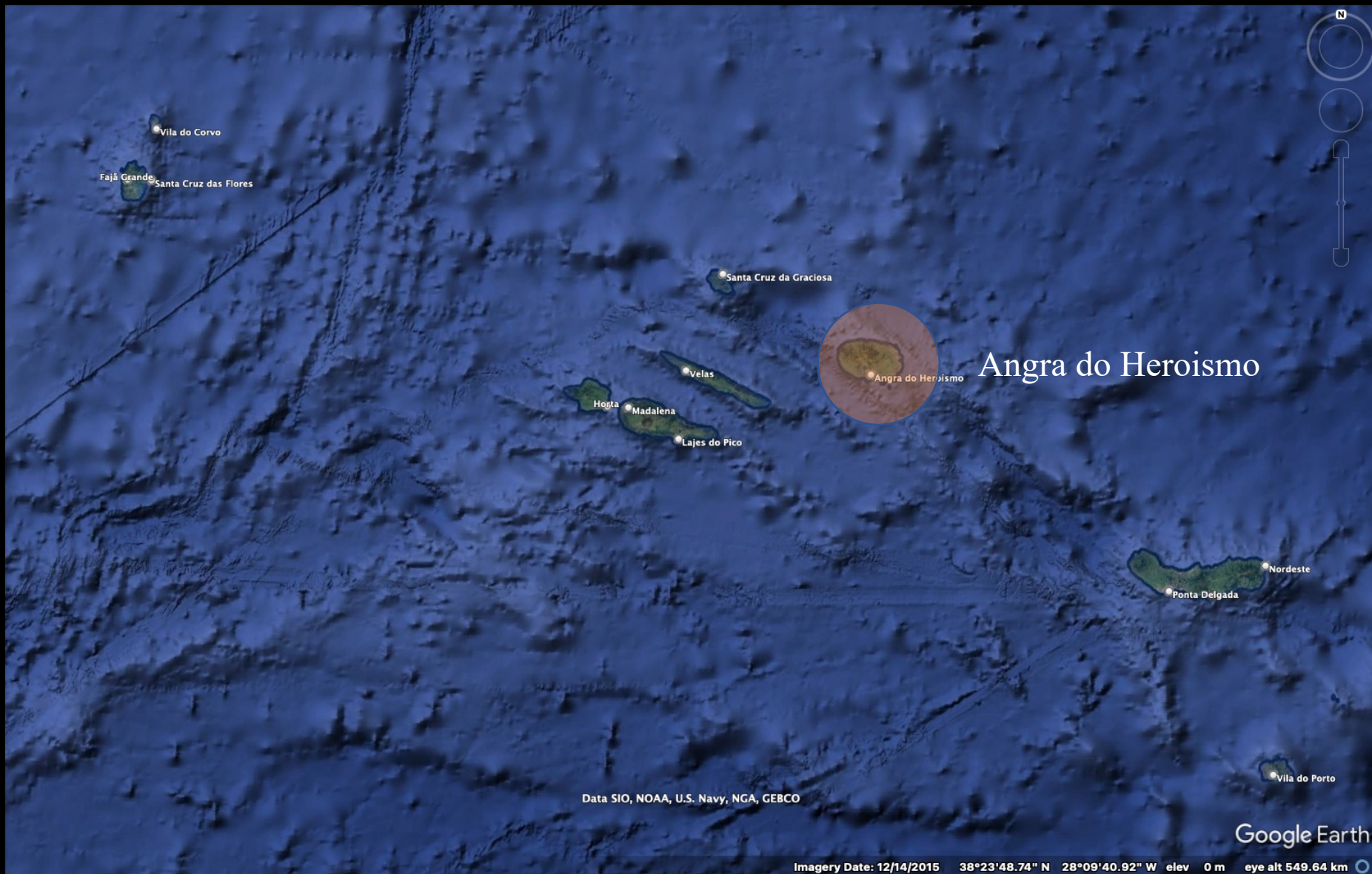


Designação	Ficheiro EPW	Est. Meteo	Zona climática		Temperatura média Dry Bulb (°C)								Hum. Relativa média (%)					Chuva (mm)				
			Koppen	ASHRAE	inverno		primavera		verão		outono		inverno	primavera	verão	outono	média	inverno	primavera	verão	outono	
					min	max	min	max	min	max	min	max										
Ilha Terceira	TMY 2007-2021	Angra do Heroismo	Csa		13	17	15	19	19	24	16	20	80.22	82.35	80.31	81.16	81.01	114	147	108	235	604
	TMY 2007-2021	Lajes	Csa		15	16	15	17	20	21	17	19	81.55	80.46	80.35	81.71	81.02	187	94	22	254	557
Graciosa	TMY 2007-2021	Santa Cruz da Graciosa	Cfa		14	16	15	17	21	22	17	19	78.71	78.02	79.17	78.13	78.51	176	169	50	164	559
Ilha do Faial	TMY 2007-2021	Horta	Csa		14	16	15	17	21	22	17	19	78.74	82.22	81.01	81.94	80.98	177	155	46	345	723
Ilha do Pico	TMY 2007-2021	Santa Luzia	Cfa		14	16	15	17	21	22	17	19	79.1	76.23	77.2	77.89	77.61	159	180	46	135	520
Ilha de São Jorge	TMY 2007-2021	Velas	Cfa		14	16	15	17	21	22	17	19	77.4	77.45	78.38	76.93	77.54	159	180	46	135	520
Ilha de São Miguel	TMY 2007-2021	Ponta delgada	Csa		12	16	14	19	19	24	15	19	83.27	79.86	78.52	82.9	81.14	216	51	47	278	592
Ilha de Santa Maria	TMY 2007-2021	Vila do Porto	Csa		15	16	16	17	21	22	18	20	83.84	78.41	77.2	79.93	79.85	140	116	37	296	589
Corvo	TMY 2007-2021	Corvo	Cfa		14	16	15	17	21	23	17	19	77.83	80.75	81.49	77.79	79.47	230	172	244	208	854
Ilha das Flores	TMY 2007-2021	Santa Cruz - AP	Cfb		14	16	15	17	21	22	17	19	80.15	74.17	78.94	75.11	77.09	255	212	284	268	1019

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth

Imagery Date: 12/14/2015 38°23'48.74" N 28°09'40.92" W elev 0 m eye alt 549.64 km



AC_Acores					
PRT_AC_Angra.do.Heroismo.085110_TMYx.2004-2018.zip	386 K	PRT_AC_Horta.085060_TMYx.2004-2018.zip	391 K	PRT_AC_Pico.AP.085125_TMYx.2007-2021.zip	407 K
PRT_AC_Angra.do.Heroismo.085110_TMYx.2007-2021.zip	421 K	PRT_AC_Horta.085060_TMYx.2007-2021.zip	416 K	PRT_AC_Flores.AP.085010_TMYx.2004-2018.zip	407 K
PRT_AC_Angra.do.Heroismo.085110_TMYx.zip	421 K	PRT_AC_Horta.085060_TMYx.zip	417 K	PRT_AC_Ponta.Delgada-Joao.Paulo.AP.085120_TMYx.2004-2018.zip	363 K
PRT_AC_Corvo.Island.AP.085020_TMYx.2007-2021.zip	412 K	PRT_AC_Horta.AP.085050_TMYx.2004-2018.zip	389 K	PRT_AC_Ponta.Delgada-Joao.Paulo.AP.085120_TMYx.2007-2021.zip	393 K
PRT_AC_Corvo.Island.AP.085020_TMYx.zip	411 K	PRT_AC_Horta.AP.085050_TMYx.2007-2021.zip	410 K	PRT_AC_Ponta.Delgada-Joao.Paulo.AP.085120_TMYx.zip	413 K
PRT_AC_Flores.AP.085010_TMYx.2004-2018.zip	399 K	PRT_AC_Horta.AP.085050_TMYx.zip	424 K	PRT_AC_Santa.Maria.AP.085150_TMYx.2004-2018.zip	366 K
PRT_AC_Flores.AP.085010_TMYx.2007-2021.zip	428 K	PRT_AC_Lajes.AP.085090_TMYx.2004-2018.zip	382 K	PRT_AC_Santa.Maria.AP.085150_TMYx.2007-2021.zip	398 K
PRT_AC_Flores.AP.085010_TMYx.zip	430 K	PRT_AC_Lajes.AP.085090_TMYx.2007-2021.zip	400 K	PRT_AC_Santa.Maria.AP.085150_TMYx.zip	391 K
PRT_AC_Graciosa.AP.085155_TMYx.2007-2021.zip	400 K	PRT_AC_Lajes.AP.085090_TMYx.zip	394 K	PRT_AC_Sao.Jorge.AP.085095_TMYx.2007-2021.zip	404 K
PRT_AC_Graciosa.AP.085155_TMYx.zip	401 K	PRT_AC_Pico.AP.085125_TMYx.2004-2018.zip	389 K	PRT_AC_Sao.Jorge.AP.085095_TMYx.zip	403 K

AG_Algarve			
PRT	AG_Earo 085550	TMVx 2007-2021 zin	122 K
PRT	AG_Earo AD085540	TMVx 2007-2021 zin	118 K
PRT	AG_Sagres 085330	TMVx 2007-2021 zin	114 K



Select Weather File

Climate Summary

Temperature and Humidity

Sun and Clouds

Wind

Psychrometric Chart

Natural Ventilation

Outdoor Comfort

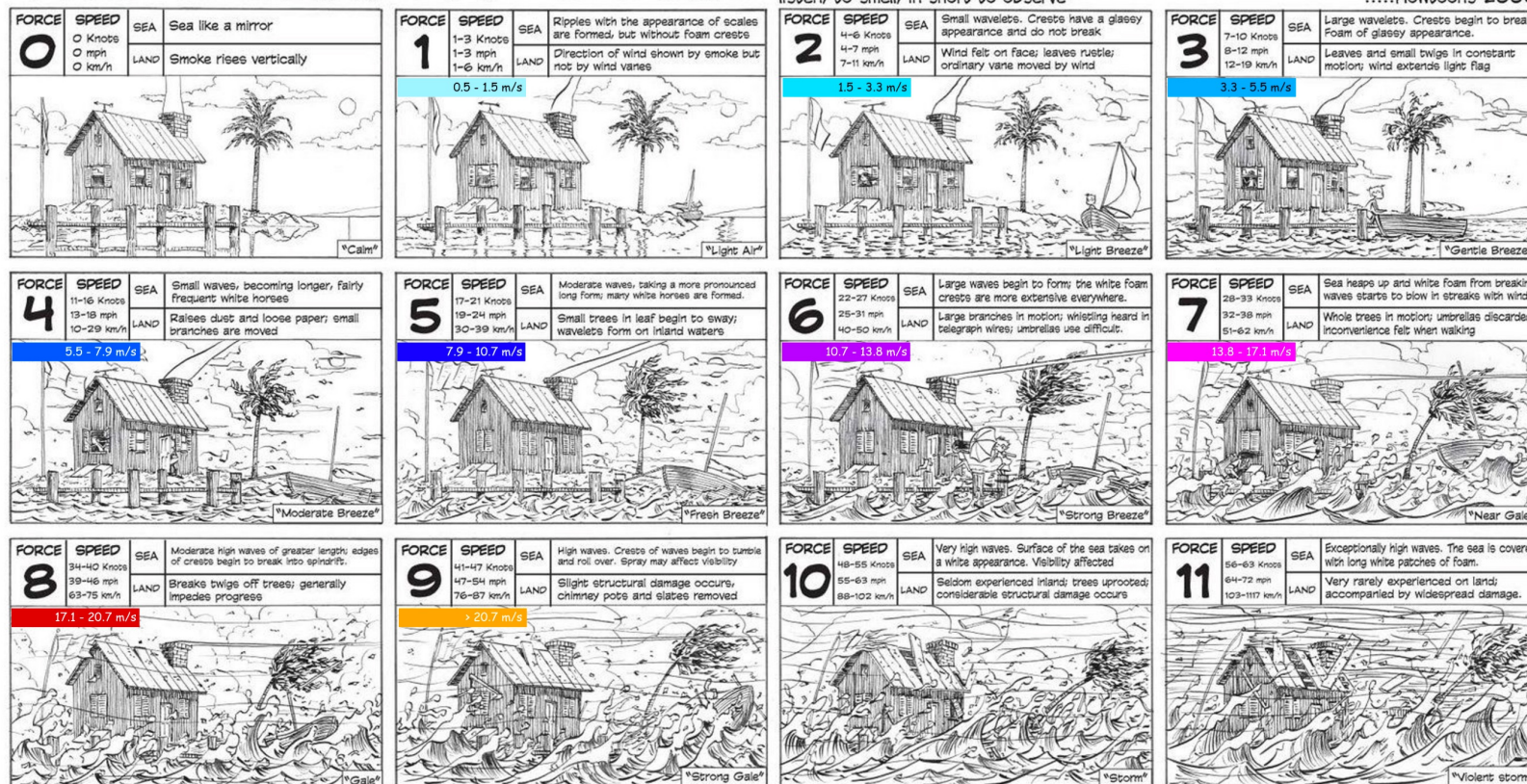
Data Explorer

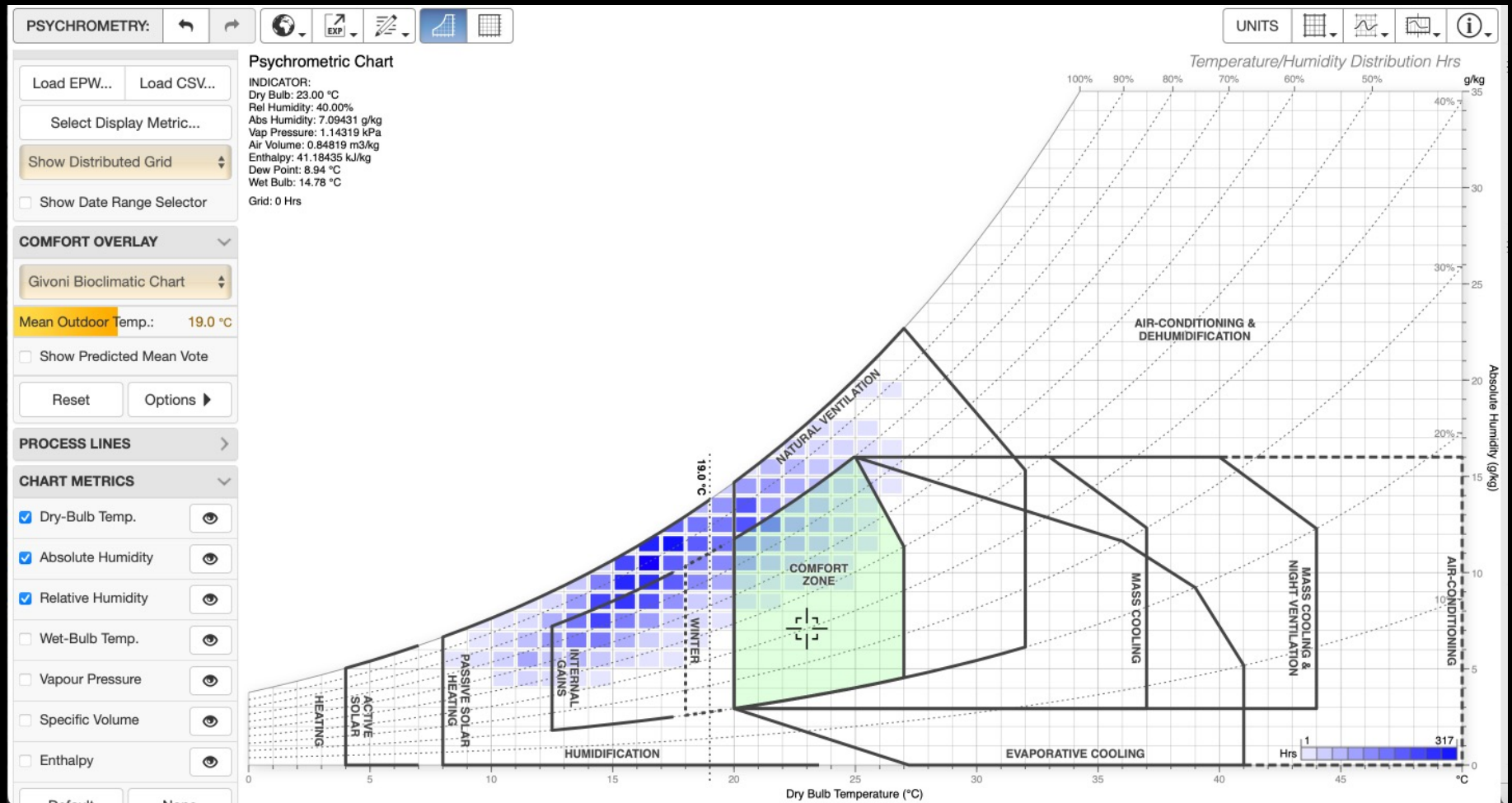
Seasonal Wind Rose

The Beaufort Scale

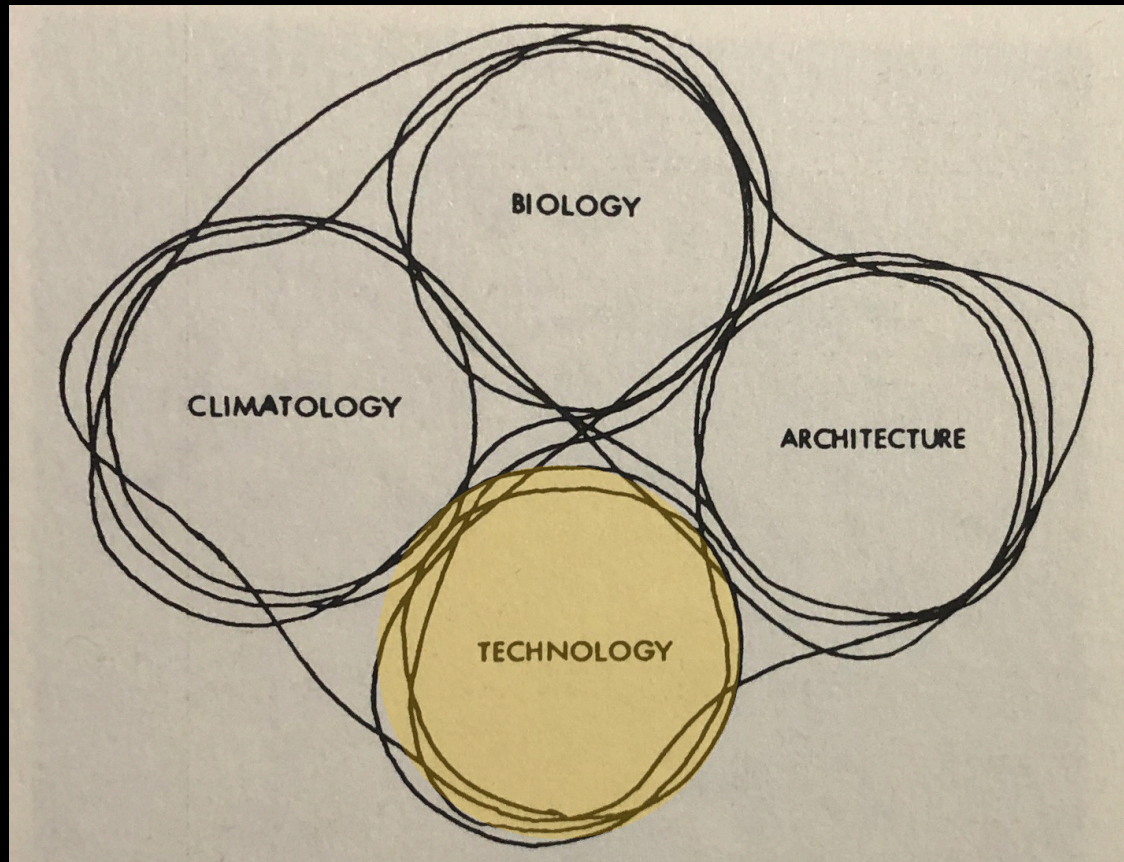
"Over thousands of years sailors have learnt to estimate the speed of the wind just by looking about. This technique matured into what we now call the Beaufort scale. The universe tells you everything you need to know about it as long as you are prepared to watch, to listen, to smell, in short to observe!"

.....Howtoons 2006





1. Aquecimento solar passivo
2. Ganhos internos (envelope)
3. Ventilação natural



Escolha do Lugar

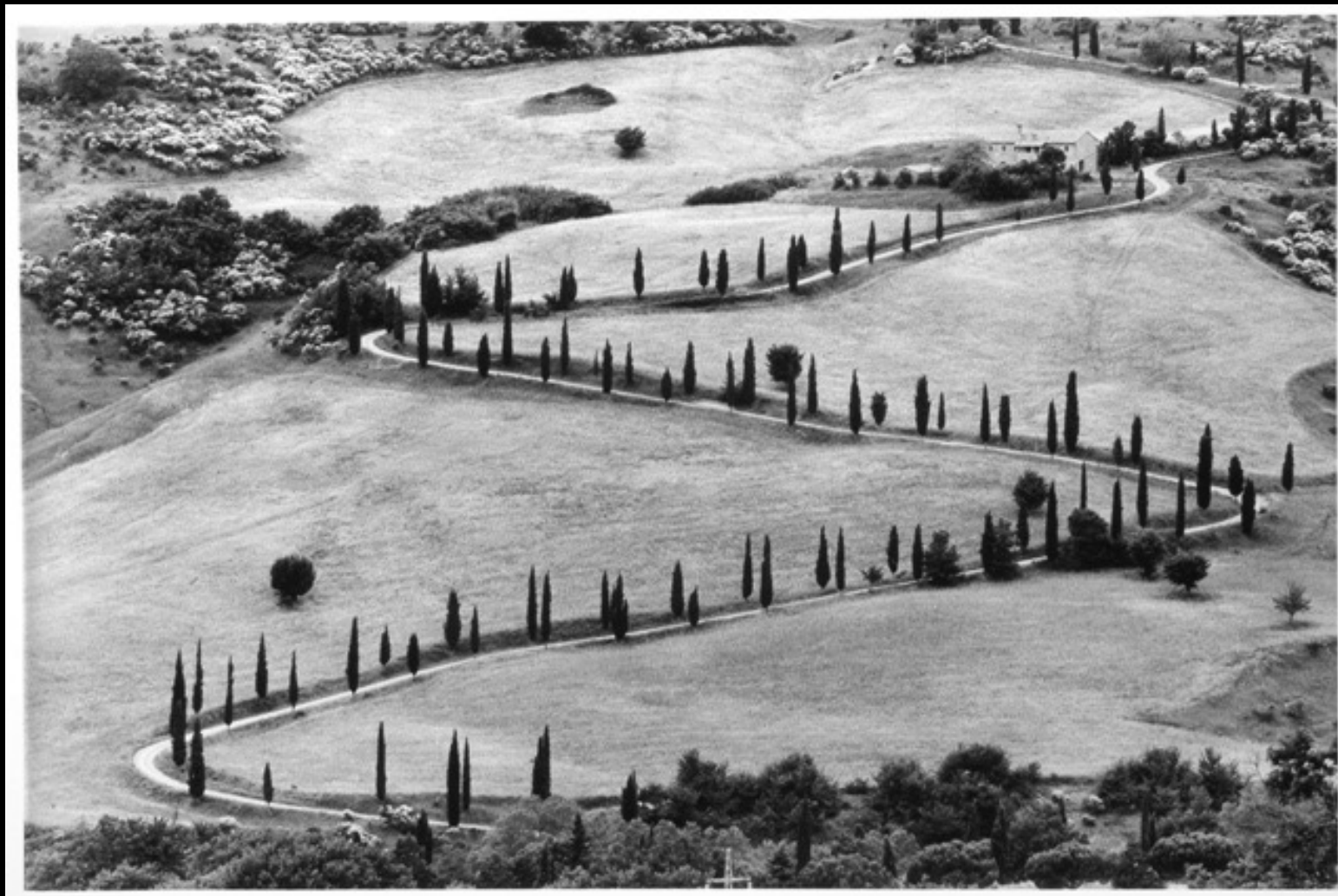
Orientação Solar

Controle Solar

Fator de Forma

Movimento do ar

Controle da temperatura interna



Val D'Orcia, Toscana. Foto de: Gianni Berengo Gardin

Escolha do Lugar

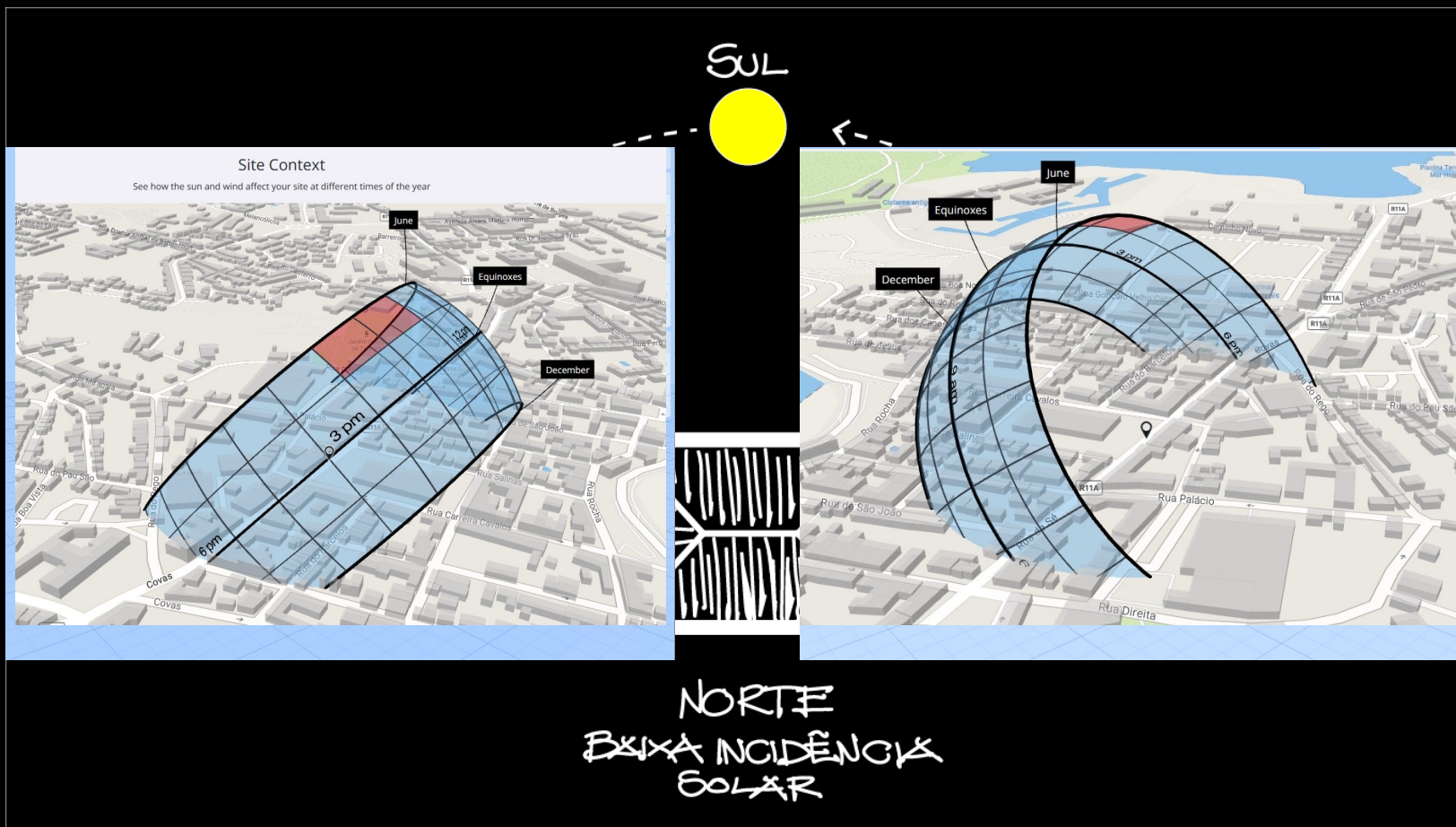
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Movimento do ar

Controle da temperatura interna



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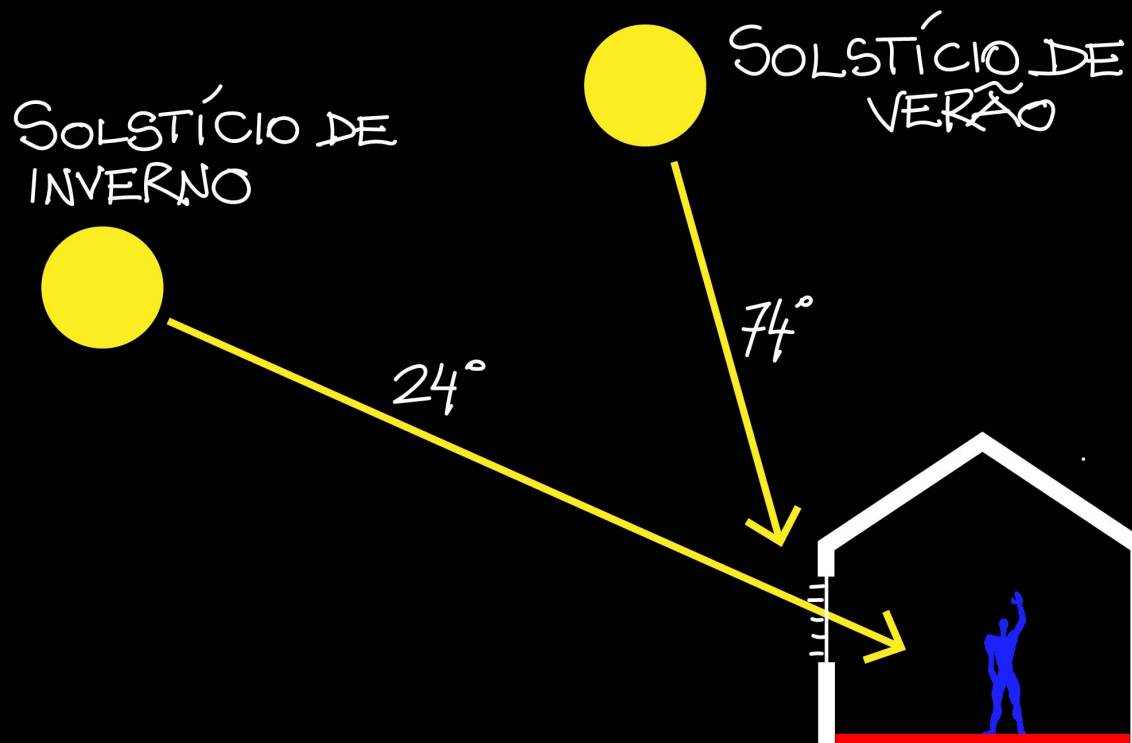
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Escolha do Lugar

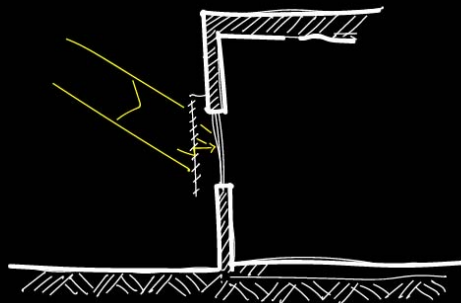
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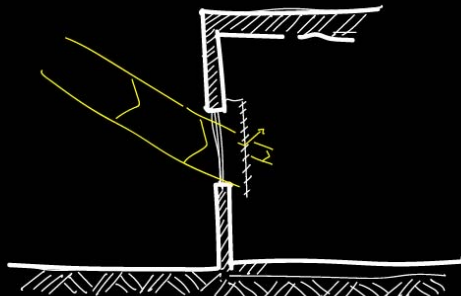
Fator de Forma

Movimento do ar

Controle da temperatura interna



SOMBREAMENTO
EXTERIOR



SOMBREAMENTO
INTERIOR



Escolha do Lugar

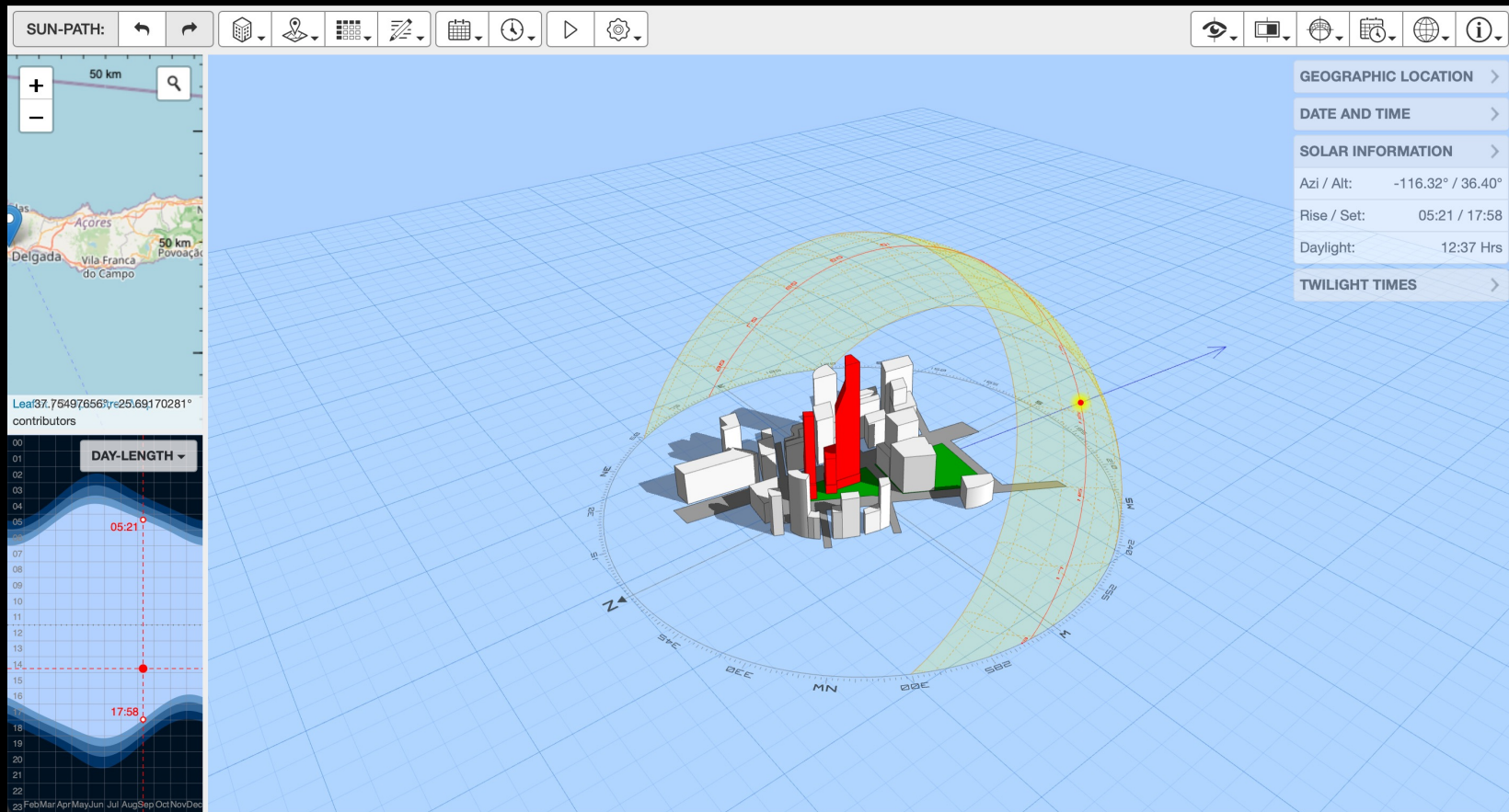
Orientação Solar

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Escolha do Lugar

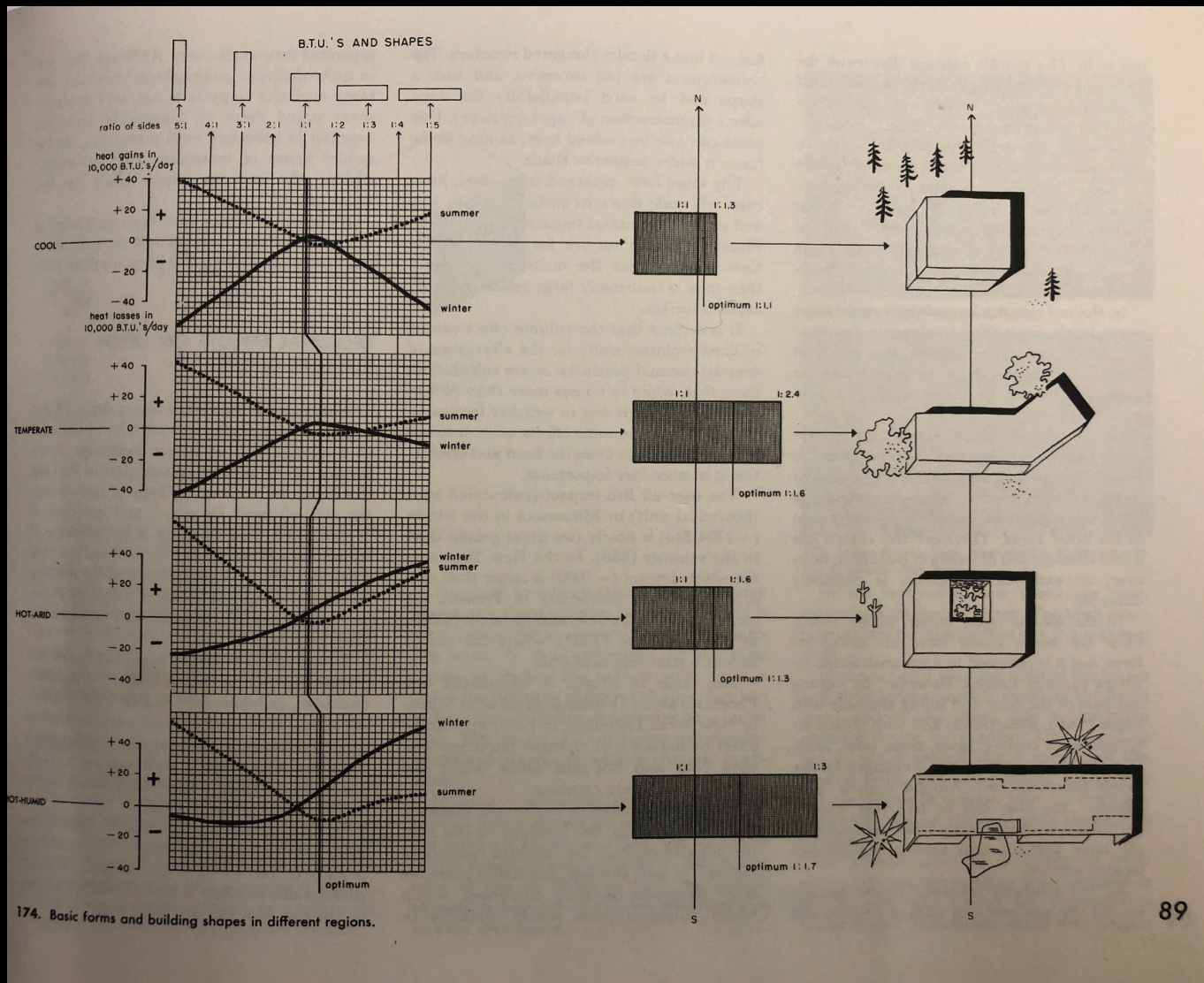
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IQAir

Air Quality

Air Monitors

Air Purifiers

Face Masks

For Business

News

Support



Dashboard



Share



Contribute data

IQAir Earth

2023-11-15 17:00 Local -1.0°C

US AQI



PM2.5 - PM10 - Wind



Escolha do Lugar

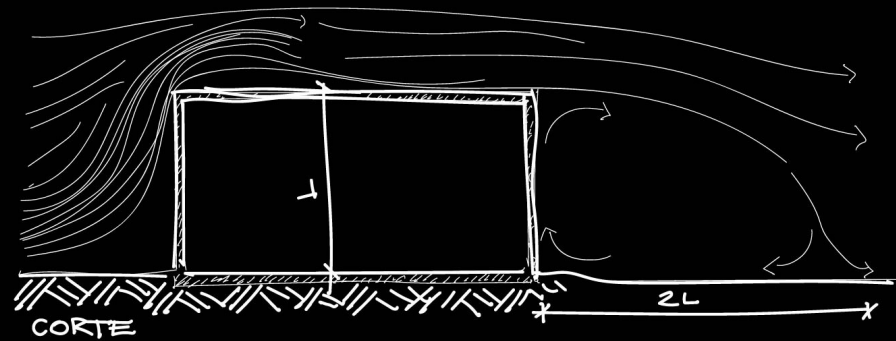
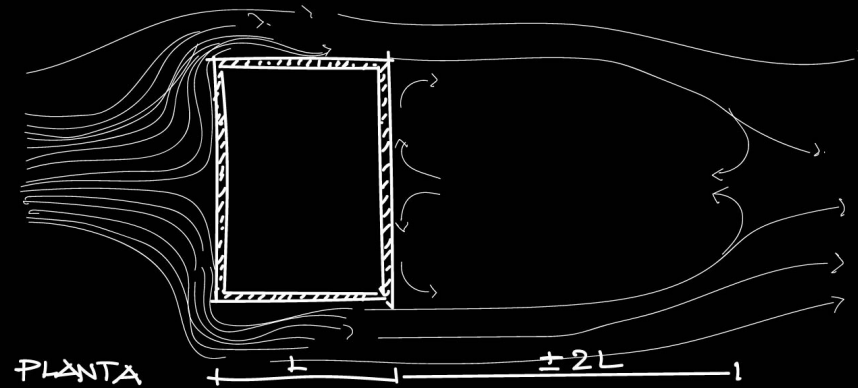
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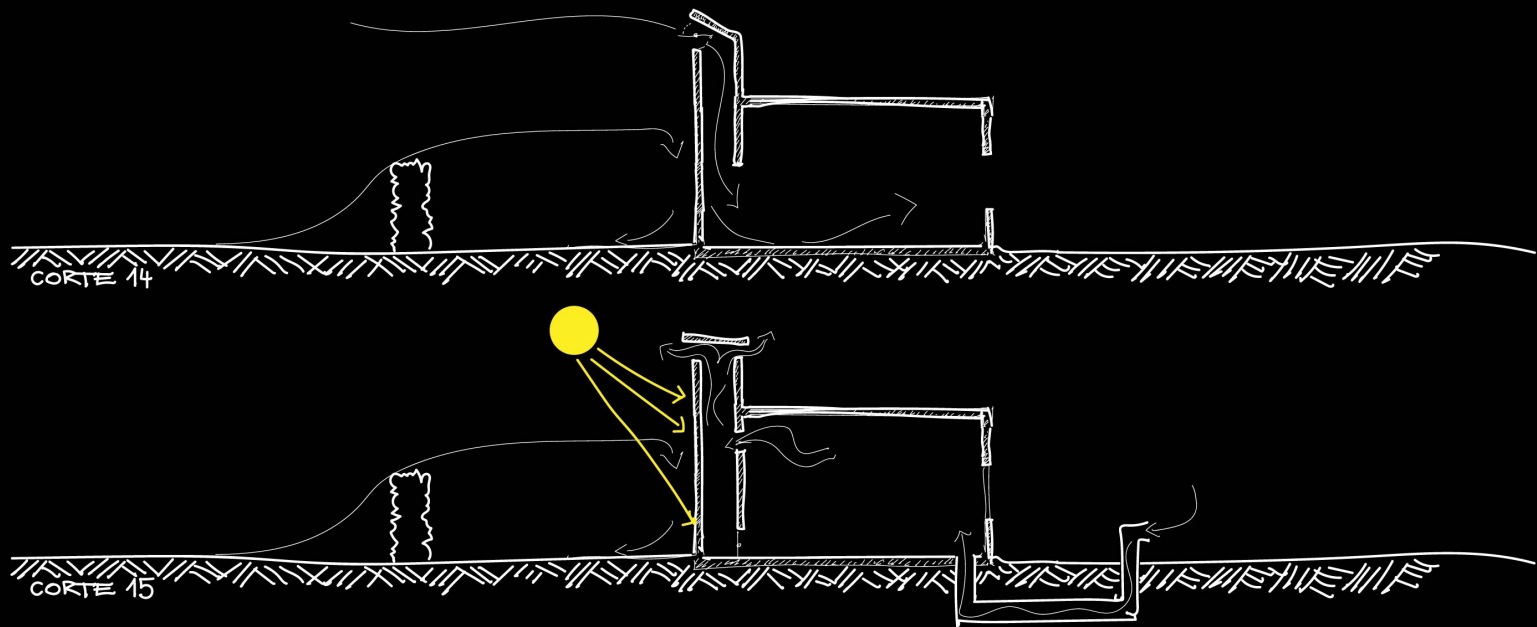
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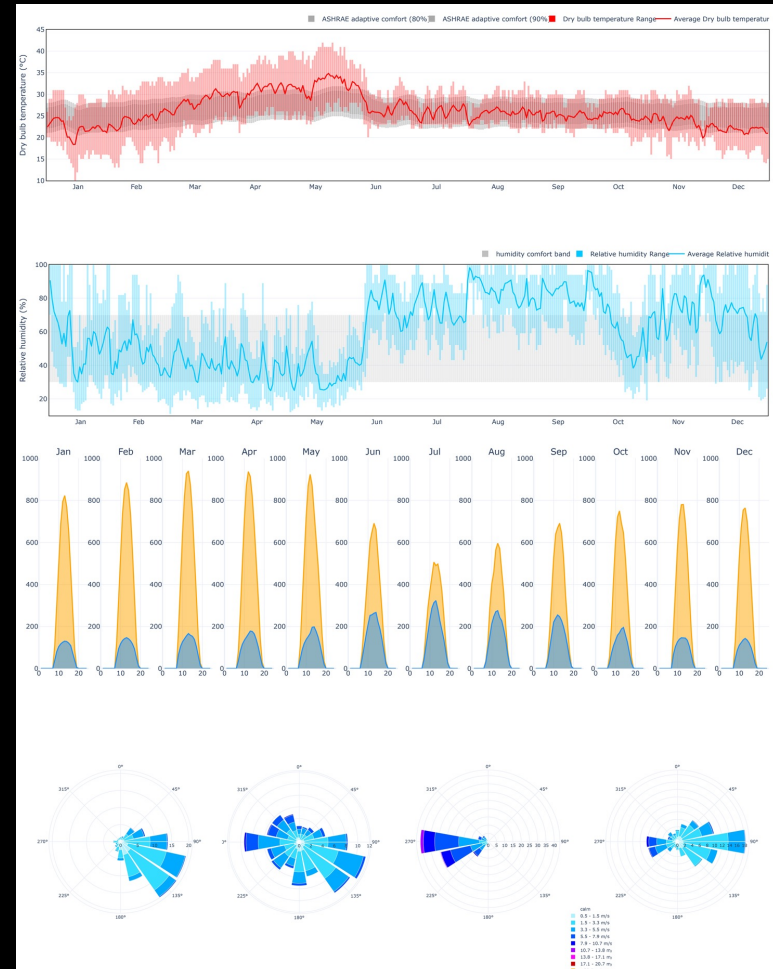
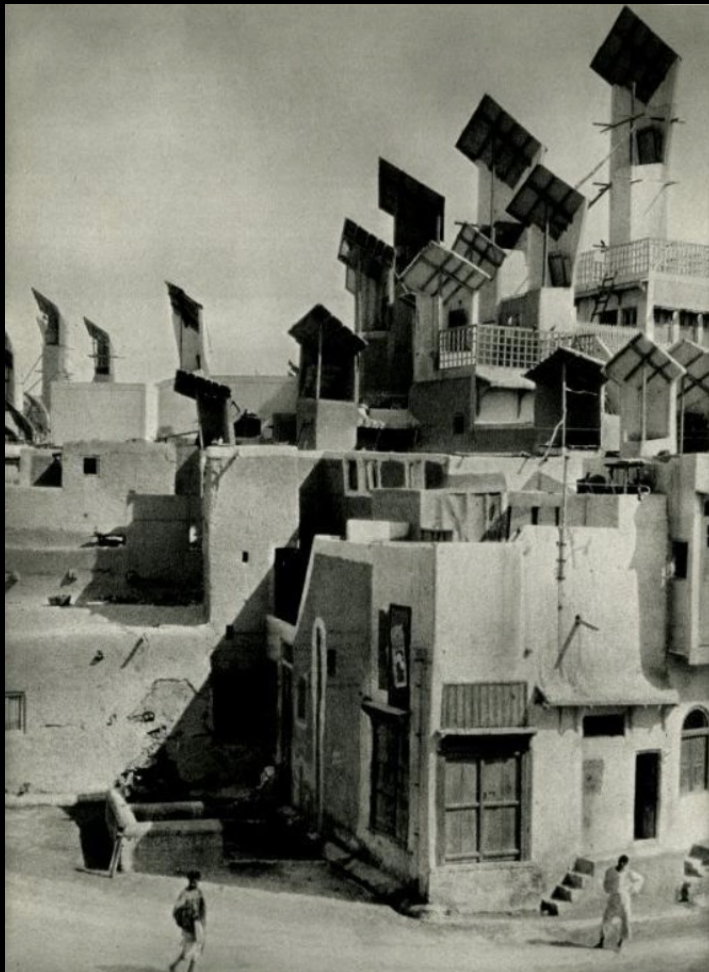
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Grande Inércia térmica



Baixa inércia térmica - Alto condutor



Baixa inércia térmica - Baixo condutor

Escolha do Lugar

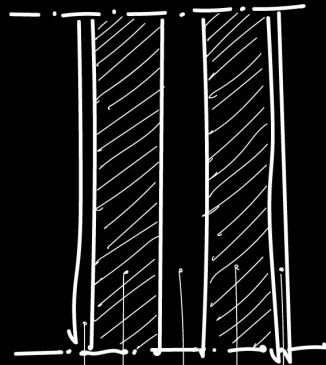
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REBOCO PINTADO
BLOCO DE BETÃO
CAIXA DE AR
BLOCO DE BETÃO LEVE
REBOCO EXT.

1.3 cm — $R = 0.007$
30 cm — $R = 1.91$
4 cm — $R = 0.18$
30 cm — $R = 1.91$
1.3 cm — $R = 0.007$

FONTE:
ITE 50

$$R_T = R_{SI} + R_1 + R_2 + R_x + R_{SE}$$

$$R_x = \frac{e}{\lambda} \rightarrow \begin{array}{l} \text{ESPESSURA} \\ \text{CONDUTIVIDADE} \\ \text{TÉRMICA} \end{array}$$

$$R_T = \underset{(R_{SI})}{0.13} + 0.007 + 1.91 + 0.18 + 1.91 + 0.007 + \underset{(R_{SE})}{0.04} = 4.184$$

$$U = \frac{1}{R_T} = 0.239 \text{ W/m}^2\text{C}$$

Escolha do Lugar

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Diário da República, 1.ª série

N.º 126

1 de julho de 2021

Pág. 128-(12)

AMBIENTE E AÇÃO CLIMÁTICA E INFRAESTRUTURAS E HABITAÇÃO

Portaria n.º 138-I/2021

de 1 de julho

Sumário: Regulamenta os requisitos mínimos de desempenho energético relativos à envolvente dos edifícios e aos sistemas técnicos e a respetiva aplicação em função do tipo de utilização e específicas características técnicas.

Tabela 3 — Coeficientes de transmissão térmica superficiais máximos dos elementos da envolvente opaca dos edifícios de habitação — Região Autónoma dos Açores, $U_{\text{máx}}$ [W/(m².°C)]

Região Autónoma dos Açores			Zona Climática		
Tipo de elemento		Condição fronteira	I1	I2	I3
Zona corrente da envolvente e PTP.	Verticais	Exterior ou interior com $b_{z\text{tu}} > 0,7$	1,75	1,60	1,45
		Interior com $b_{z\text{tu}} \leq 0,7$	2,00	2,00	1,90
	Horizontais	Exterior ou interior com $b_{z\text{tu}} > 0,7$	1,25	1,00	0,90
		Interior com $b_{z\text{tu}} \leq 0,7$	1,65	1,30	1,20



de Mós;
(direita) Habitação com caleira integrada na fachada para recolha de água.
Mendiga [14]

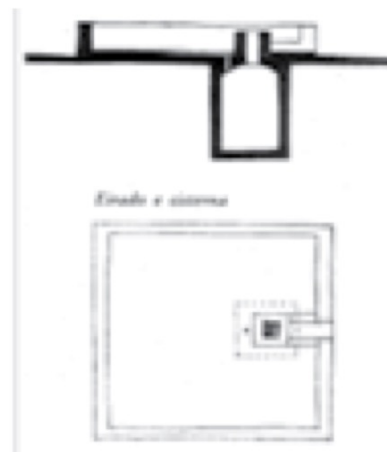
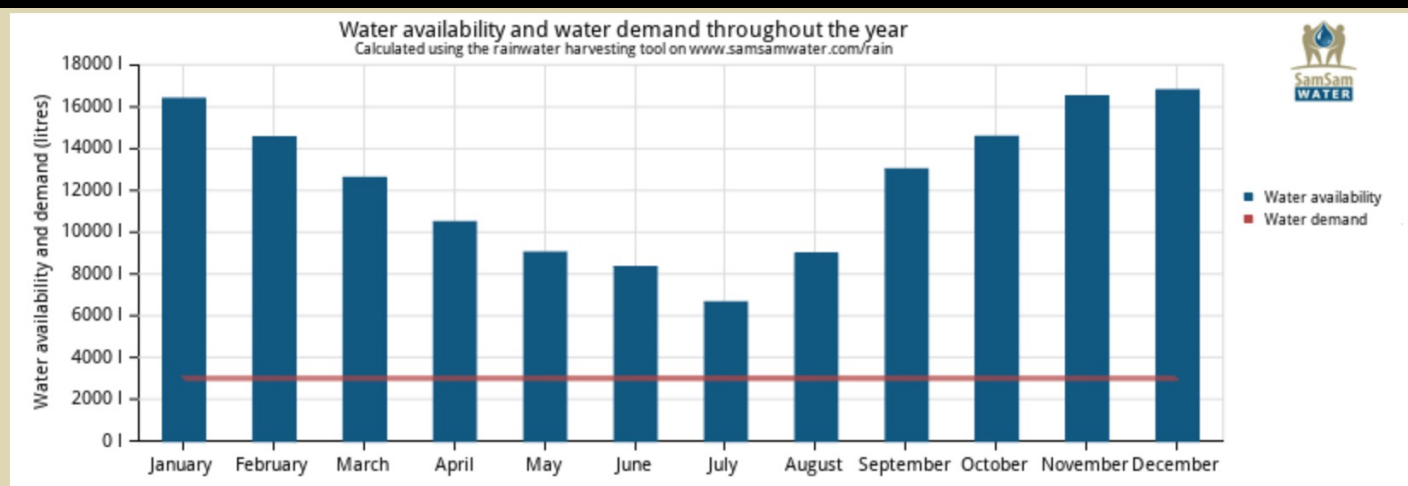


Figura 19 - Habitação com sistema de recolha de águas pluviais.
Tunes, Silves [14]



Required storage

Since the amount of water that can be collected from this roof is enough to fulfil the demand, even in the driest months, no large storage reservoir is required. A small storage volume to bridge a number of days without rain should be enough to provide an adequate water supply throughout the year.

Dry and wet years

This calculation is based on the average monthly rainfall. The actual rainfall differs from month to month and year to year. The amount of available water and filling of the tank might therefore be different and change from year to year.

When constructing a rainwater harvesting system it is important to take this into account. Below is a description of the situation in a dry year (20% chance) and a wet year (20% chance).

Situation in a dry year: the amount of water that can be collected from the roof is larger than the water demand. A small storage volume to bridge a number of days without rain should be enough.

Situation in a wet year: there will be more than enough water to fulfil the demand. A small storage volume to bridge a number of days without rain should be enough.

Data source

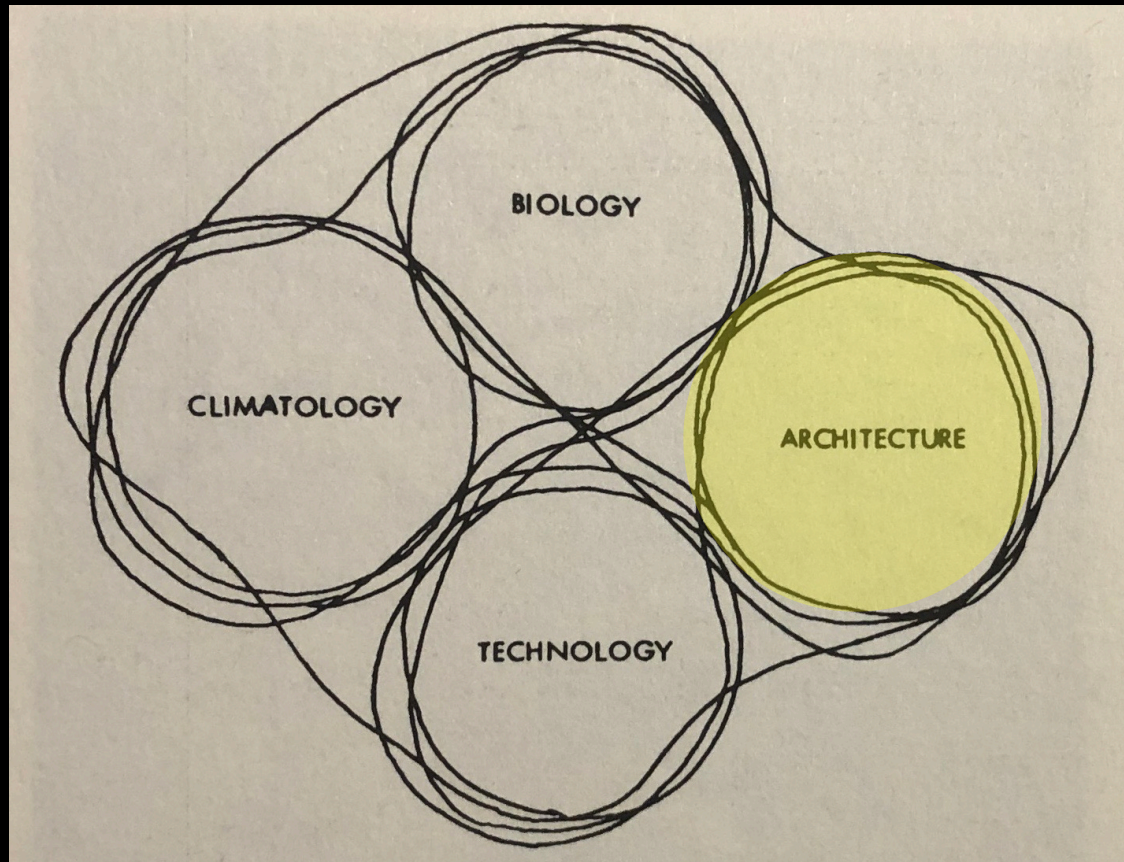
The rainfall data used for this calculation is based on the CRU CL 2.0 dataset which is described in [New, M., Lister, D., Hulme, M. and Makin, I., 2002: A high-resolution data set of surface climate over global land areas. Climate Research 21:1-25.](#)

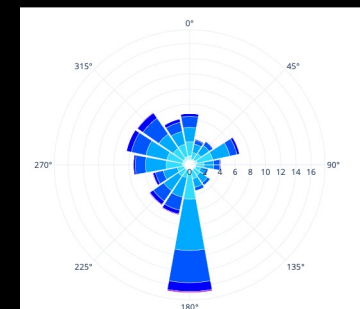
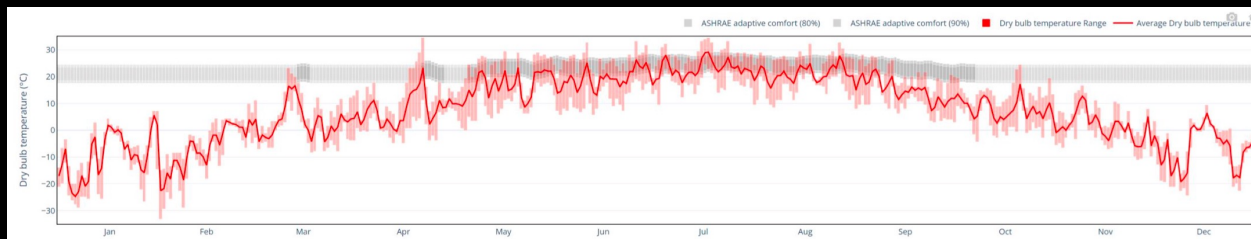
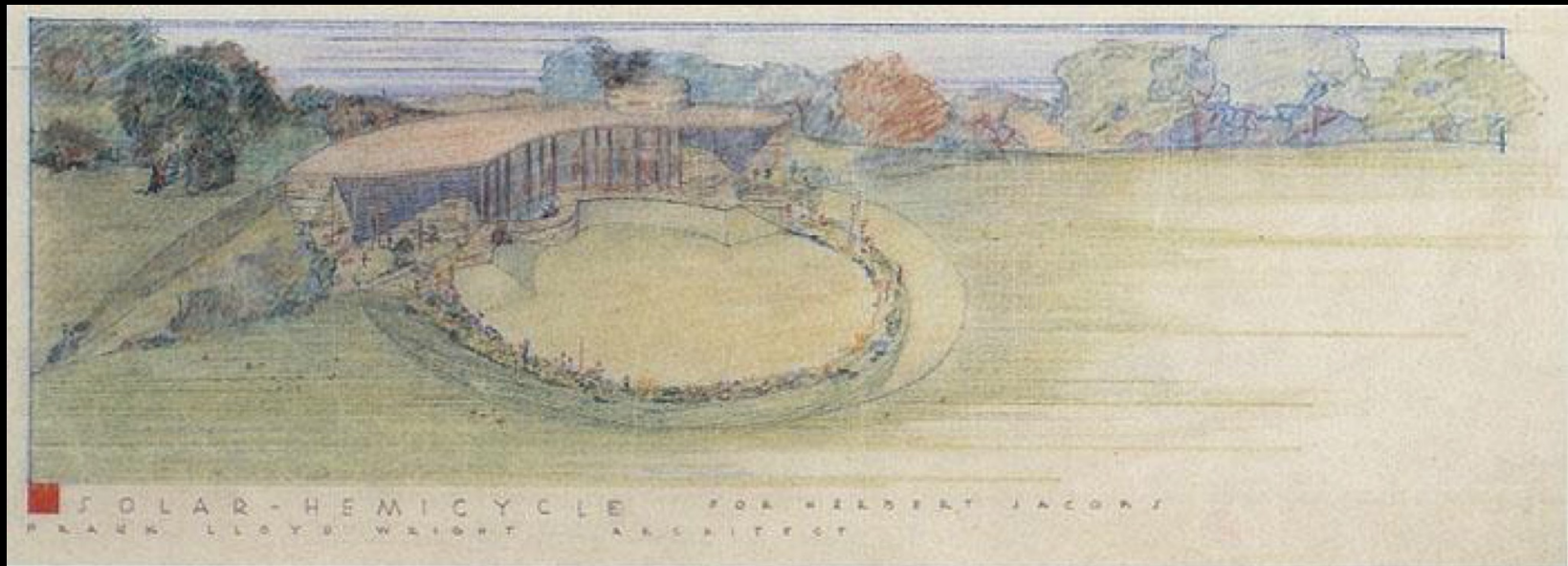
More information

[+ Show information on the construction and maintenance of rainwater harvesting systems.](#)

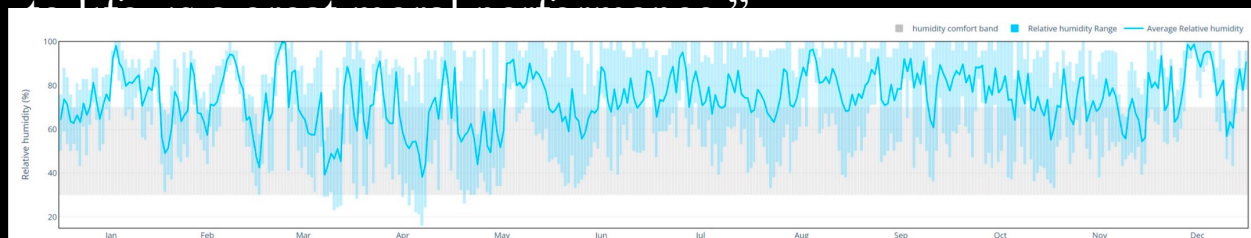
[previous](#)

[new calculation](#)



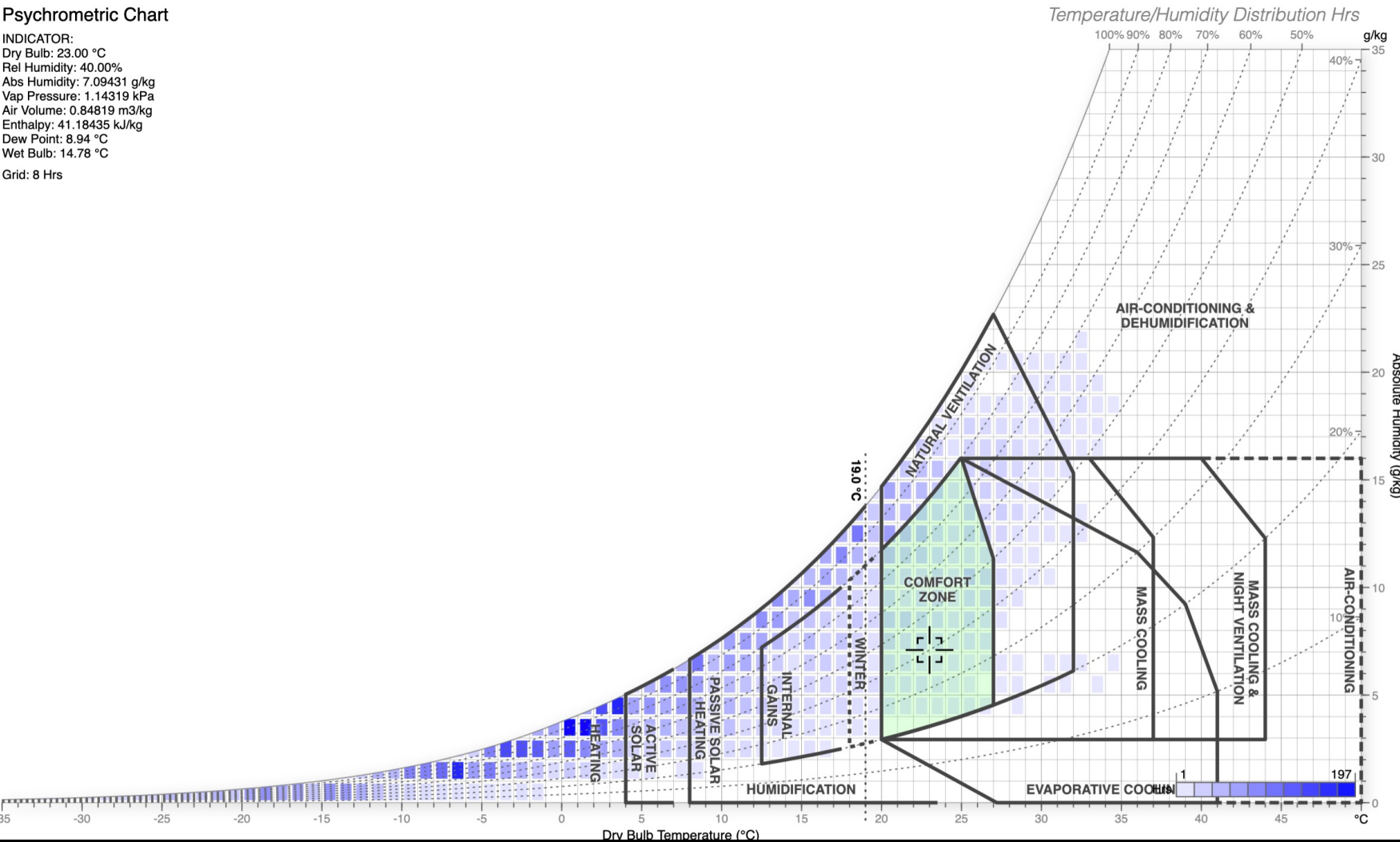


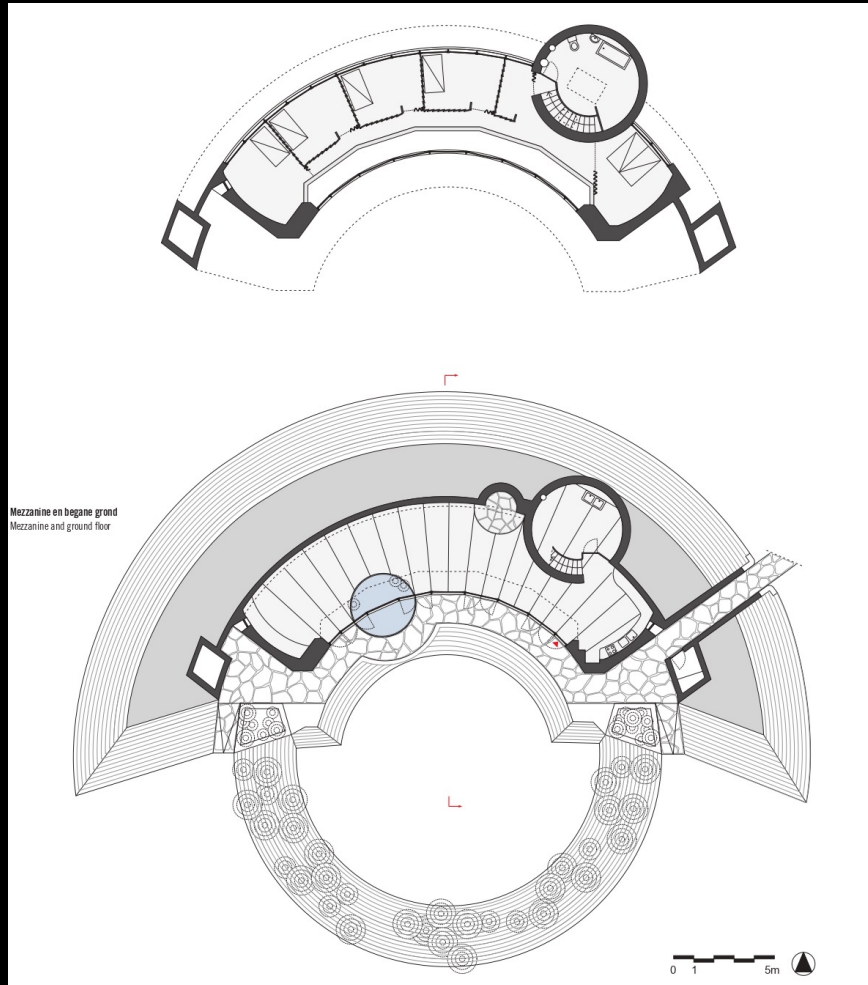
to life and a gracious element added



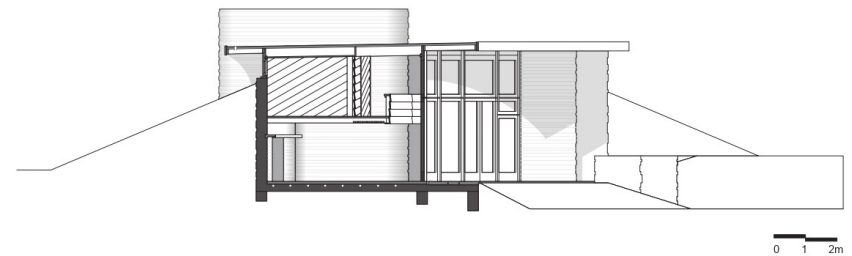
Psychrometric Chart

INDICATOR:
Dry Bulb: 23.00 °C
Rel Humidity: 40.00%
Abs Humidity: 7.09431 g/kg
Vap Pressure: 1.14319 kPa
Air Volume: 0.84819 m3/kg
Enthalpy: 41.18435 kJ/kg
Dew Point: 8.94 °C
Wet Bulb: 14.78 °C
Grid: 8 Hrs



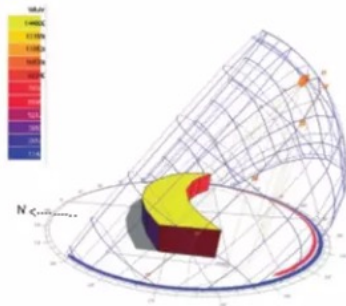


Edgveel
with façade
by Stiller&Esto



Samantha Dunne: HERBERT JACOB HOUSE II redesigned for the Sidney Climate

SOLAR PATH & SOLAR ACCESS



OBJECT ATTRIBUTES

Total Radiation
Value Range: 114000.0 - 1440000.0 Wh/m2
© ECOTECT v6

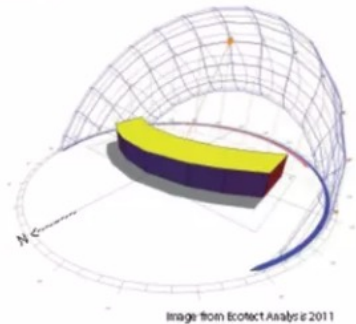
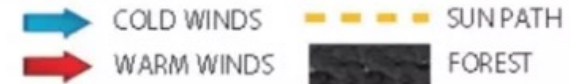


Image from Ecotect Analysis 2011

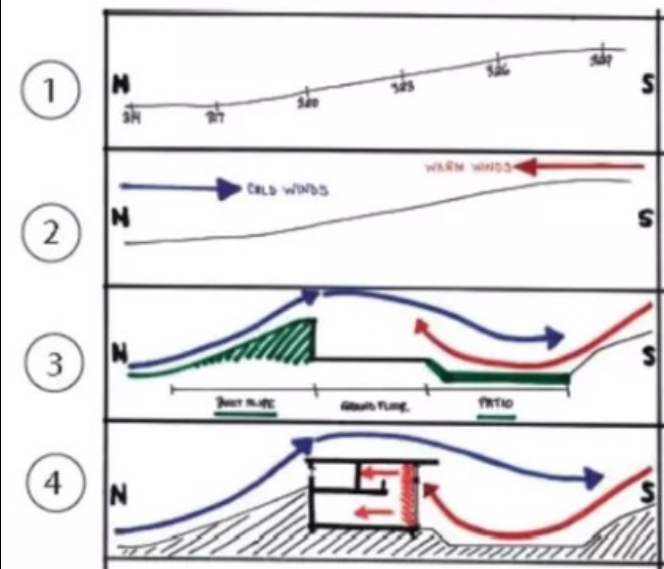
1. South facade follows solar path during warm and cooler seasons
2. Warm season: improves daylight illumination. Shading systems are considered.
3. Cooler season: Improves daylight illumination. Advantage for heating-passive heating.

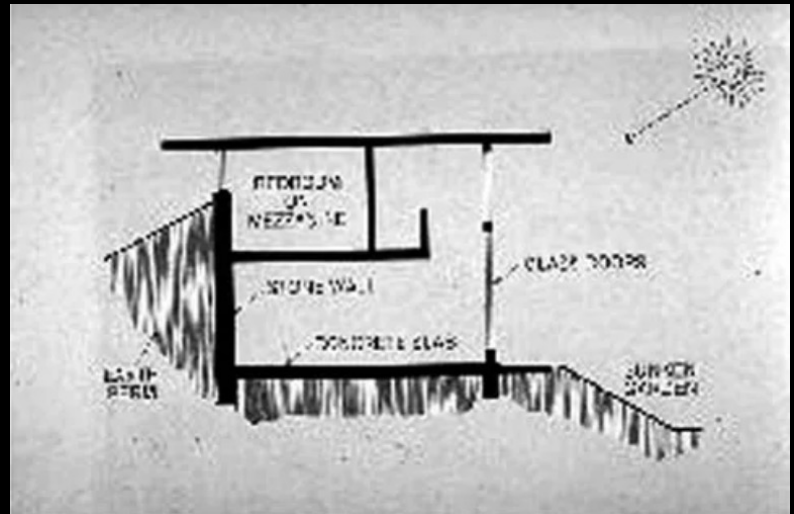


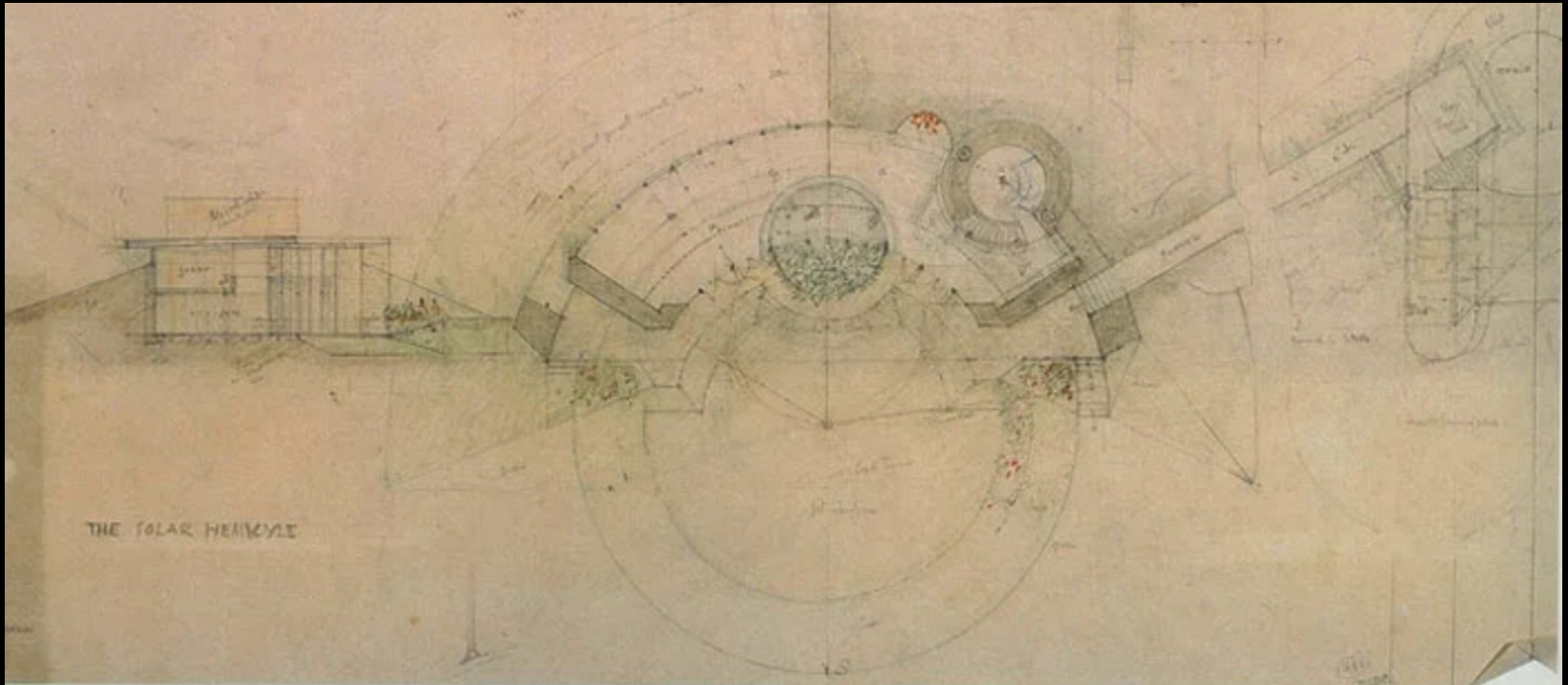
Jacob II House, 2995 Sharn Trail, Middleburg, VT 05752, USA - Google Maps, 2015. Google Maps. [ONLINE] Available at: <https://www.google.com/maps/@43.9026667,-73.9547778,15z> [Accessed 15 April 2015].



GEOGRAPHIC ORIENTATION PROCESS



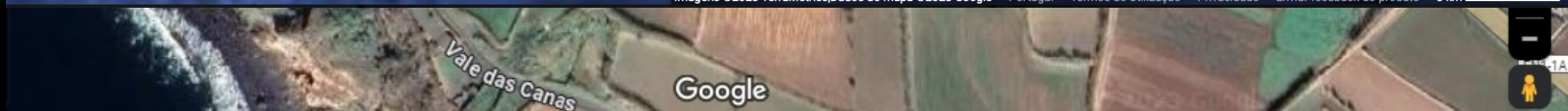
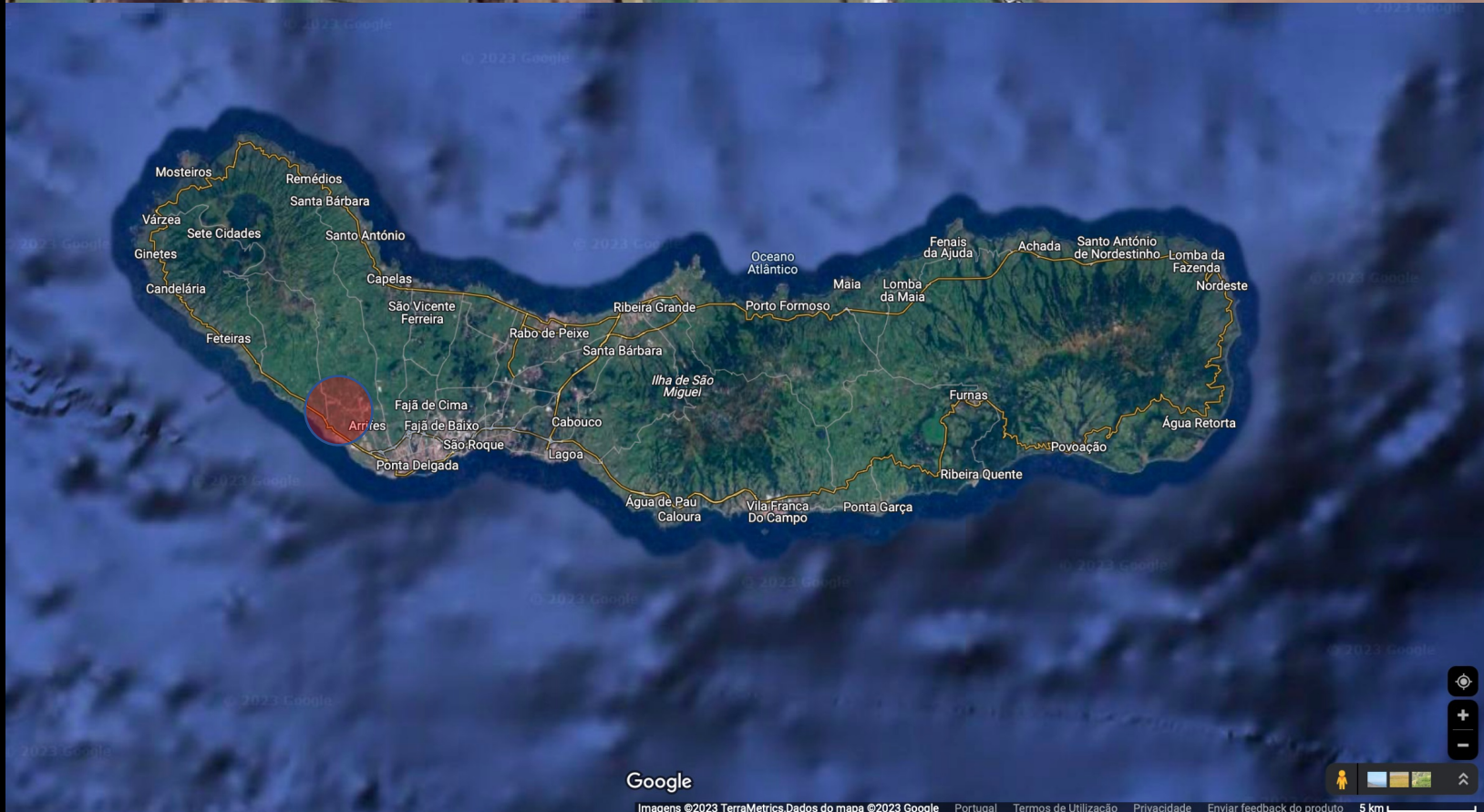






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1. Apresentação.
2. Introdução às avarias do planeta Terra
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3. Desenhar com o clima utilizando ferramentas digitais
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 - 3.1 a génese da bioclimática
 - 3.2 A metodologia do Olgyay
 - 3.2.1 Biologia
 - 3.2.2 Análise climática
 - 3.2.3 Estratégia bioclimáticas e
a carta de Givoni
 - 3.2.4 Arquitetura (caso de estudo)
 - 3.3 Recolha da água da chuva
4. **Caso de estudo: uma análise de bioclimática
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6. Conclusões e Discussão.



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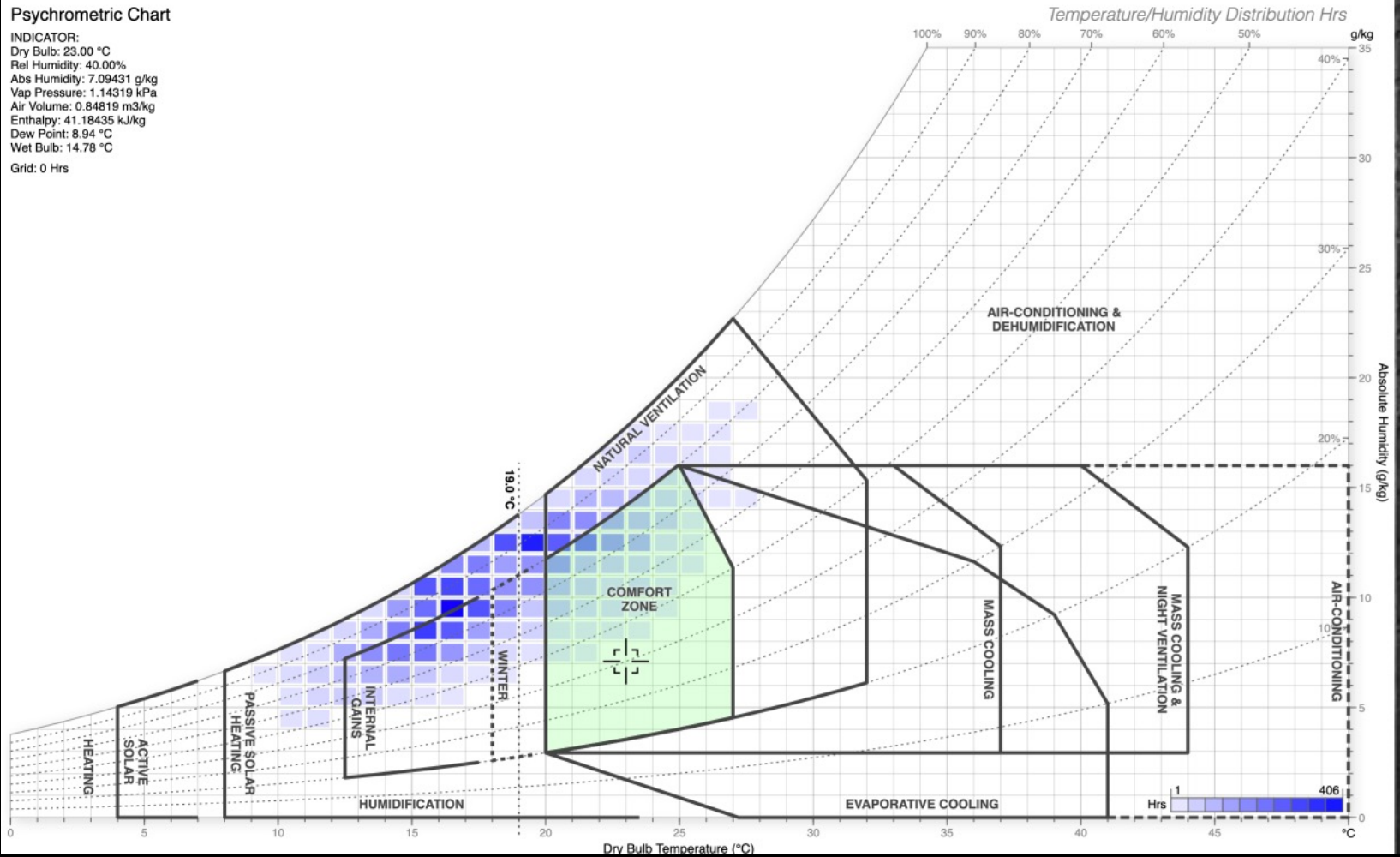
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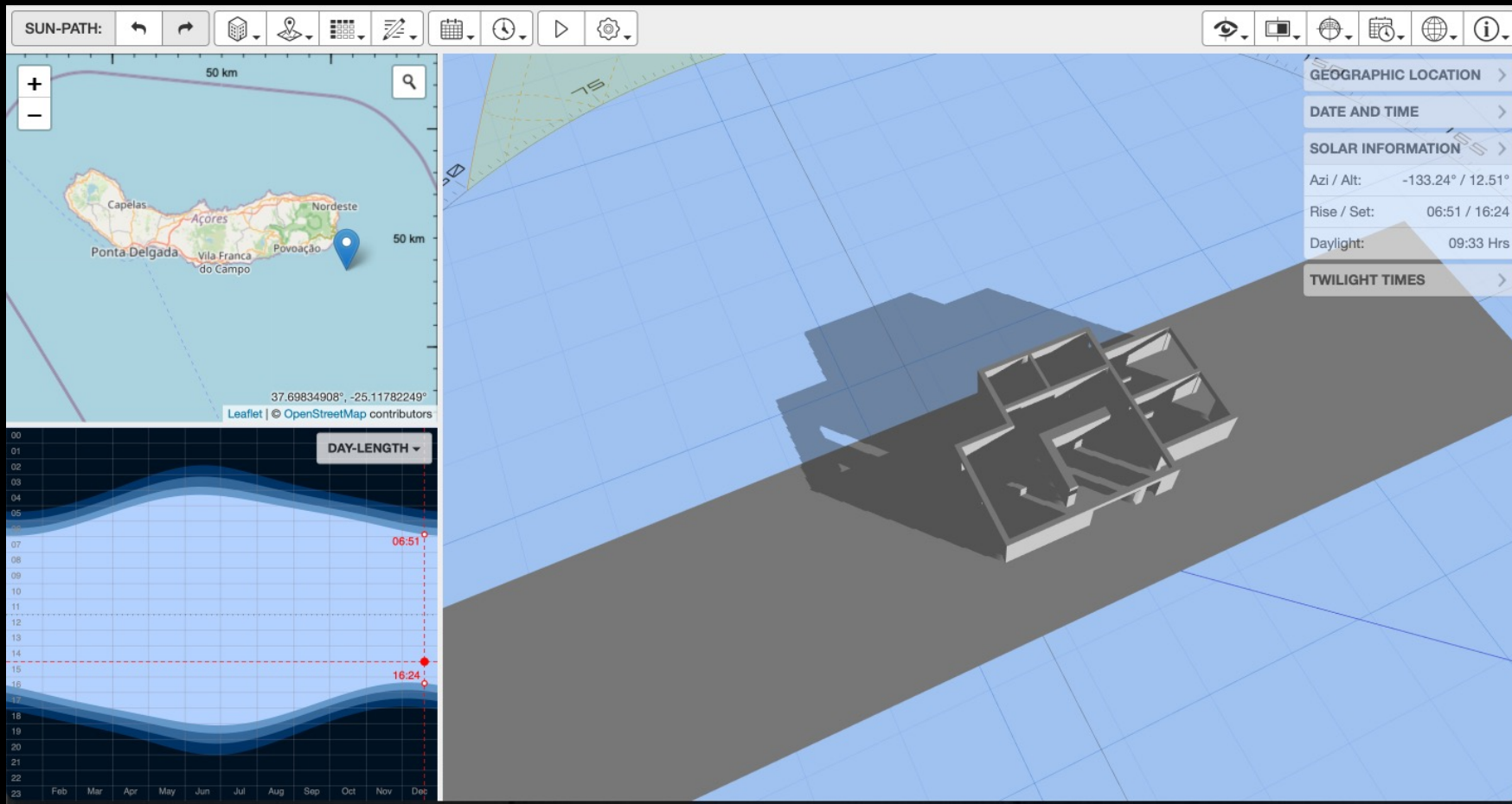
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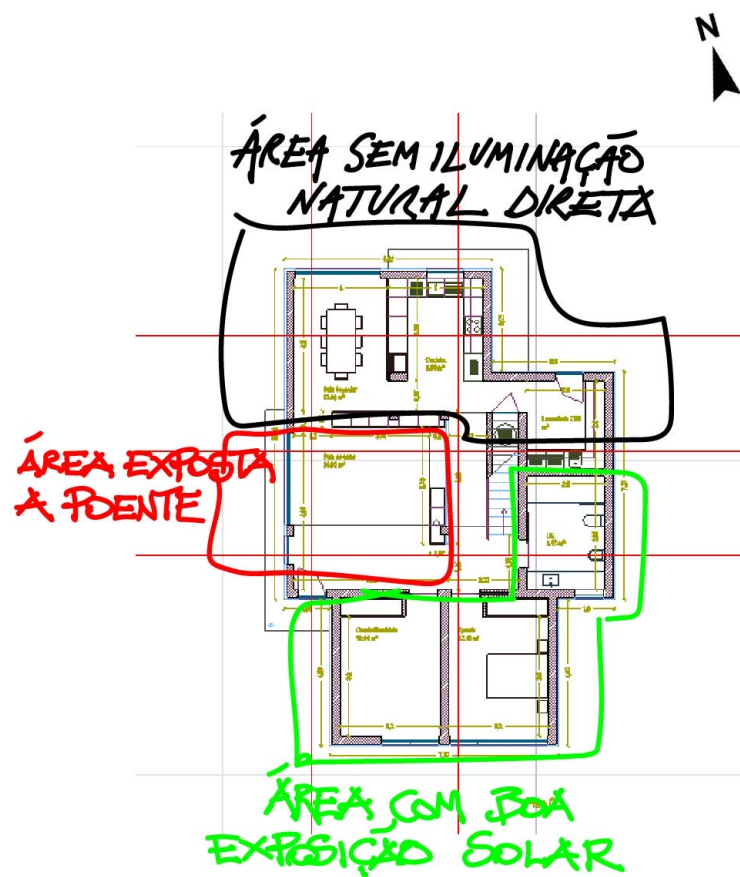
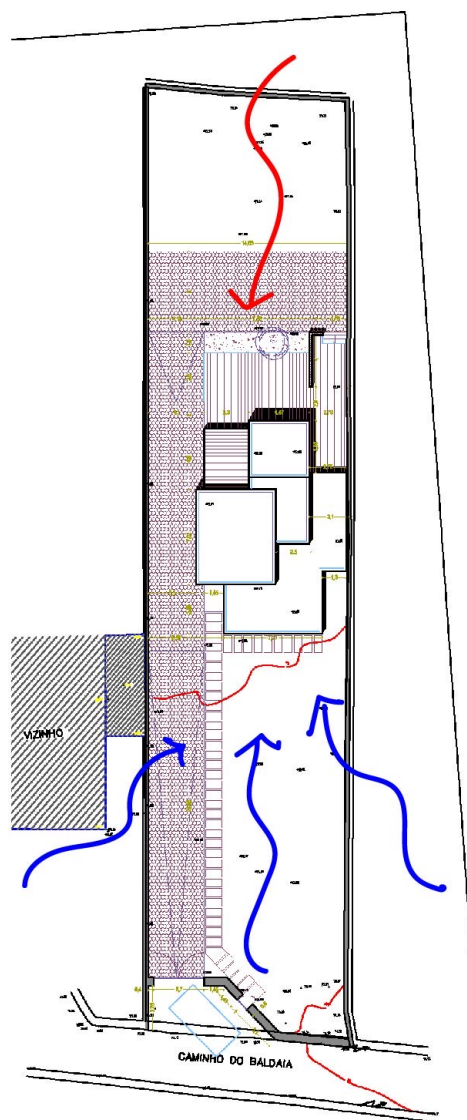
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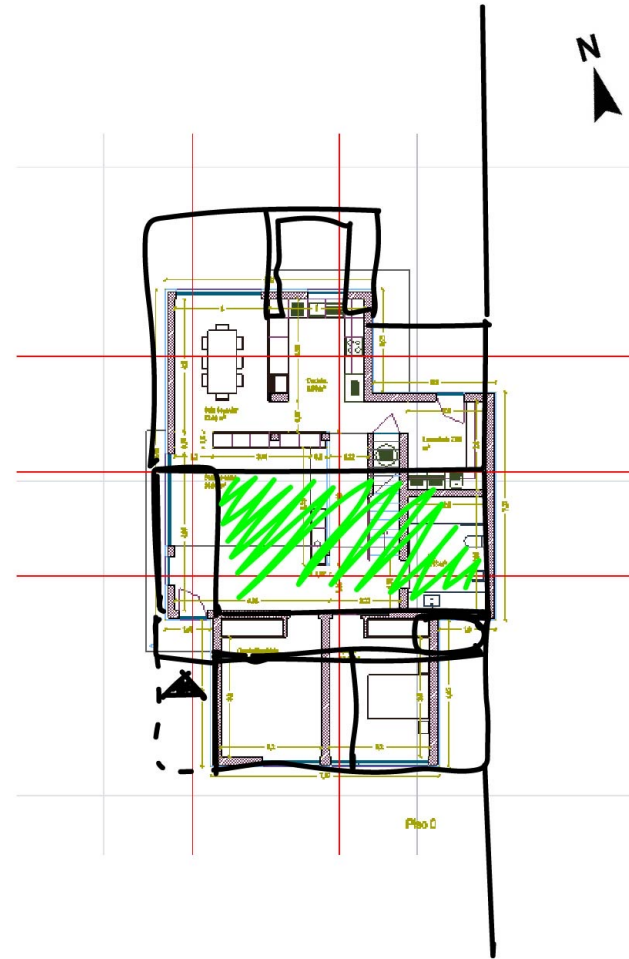
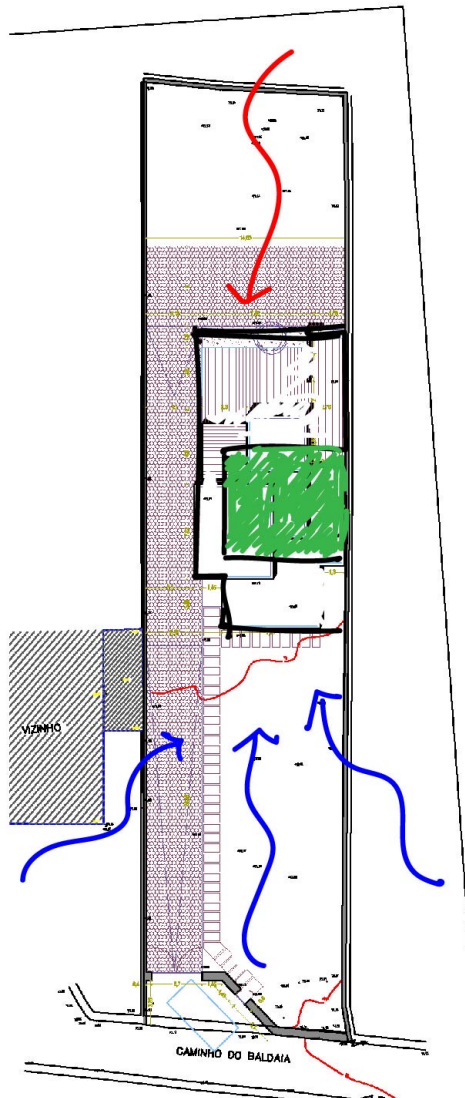
Wet Bulb: 14.78 °C

Grid: 0 Hrs



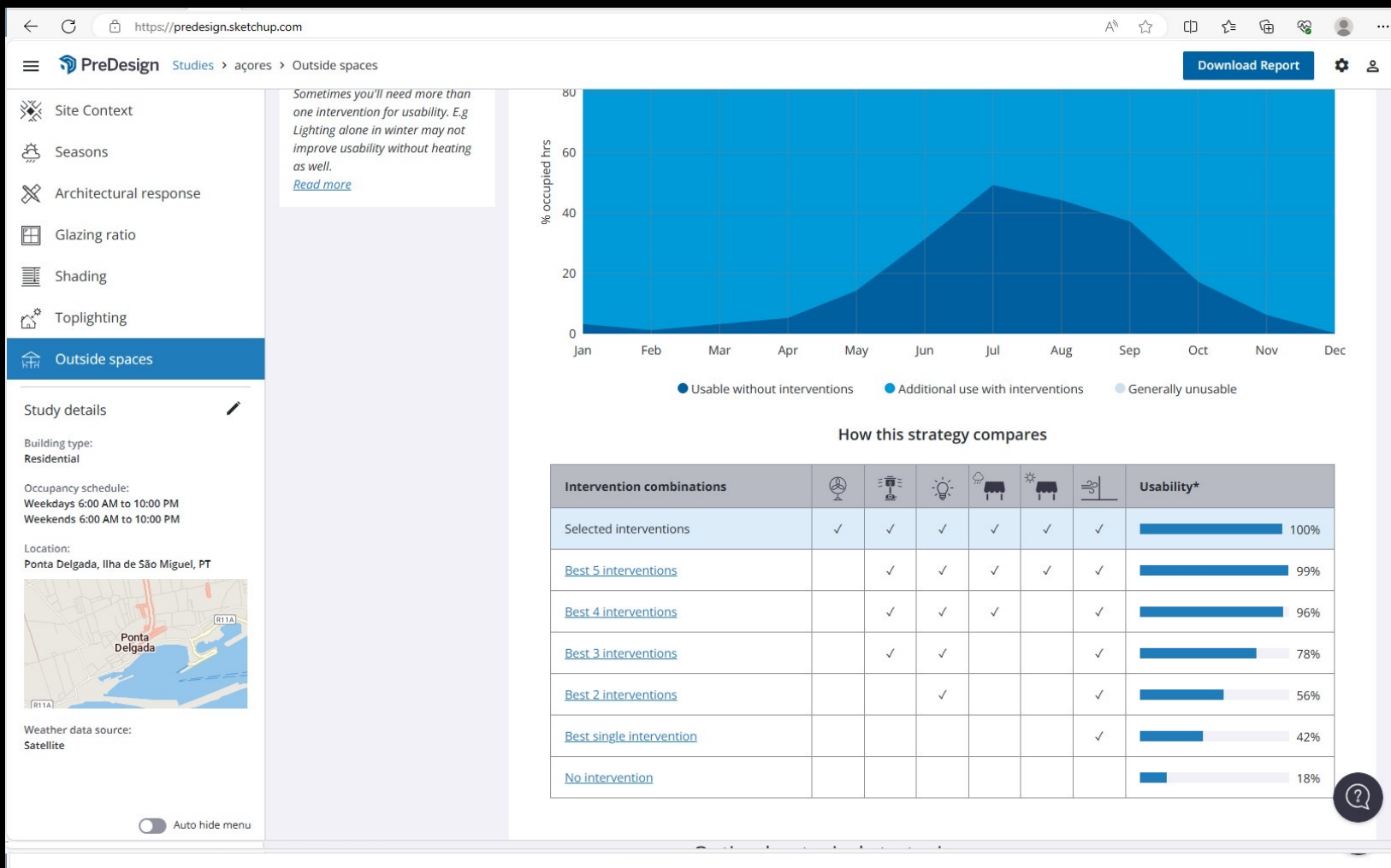


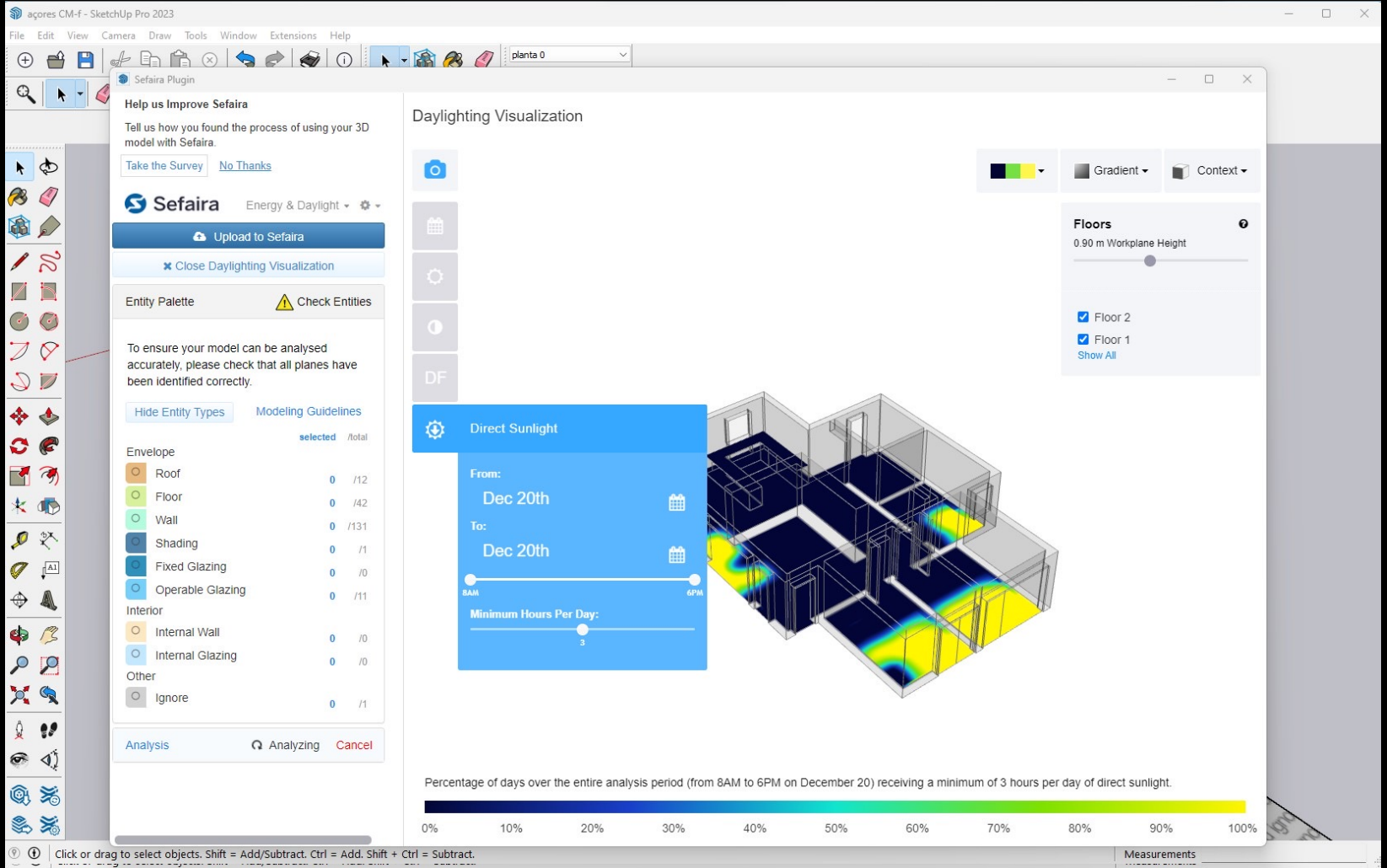




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Projeto bioclimático nos Açores: da teoria à prática, para arquitetos.

2.5h

Obrigado!

16.11.2023

Ph.D. Arch. Nadir Bonaccorso
nb@nbaa.pt