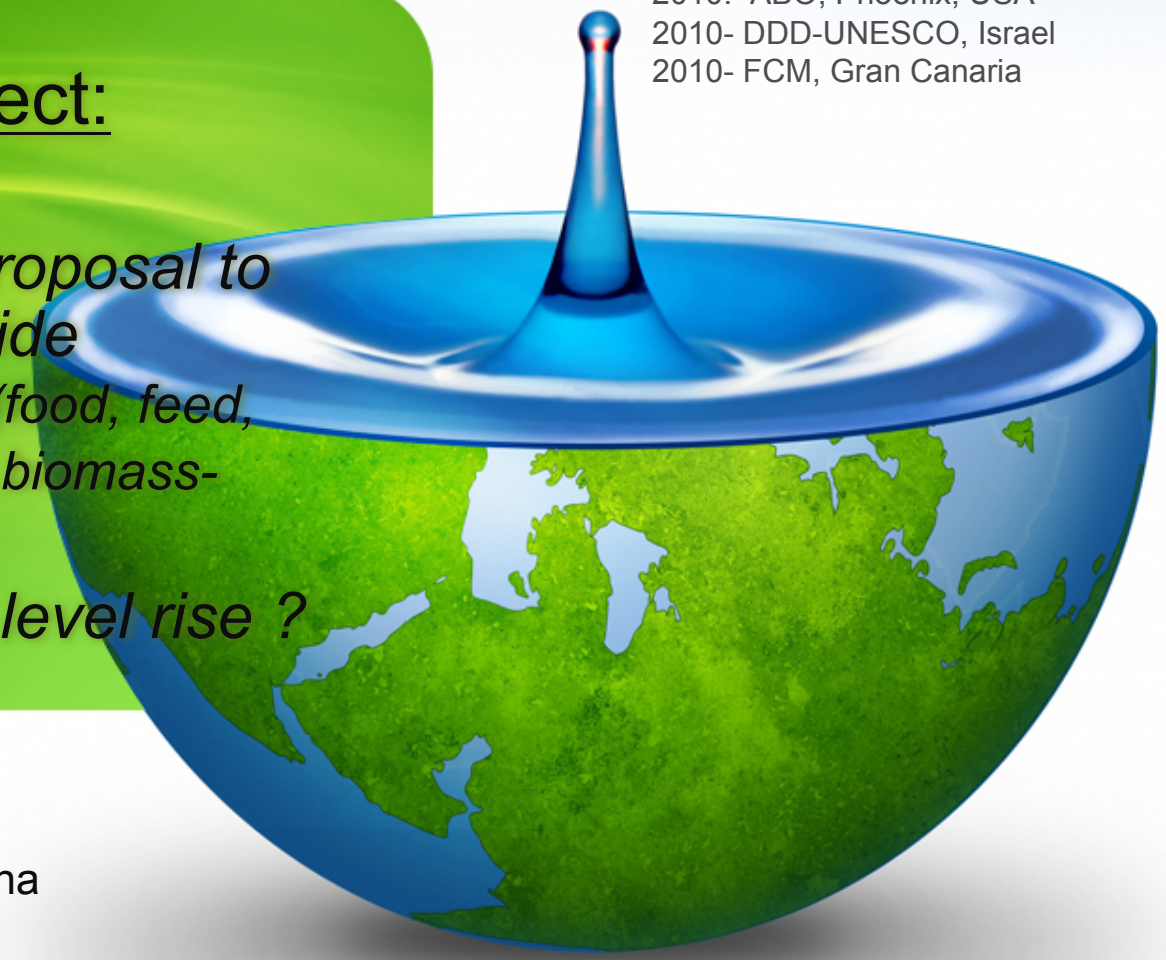
2009.- Millennium Goals, UN, USA
2009.- Bellona Foundation, Oslo
2009.- ABO-San Diego, USA
2009.- SEAP, Tenerife
2009.- Synthetic Genomics+Exxon,USA
2010.- FAO, Rome, Italy
2010.- Proexca, Washington, USA
2010.- EABA, Florence, Italy
2010.- ABO, Phoenix, USA
2010- DDD-UNESCO, Israel
2010- FCM, Gran Canaria

Green Desert Project:

sustainable biotech proposal to regreen Sahara, provide sustainable richness (food, feed, energy, bioactives, water, biomass-biofuels)

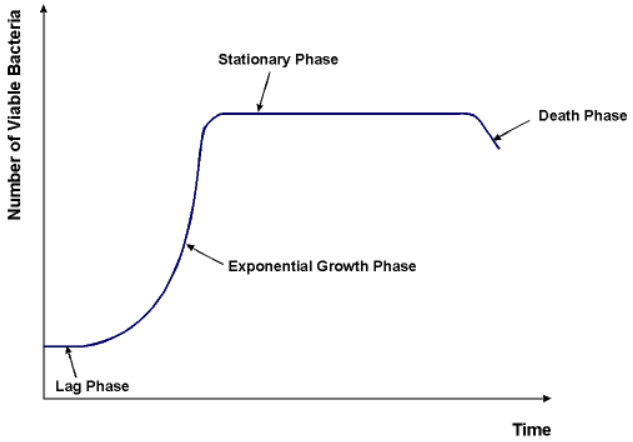
… and reduce ocean level rise ?

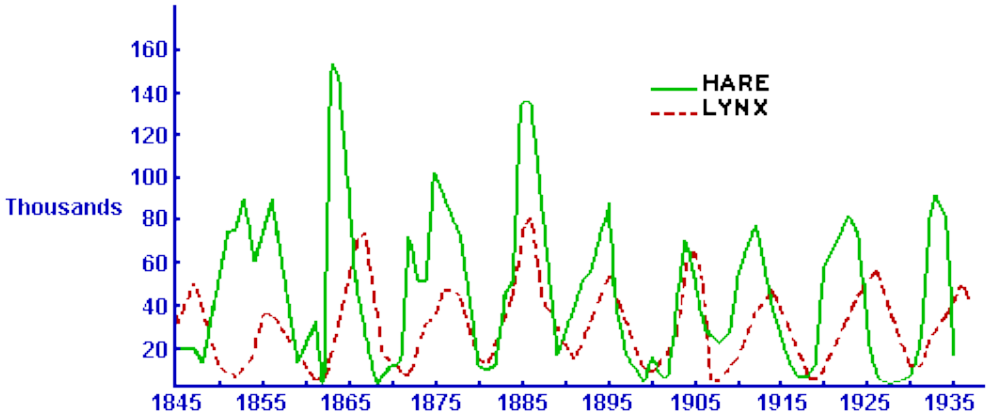


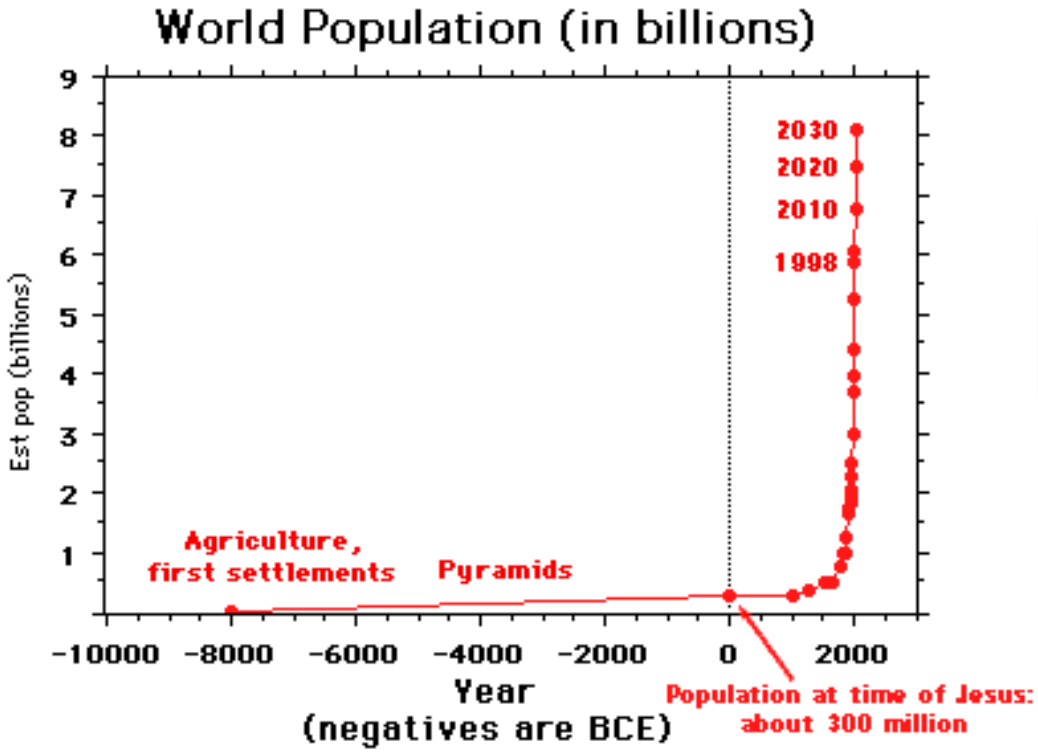
Dr. Guillermo Garcia-Blairsy Reina

Director, Marine Biotechnology Cener & Algae Bank, Univ. Las Palmas, Canary Islands, Spain.
President, Bioagramar Foundation www.bioagramar.org

Curvas demográficas en biología y en células cancerosas





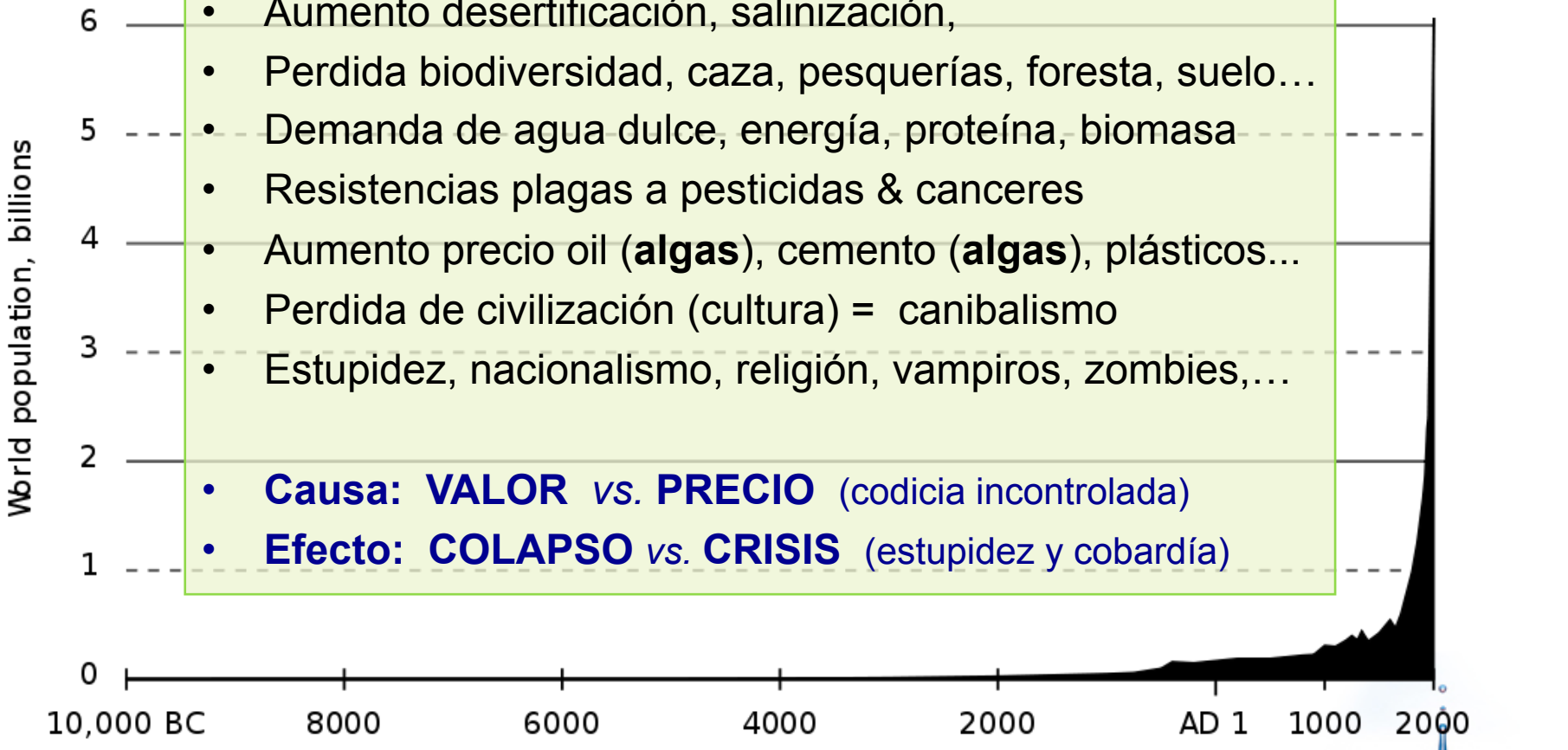


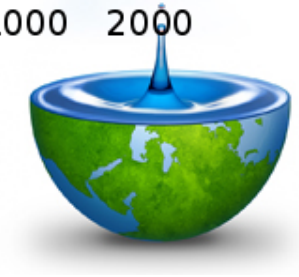
Crecimiento = Progreso
… de estúpidos!!!

La curva que nos espera… ya no es la de la felicidad

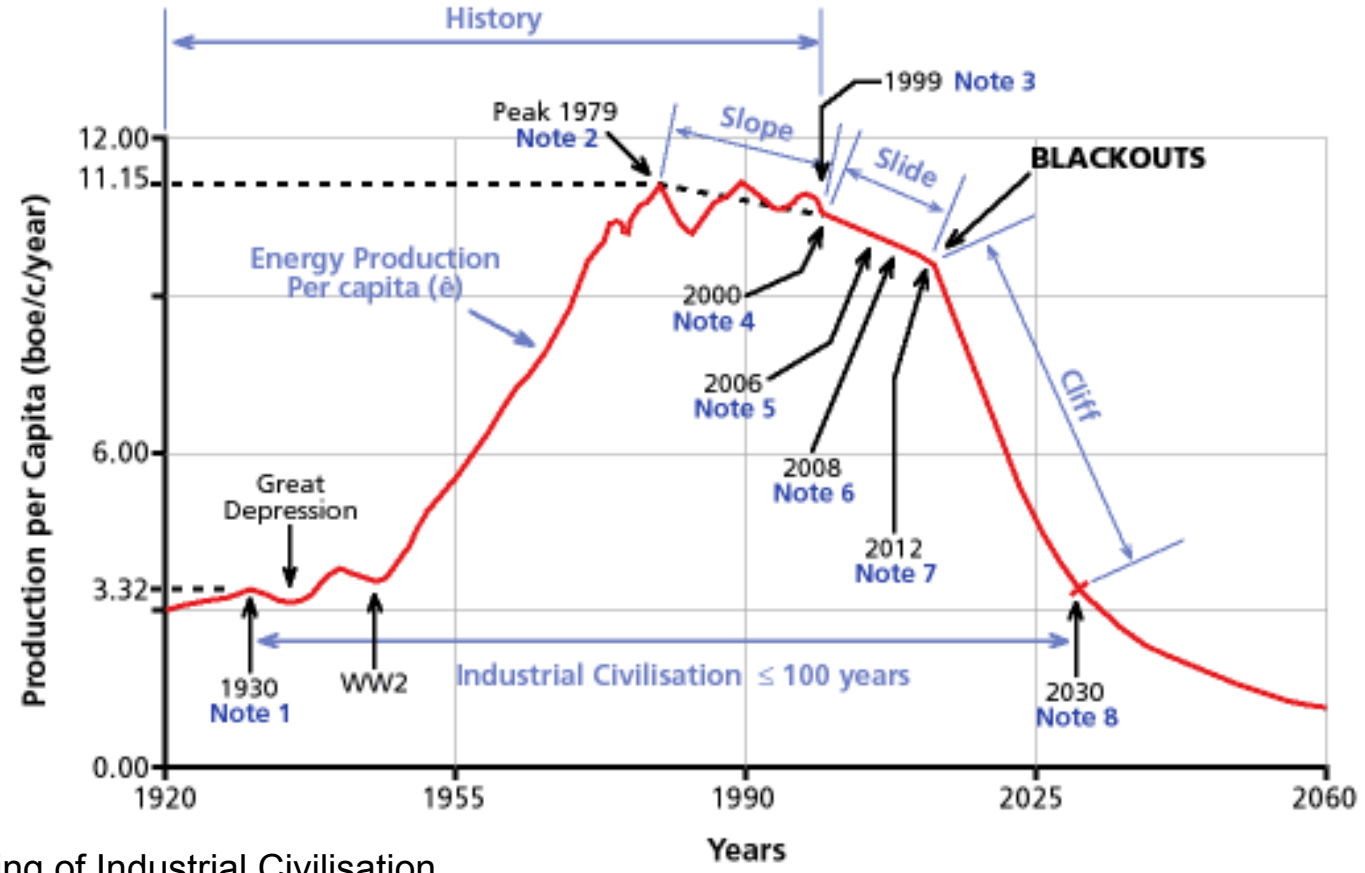
- Aumento CO_2 y GHG
- Aumento desertificación, salinización,
- Perdida biodiversidad, caza, pesquerías, foresta, suelo…
- Demanda de agua dulce, energía, proteína, biomasa
- Resistencias plagas a pesticidas & canceres
- Aumento precio oil (**algas**), cemento (**algas**), plásticos...
- Perdida de civilización (cultura) = canibalismo
- Estupidez, nacionalismo, religión, vampiros, zombies,…

- **Causa: VALOR** *vs.* **PRECIO** (codicia incontrolada)
- **Efecto: COLAPSO** *vs.* **CRISIS** (estupidez y cobardía)



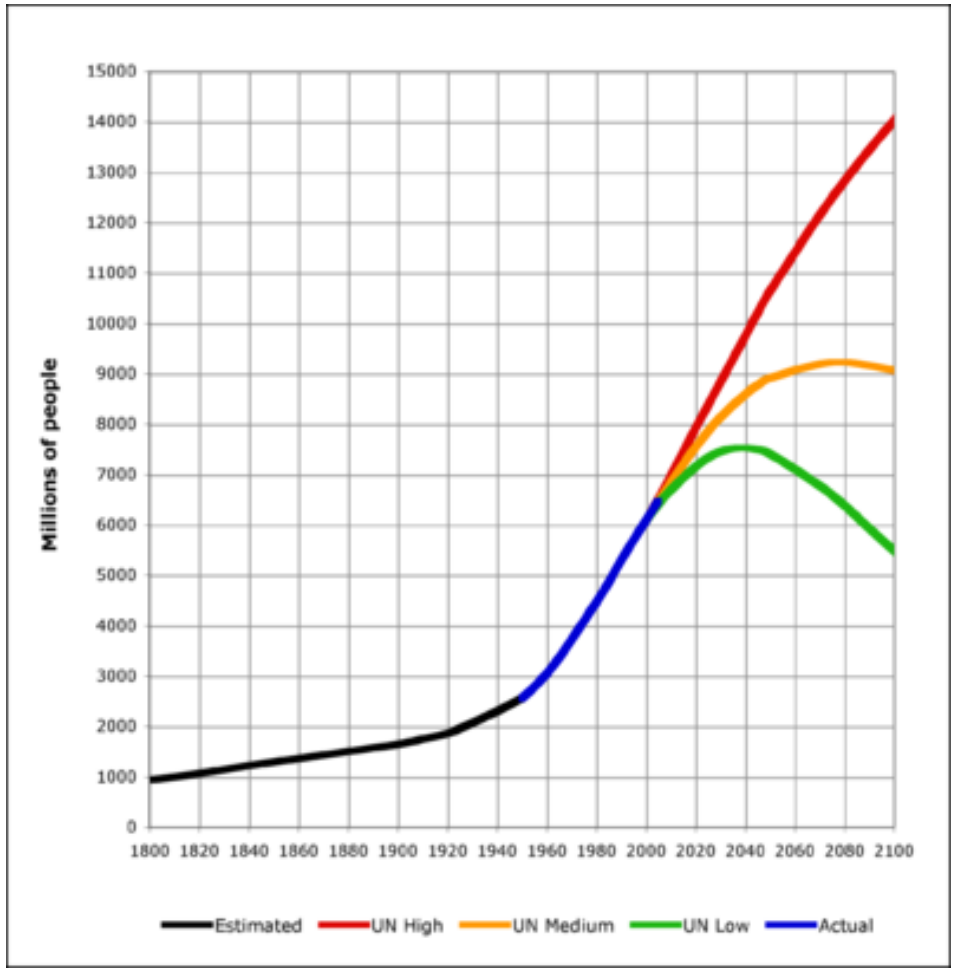


Olduvai Theory: life expectancy of Industrial civilisation is 100 years *(aprox)*



- 1: (1930) the beginning of Industrial Civilisation
  2: (1979) all time peak of world energy production per capita
  3: (1999) the end of cheap oil
  4: (2000) eruption of violence in the Middle East
  5: (2006) all-time peak in world oil production
  6: (2008) OPEC crossover when more than 50% of oil comes from the OPEC nations
  7: (2012) permanent blackouts spread worldwide
  8: (2030) world energy production falls to 1930 level

?.....?.....?...



Reproducirse (tener hijos) NO es un **derecho**,…. es una **responsabilidad**

"respons-habile"

- No hay carencia de energía, hay exceso de humanoides
- La Edad de Piedra no acabó porque se acabaran las piedras

Biofuels, biocapitalism, bioeconomy, bioindusty, biorefinery,, … but ***biomass !***

- ***How ?***
  - Integrated + marine + photosynthetic (fish-algae-crustaceae-microalgae,….)
  - Positive balance: *energy* + *ecology* + *economy* = *strict* ***LCA***
  - Through ***IAAB***: integrated acua-agrobiotechnologies = *new bioindustrial ecosystem (aquasystem + agrosystem)*
  - Residue = resource, gravity is a friend, photosyntesis is annual

- ***Where****, at global scale & impact ?*
  - **20.000 km²** of *shebjas*, below sea level in Sahara (Mauritania-Libia)

- ***Why IAAB*** *and* ***why*** *Sahara ?*
  - More profitable (economy & technical) = best resources
  - More feasible
  - More quickly
  - More needed

Regreening deserts trough algafuel: opportunity or hype ?

ALGAFUEL (biomass): dilemma and solutions

- ***if strict LCA*** = *3xe positive balance (economy + energy + ecology)*

- ***then must be for free:***
  - **Nitrogen** (up to 40% of the energy)
  - **Phosphate** (exhausted)
  - **Pumping costs** (higher than CO_2 costs)
  - **CO_2** (no industries in deserts)

- ***through***:
  - ***IAAB*** **= INTEGRATED AQUA-AGROBIOTECH**
  - ***GDP*** **= GREEN DESERT PROJECT (Sahara below sea level)**

Bioeconomy, bioindustry, biorefinery, biofuels, …

IAAB-biomass

- *Biomass (food, feed, metabolites, bioactives,...) production without CO_2 emission (**CO_2 credits**)*

- ***Algafuel** production with 3x positive balance*
  (energy + ecology + economic)

- *Stable economic profit*
  (IAAB = multimarket integration of high & low added value products)

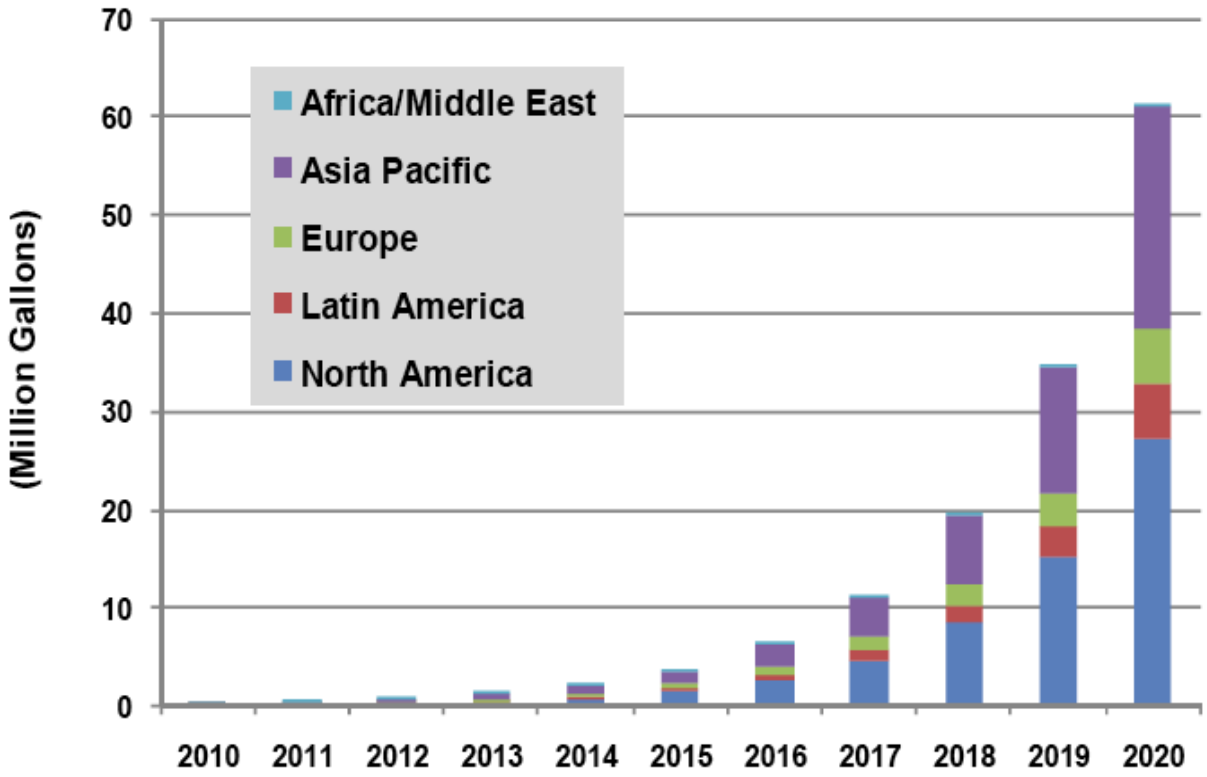
… and contributes to reduce sea leve rise ??!!

Production reaching 61 Mgal/ y

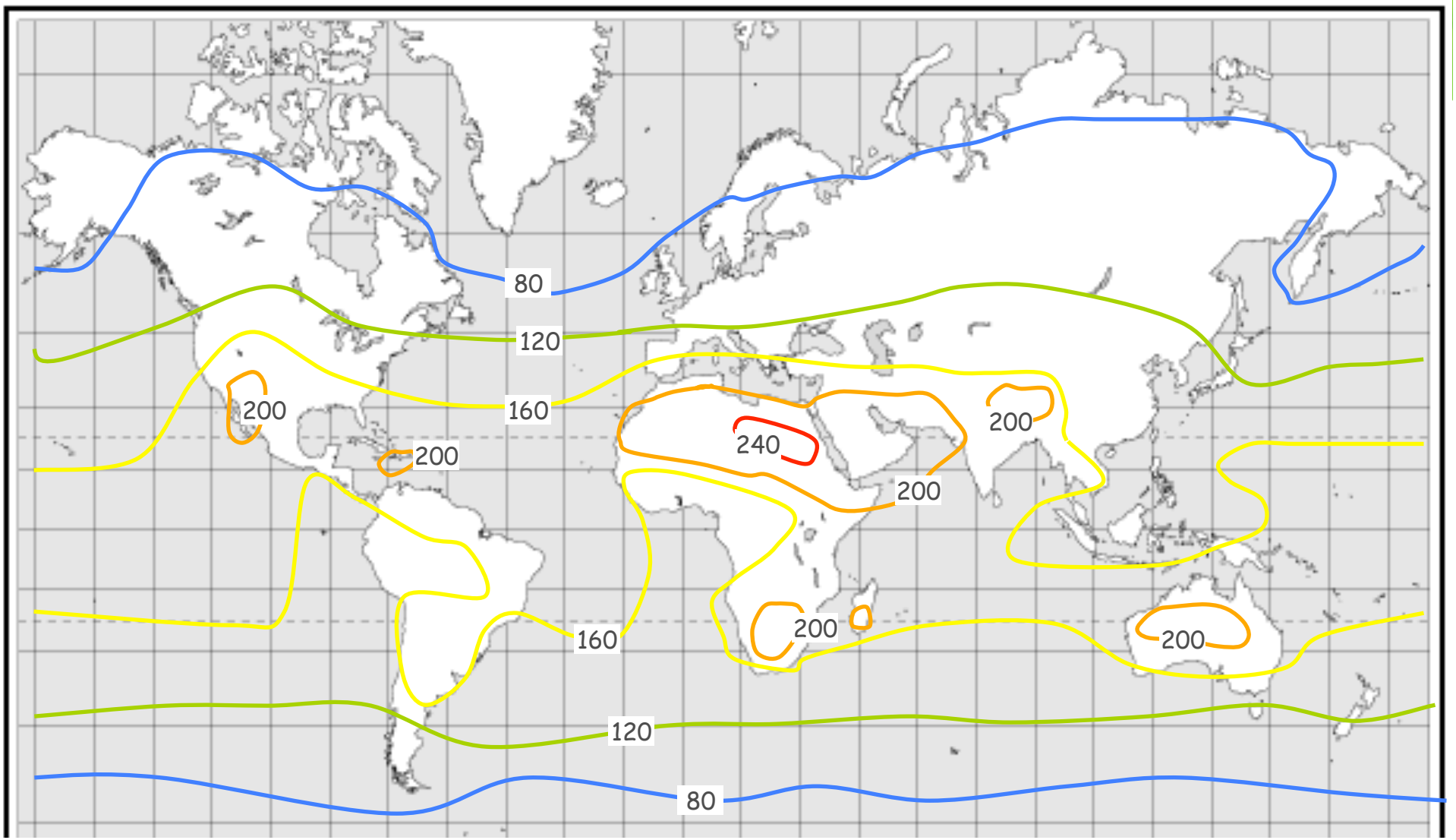
Market value of B$ 1.3 by 2020

a drop in the bucket for biofuels, but a compound annual growth rate (CAGR) of 72%
(on par with early development in the biodiesel industry)

Algae-Based Biofuels Production by Region, World Markets: 2010-2020



(Source: Pike Research)

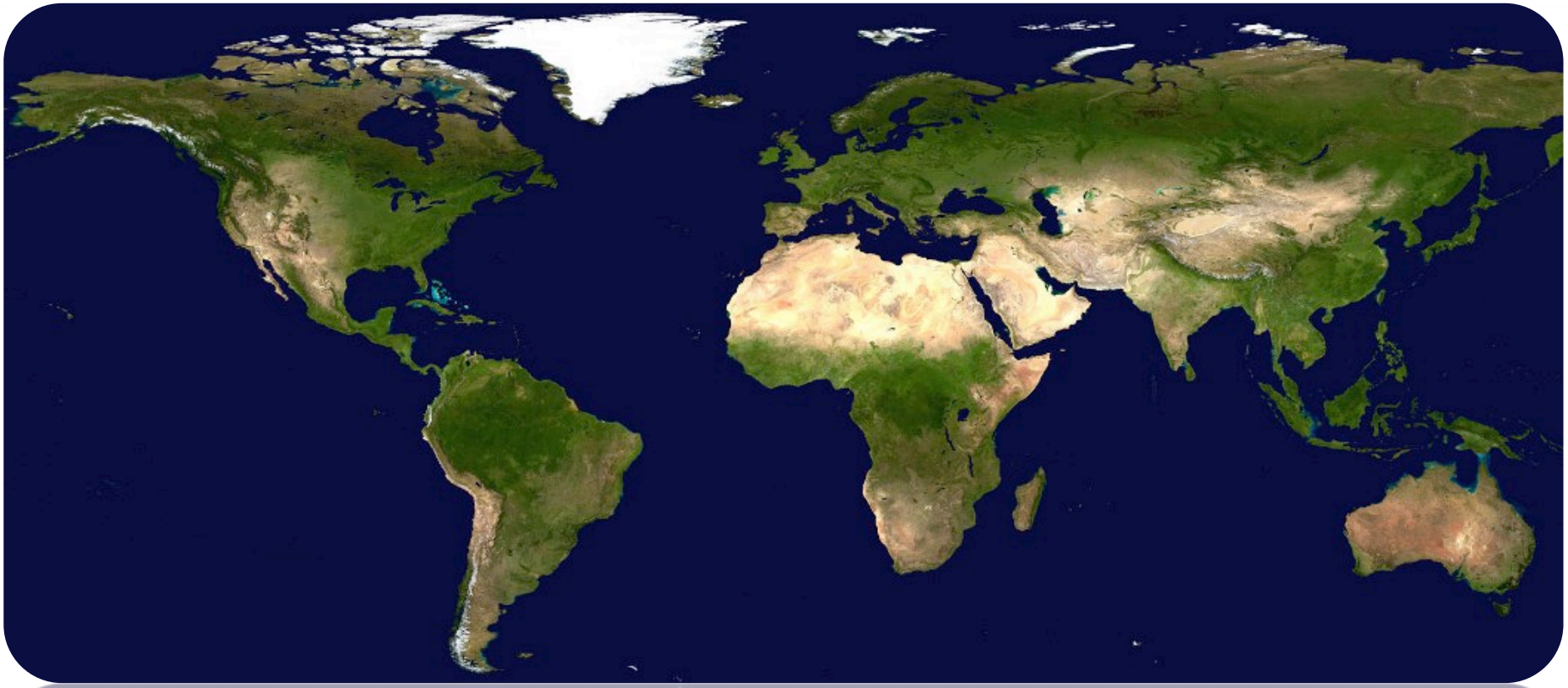


World map of **algae biomass productivity** (t ha^{-1} $year^{-1}$)

(at 5% photosynthetic efficiency and 20 MJ kg^{-1} dry biomass)

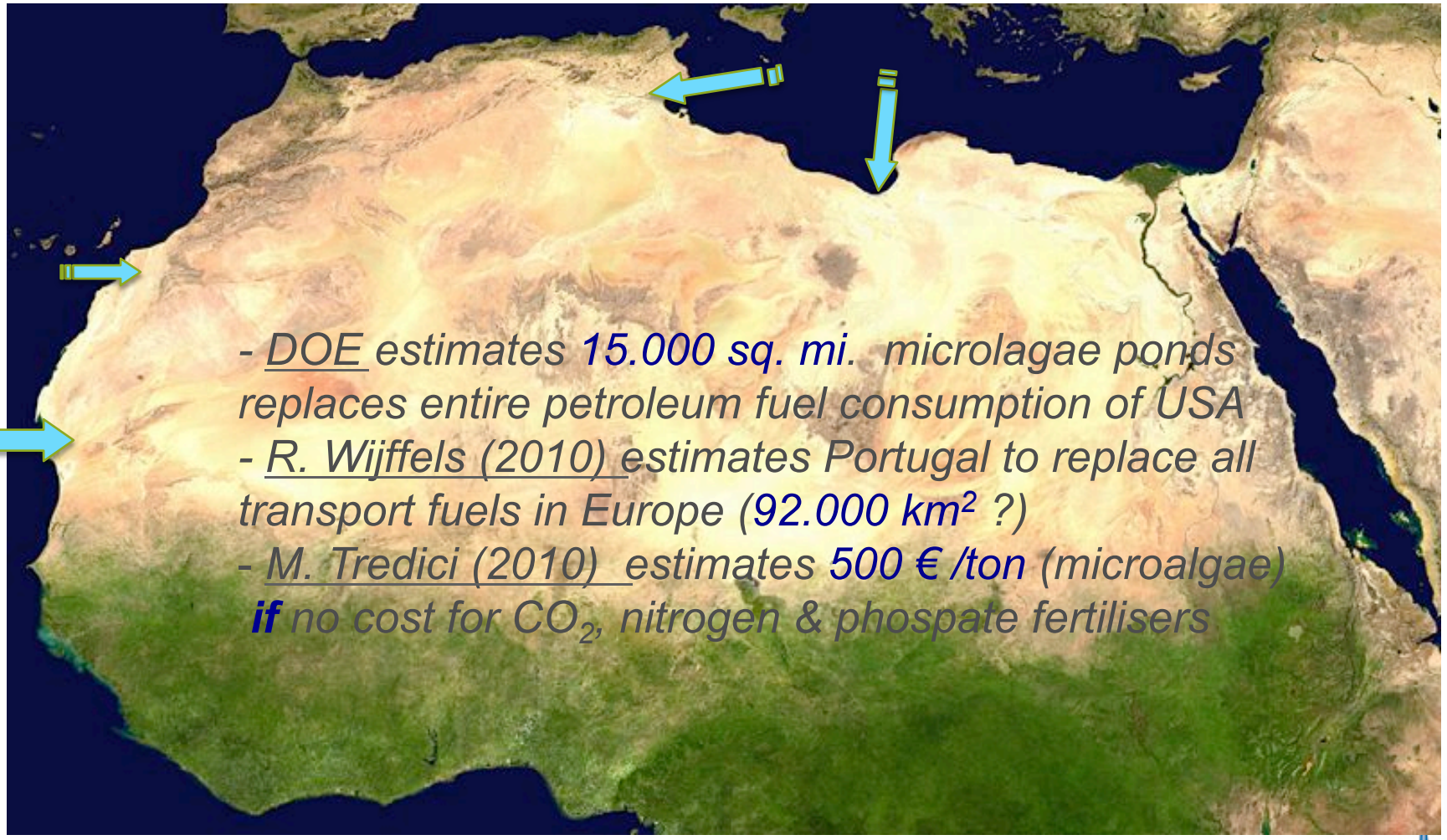
"TREDICI MAP" **(Algae Biomass Org. 2009)**

Green Deserts

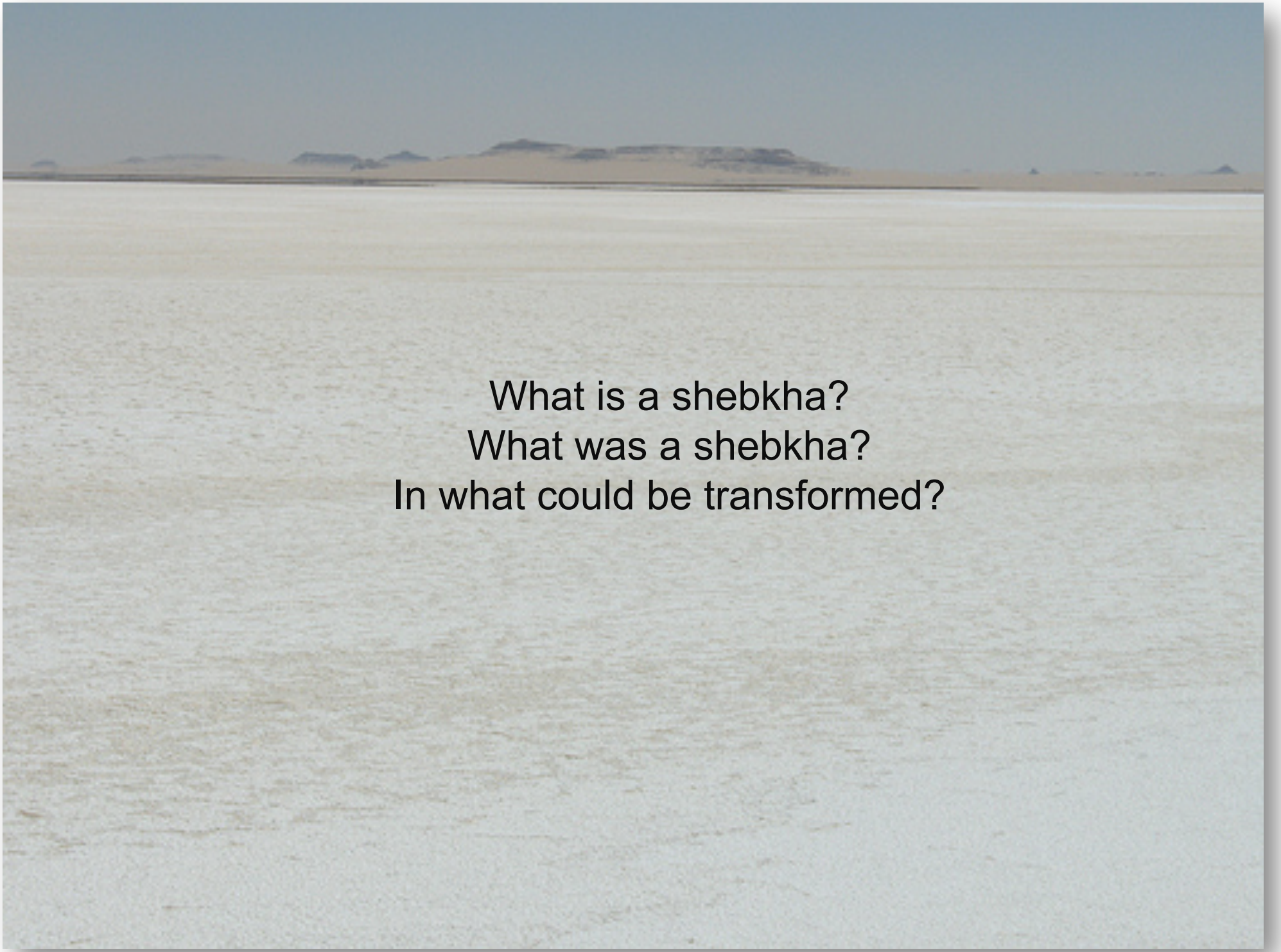


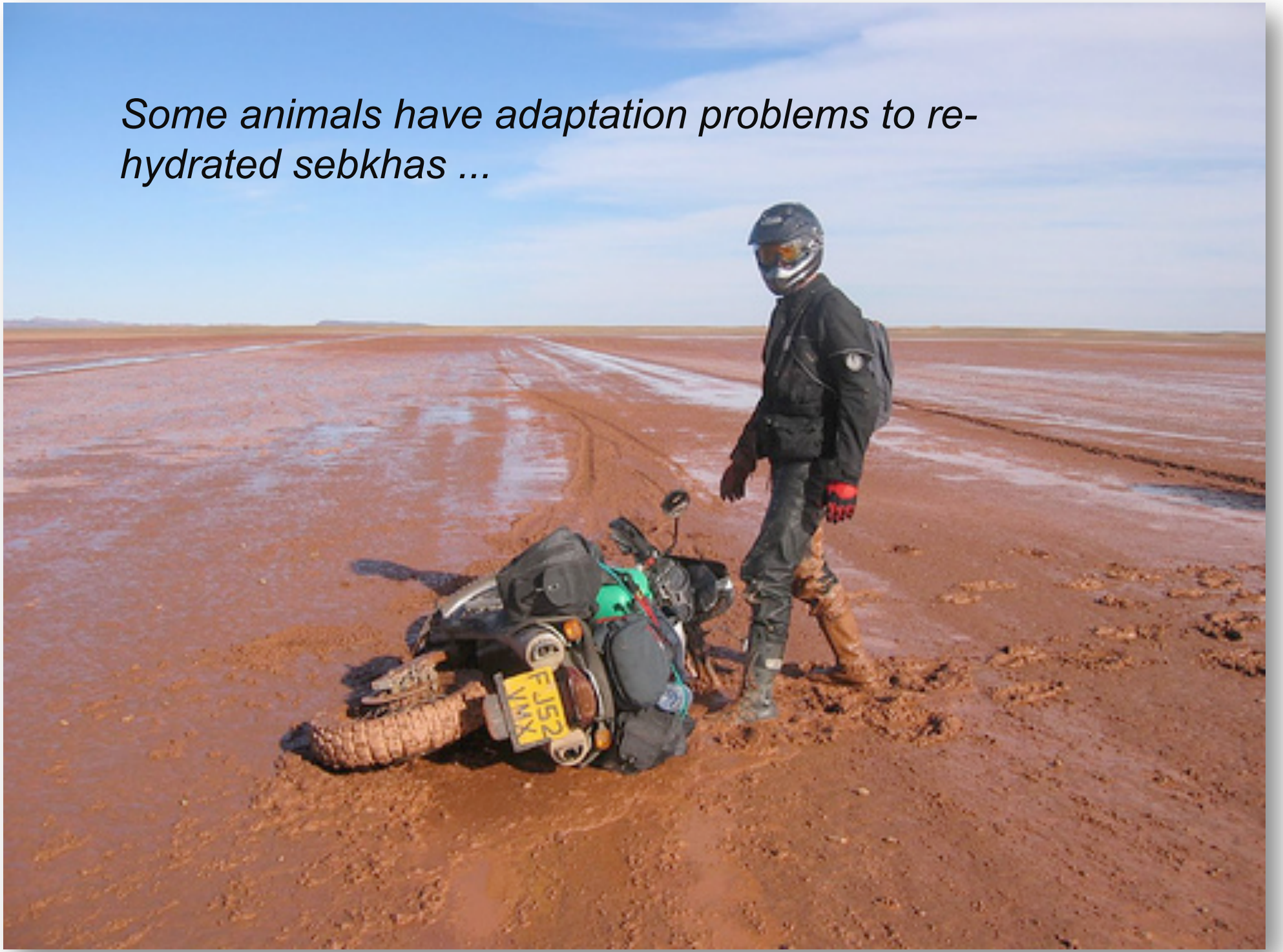
Where ? … is enough sun, water & space to produce huge amounts of marine biomass & biofuels & climatic bioengineering and with the “as-usual-withouts” ?

LCA ?? = IAAB = Green Desert Project



20.000 km² of *shebkhas* below sea level turnable into biotecnopolis by IAAB + biorefineries


What is a shebkha?
What was a shebkha?
In what could be transformed?


Some animals have adaptation problems to re-hydrated sebkhas ...

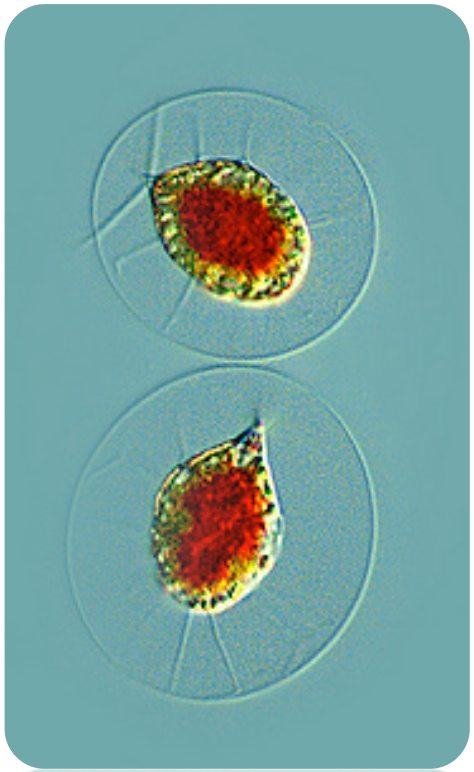

… while others not !

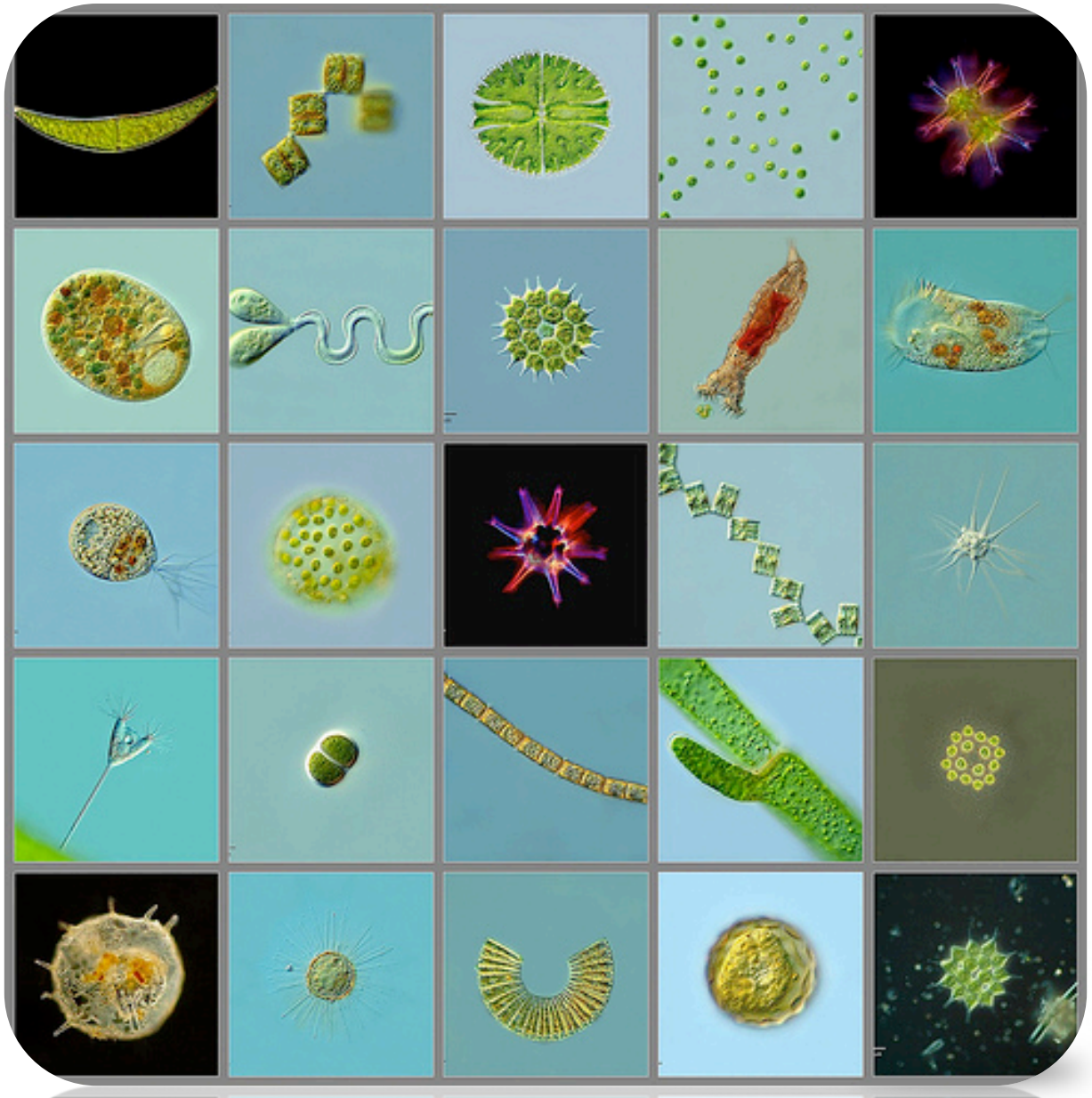
Green Deserts

Fundación agramar
biotecnología sostenible y agronomía marina

Live is microscopic

… but only if you are a macroscopic pluricellular !





Green Deserts

ALL kind of valuable pigments = all kind of valuable microalgae = richness of higher value than salt

Green Deserts

… but in **Australia**:
Dunaliella salina (microalgae) farm for human consumption

Green Deserts

Dunaliella farms (semi-extensive) for COGNIS Betatene® natural mixed carotenoids

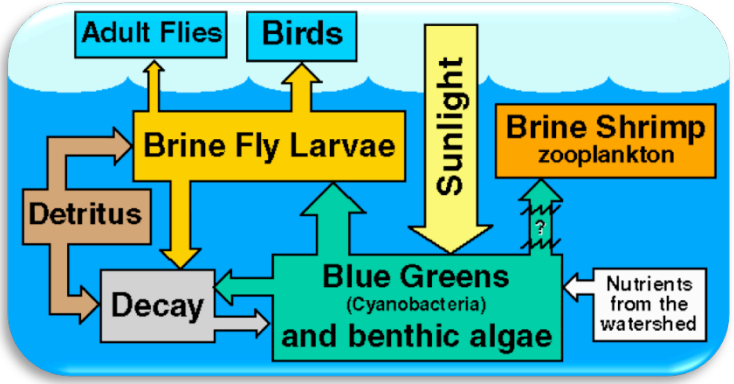
Australia: Hutt Lagoon, Whyalla, Lake Mc Leod,…
but not bsl !!!

Green Deserts

Great Salt Lake, Utah = ***"USA-sebkha"***

world´s biggest hyper-saline cultivation pond **(4.000 km²)** for microalgae (*Dunalliela salina*) and brine shrimp (*Artemia salina*).

Green Deserts



- 15.000.000 pounds / year
- 30 $/pound
- **79 companies**

Green Deserts: la verdad (inconfesable) de la idea inicial:

… QUESTIONS & ANSWERS in the middle of the desert:

Q.- If ocean rise is **1,5 mm/year** … how much is the overloading ?

- 540 km^3/y = 4x Uruguay river = ***1 Mississippi*** *(6x Nile,….)*

Q.- How can we get rid of 4 Uruguay rivers ?:

- "Evacuating" 4 Uruguay rivers out of the oceans

Q.- ... Where ?:

- In 4 coastal desert saline depressions ("sebkhas","chotts") below sea level, surrounding Sahara (Mauritania, Morocco, Tunisia-Algeria & Libya)

Q.- ... How ?:

- Channeling seawater by gravity into the sebkhas,... ***and generating sustainable richness (biomass, food, feed, energy, forest,…)*** *exploiting 4 unlimited resources:*

- *Gravity, Sunlight & Seawater: costless*
- *Knowledge: priceless*

Green Deserts

Sahara was a humid sabana and forest only 6.000 years ago!!

- J. A. Holmes, 2008. How the Sahara Became Dry, Science, 320: 752 – 753
- S. Kröpelin et al., 2008. Climate-Driven Ecosystem Succession in the Sahara: The Past 6000 Years, Science, 320: 765 - 768

… "easy" reversion & recovery of Sahara by IAAB – REHYDRATION = sea-level rise mitigation

If ocean rise is **1,5 mm/year** … how much is the overloading ?

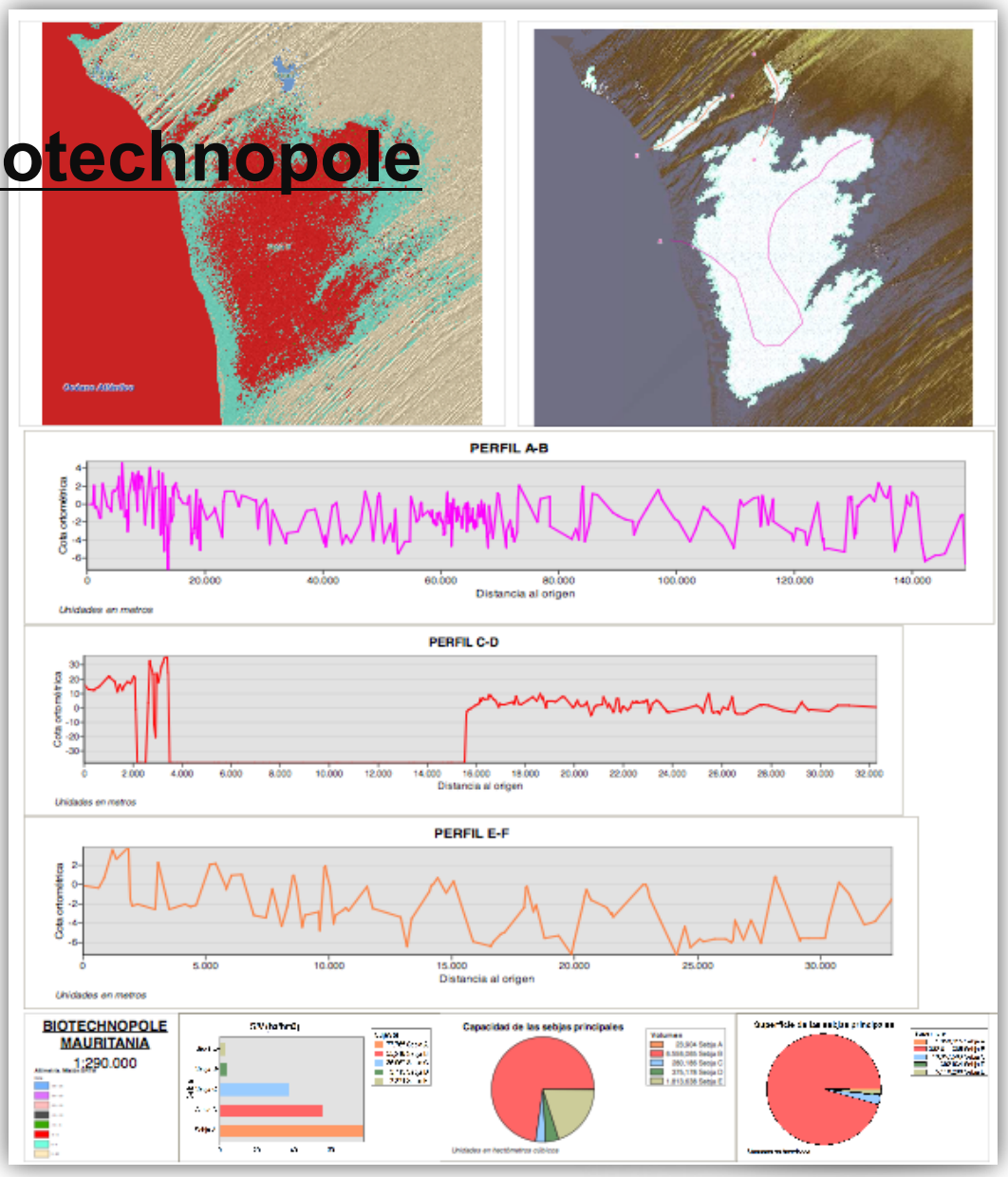
- *540 km^3 /y = 4x Uruguay river =* ***1 Mississippi***

Green Desert Project

Mauritania shebkha **Biotechnopole**

1. Number of **sebkhas-bsl** (*below sea level)*
2. Depth (*bsl*) per shebkha
3. Distance to shore
4. Elevation
5. Interconnection
6. Area (surface)
7. Volumen (capacity)

Area = Great Salt Lake

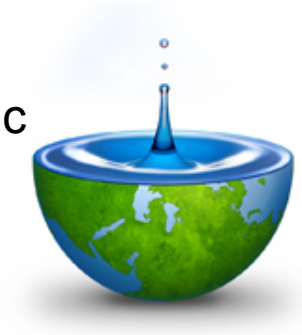


Summary of *shebkas bsl* in Sahara

4 main goups of shebjas *bsl* arround Sahara coasts

	Nº of shebjas	Km^2 (below sea)	Km^3	S/V	Distance (Km)
Tunez-Argelia	5	9.500	200	4	50x50x60
Libia	13	6.400	100	24	3
Mauritania	5	3.800	10	35	6
Marrocco	4	450	20	14	15
TOTAL		**20.100**	**330**		

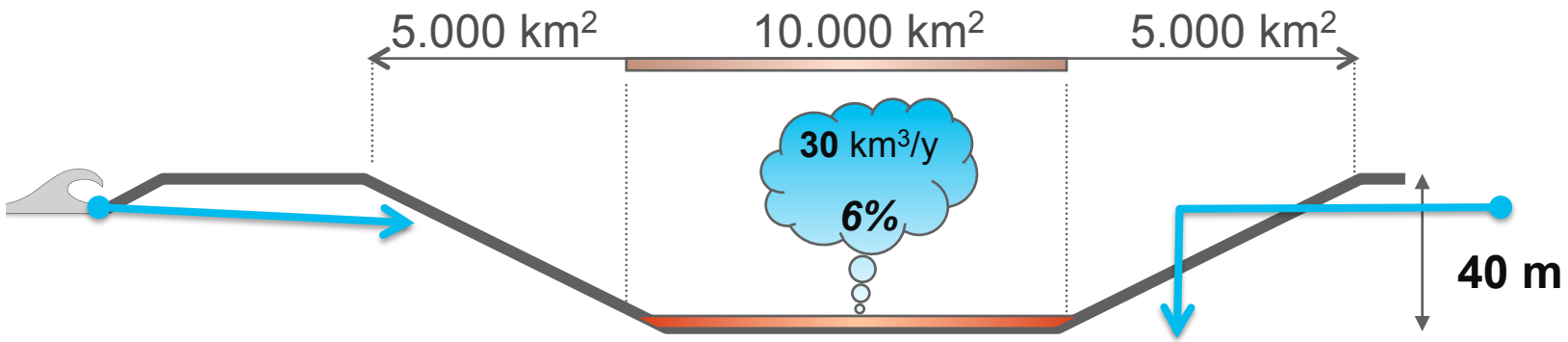
- Mississippi river fills the 4 shebjas in 7 months
- but an evaporation rate of ***3 m/year*** creates a sustainable "metabolic motor"



Flow & biomass production in shebkhas *bsl*

N0 pumping cost

(seawater income = natural evaporation)



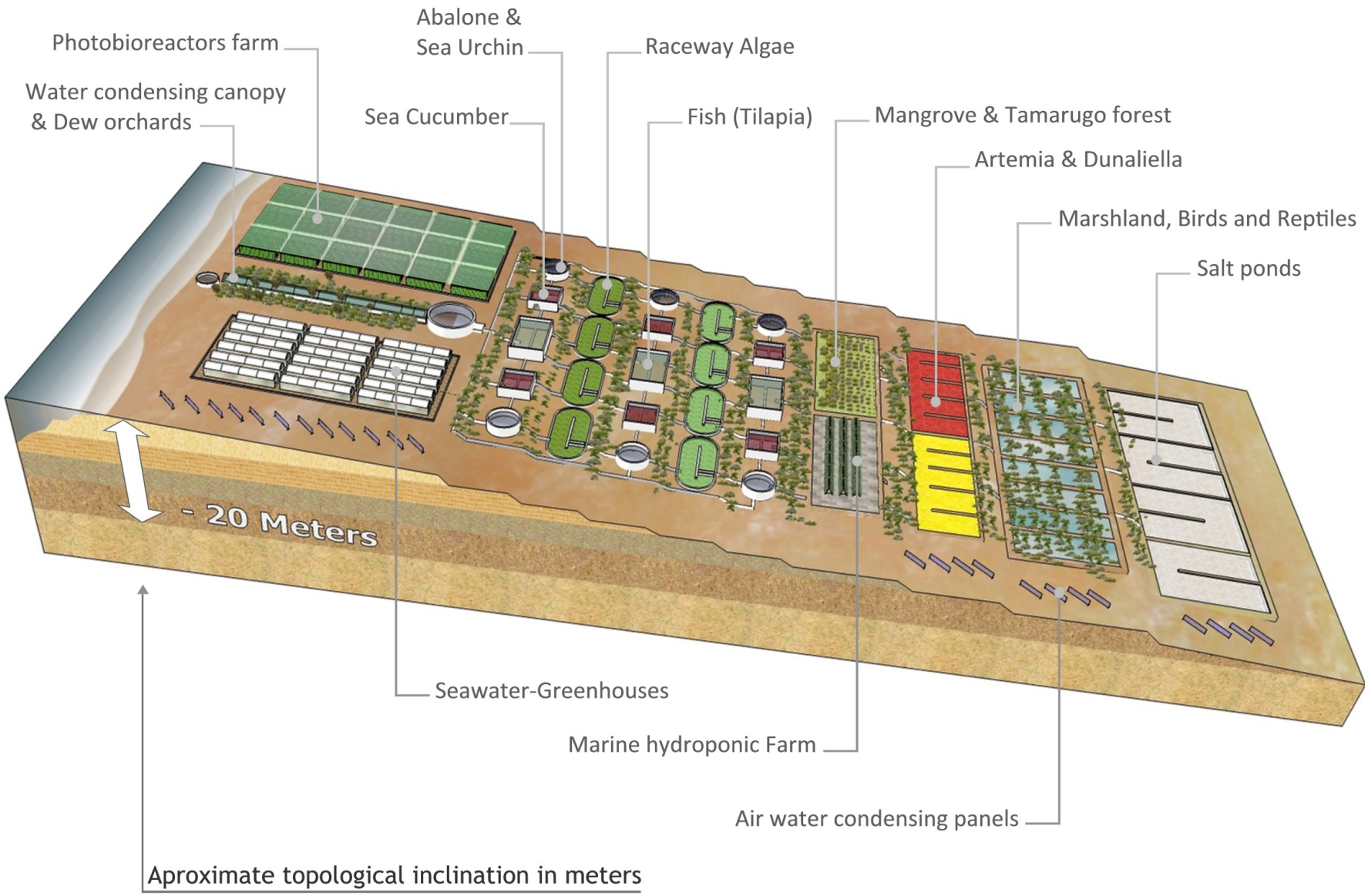
BIOMASS *(marine)*
Fish /shrimp – algae – moluscs – sea urchin - abalone – microalgae - halophytes – holoturia - marine forest

15 km³/y | **15** km³/y

ENERGY
Hydro-solar : 200 MW
↓
Freshwater: 0,53 km³/y
↓
Reforestation, biofuels,..

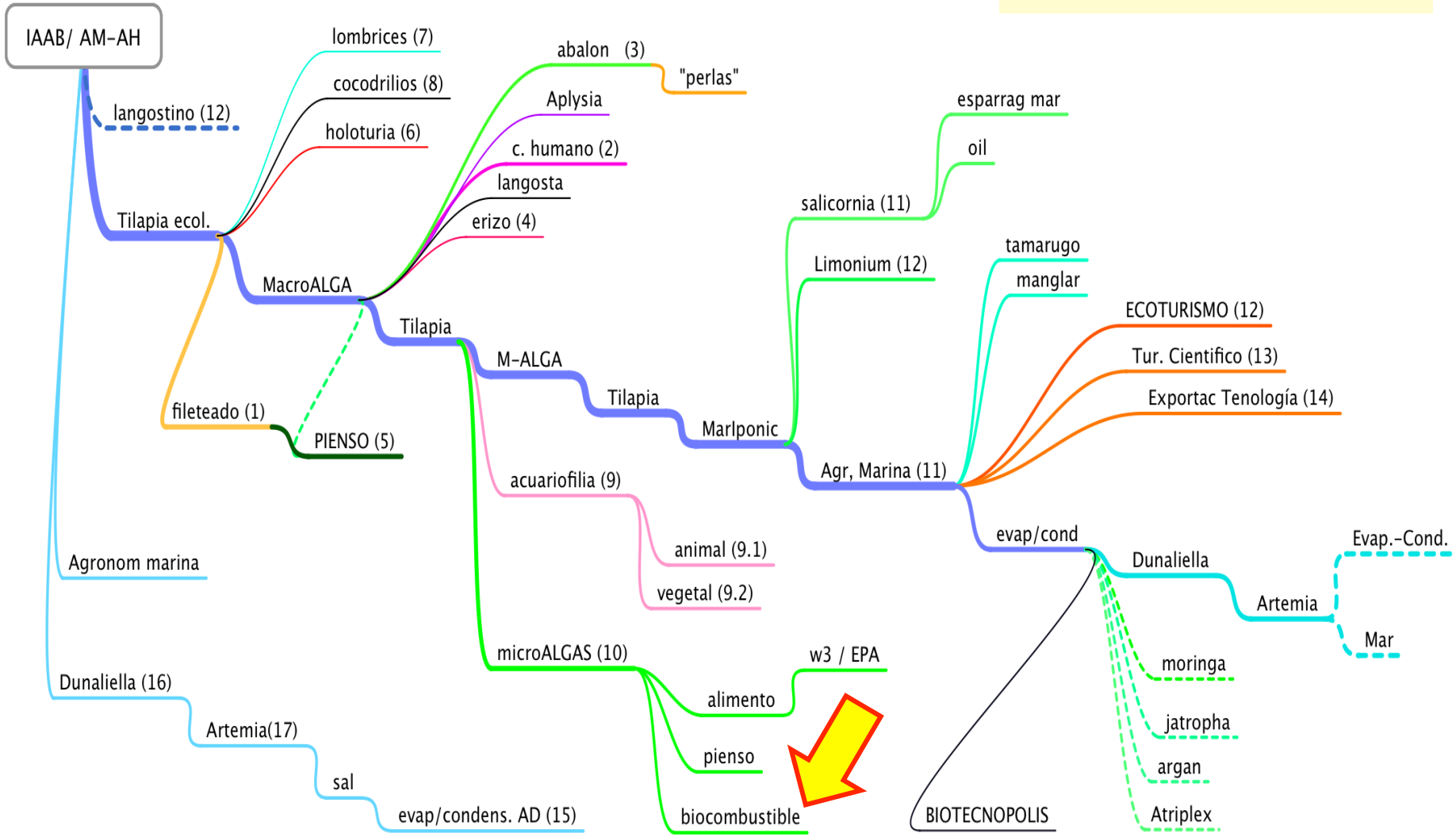
Dunaliella & Artemia

Green Desert Project: IAAB-module for Sahara shebjas



IAAB: seawater bioindustrial ecosystem
(complex but not complicated)

"*IAAB for biomass*"
before
"*biorefinery concept*"



IAAB technologies = water types

IAAB = integration of **AQUASYSTEMS** (self-integrated) + **AGROSYSTEM**

- **IAAB/ FW =** **integrated polycultures** **fresh- water**
- **IAAB/ SW =** **integrated polycultures** **sea-water**
- **IAAB/ BW=** **integrated polycultures** **brakish-water**
- **IAAB/ HS=** **integrated polycultures** **hypersaline-water**
- **IAAB/ WW=** **integrated polycultures** **urban wastewater**

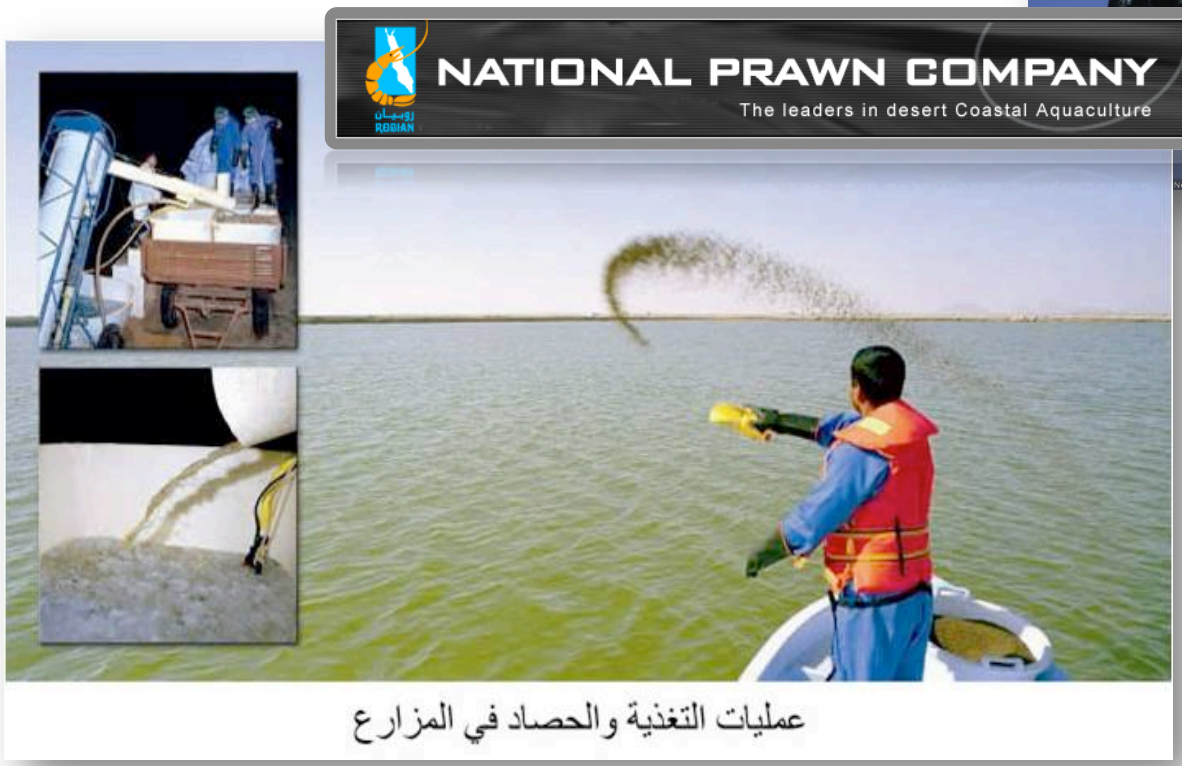
Species (biomass) & markets specific for each kind of water

Tasa autoconsumo alimentario de Canarias = **6%**

Tecnologías ya existentes (ejemplos ….)

World's largest fully integrated desert aquaculture farm *(Saudi Arabia)*

12,000 t/y of antibiotic-free premium quality shrimp produced eco-friendly



Acadian Seaplants

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Canada ..!!!!!

Pioneered the on-land cultivation of seaweeds in tanks

$3 million (2005)

Seaweed (macroalgae) farm in the desert

New seaweed technology reduce production cost by 10x, by means of earthen ponds with very reduced exchange of seawater

Seaweed farm in the desert

Technology to grow highly scalable, premium quality algae with shrimp-fishpond effluents, and with more protein than fish

Microalgae farms in USA

Microalgae Farms *(raceways)*

- Hawaii (*Cyanotech*)
- California (*Earthrise farms*)

Green Deserts

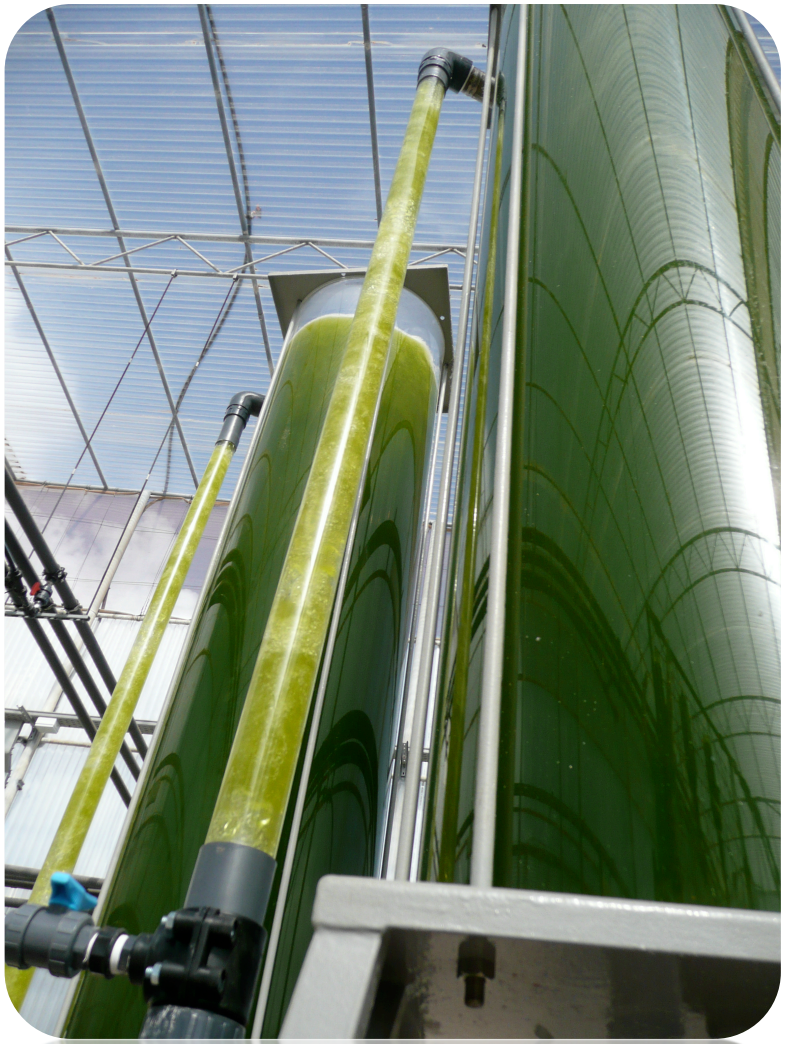
Green Deserts

Algae for biofuel´s bio-revolution

(26 bio-companies 2004-2009, and growing…)

EXXON- MOBIL: 600 M $ (sept, 2009) in R&D algafuels

The “very best” photobioreactors



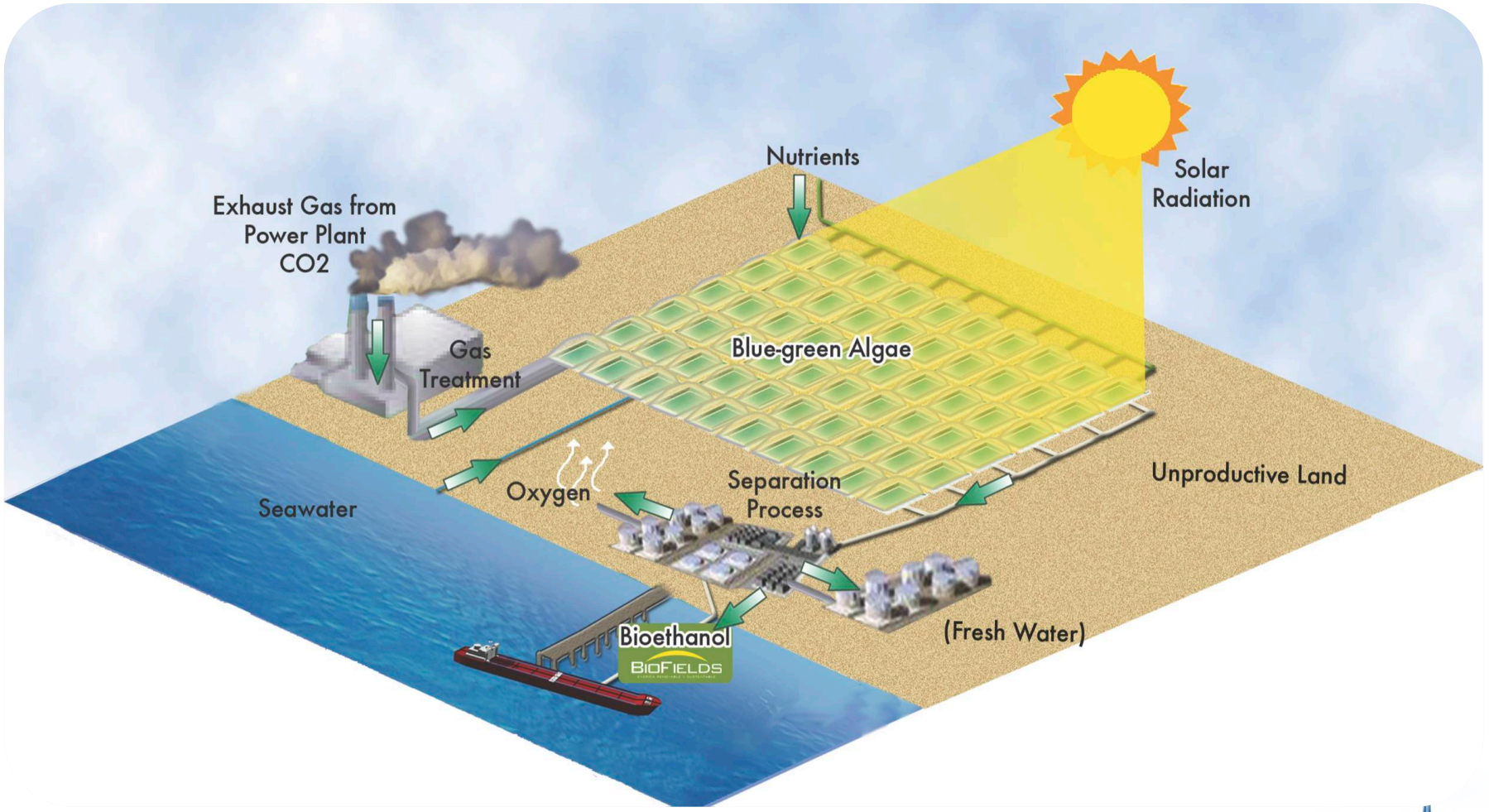
Centro de Biotecnología Marina
Universidad de Las Palmas de Gran Canaria

- *Patented by REPSOL*

300 ha of photobioreactors supplied by only 1 ha of fish-ponds

algafuels *migth then be 3xe feasible*

Other examples / designs of algae farms for algaefuels …



…. but all will demand huge extensions of sunny deserts
… but only Sahara is free of pumping costs

New strains under natural environment

BANCO NACIONAL DE ALGAS
marinebiotechnology.org

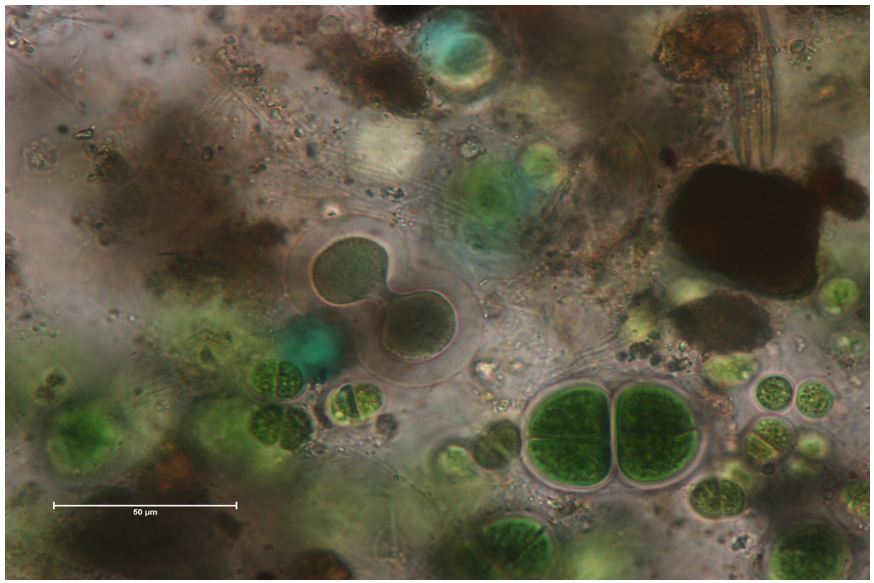
CENTRO DE BIOTECNOLOGIA MARINA
marinebiotechnology.org

Extremophylles (extreme environment)

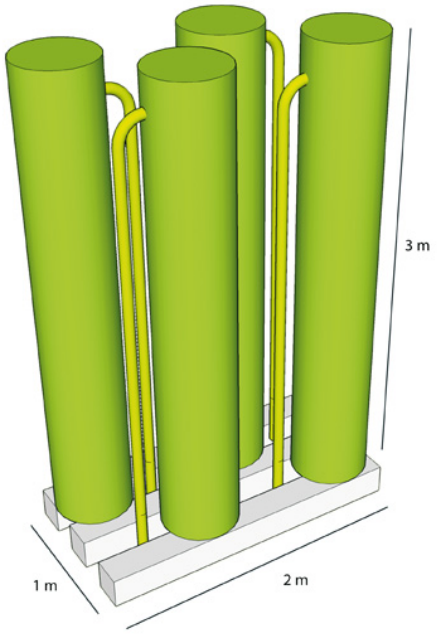
Biodiversity .... *ma non troppo*

Selection, Cultivation &

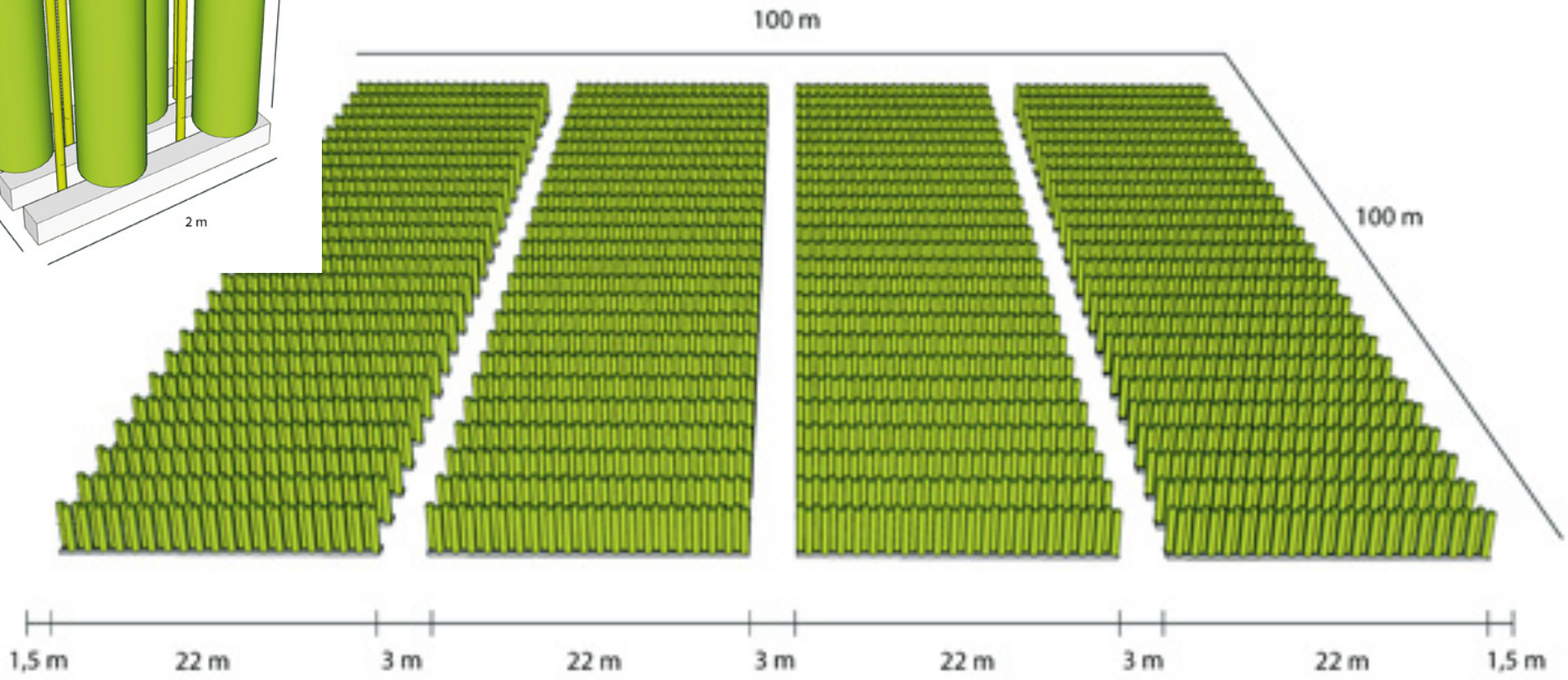
Bioprospection



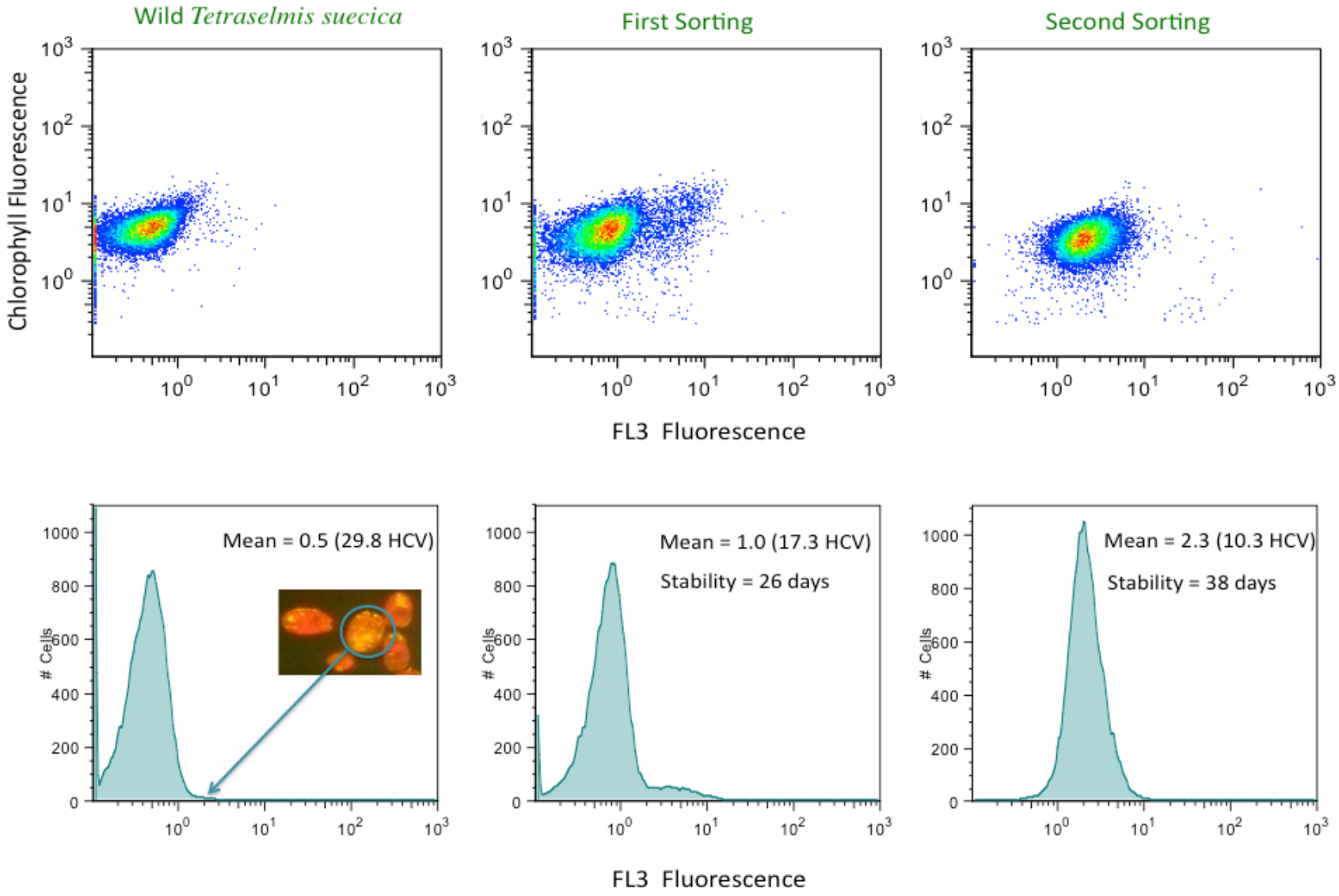
Microalgae farm for biomass and biofuels in Sahara



No water-pumpig costs
No cost for fertilizers (nitrogen & phospate)
No cost for CO_2 (main nutrient)
More than 100 ton (dw) / ha/ha



Selection of a "fatty marathon runner"



Green Deserts

Hydroponic cultivation of vegetables with freshwater…

Seawater hydropony of land plants (the new marine agronomy)

Hydroponic cultivation of vegetables with … seawater !!

Imagine irrigating plants with plain seawater, yielding
3x of sugarcane, ...
and with 30% oilseeds,
only with fishpond effluents

Halophytes: plants grown in seawater

- Hydroponic cultivation of plants in plain seawater
- Selection of new strains from wild new species
- Development of a new marine agrosystem

Mejora genética de halofilas

- Selección de plantas por rendimiento en semillas:
  - **Tamaño inflorescencia**
  - **Numero inflorescencias**
  - **Oil content**
- Selección por rendimiento en biomasa
- Selección por rendimiento económico (metabolitos,…)

ESTIMAS de PRODUCCION comparativas (halofitas – algas en FBR)

- Diseño PIRAmide 170x25
  - 8 tubos productivos/zafra/pira. Solapamiento zafras (= 2 zafras/a)
  - Superficie útil = **56%** (26.823 mL tubos cultivo/ha)
  - Nº plantas/ m Lineal = 25 (670.575 plantas/ha)
  - Producción biomasa total/planta (clon Q12) = 120 g PSSC
  - Producción semilla/ planta (Q12)= 18 g

	PIRA	FBR 25-4-4	
Biomasa total	***160***	***110***	*tm PSSC/ha/a*
Semilla	*24*	*---*	*tm/ha/a*
Biofiltración CO_2	*288*	*194*	*tm CO_2/ha/a*
Lípidos (30%)	*7,2*	*40 (37%)*	*tm lípidos/ha/a*
TG (?)	*?*	*9 (8%)*	*tm TG/ha/a*

Producción biomasa (tm/ha/a): switchgrass 10, trigo 15,5 (9 grano), colza 8 (4 grano)

Biofiltración (tm CO2/ha/a): bosques templado 18,

Producción (tm oil/ha/a): palm 5, colza 1, girasol 0,8, soja 0,4

New African species (& bioactives)

- Latex + halophyte (Equatorial Guinea)
- Anti-neurodegenerative activity (Alzheimer, Parkinson,..)

Green Desert Project: IAAB-biotecnopole ***modules***

4 technologies (90% existing) / multiple makets

- **Integrated Intensive Mariculture + RAS**
  - Food of high quality without CO_2 *(CO_2 credits, fish, seaweeds, molluscs, microalgae, crustacea, cyanobacteria, worms, halophytes,….*
  - **Microalgae farming**: *1ha fishpond= 340 ha microalgae PBRs*
  - Biofuels with possitive balance
  - Feed, food, nutraceuticals, pigments, bioactives,…
- **Marine hydropony** *(halophytes: seawater irrigation)*
  - Food without CO_2
  - Biofuels with possitive balance
  - Oil, Anti-neurodegeneratives,..
- **Extensive Mariculture** *(Great Salt Lake, Utah = 79 companies)*
  - Carotenoids
  - Artemia cysts

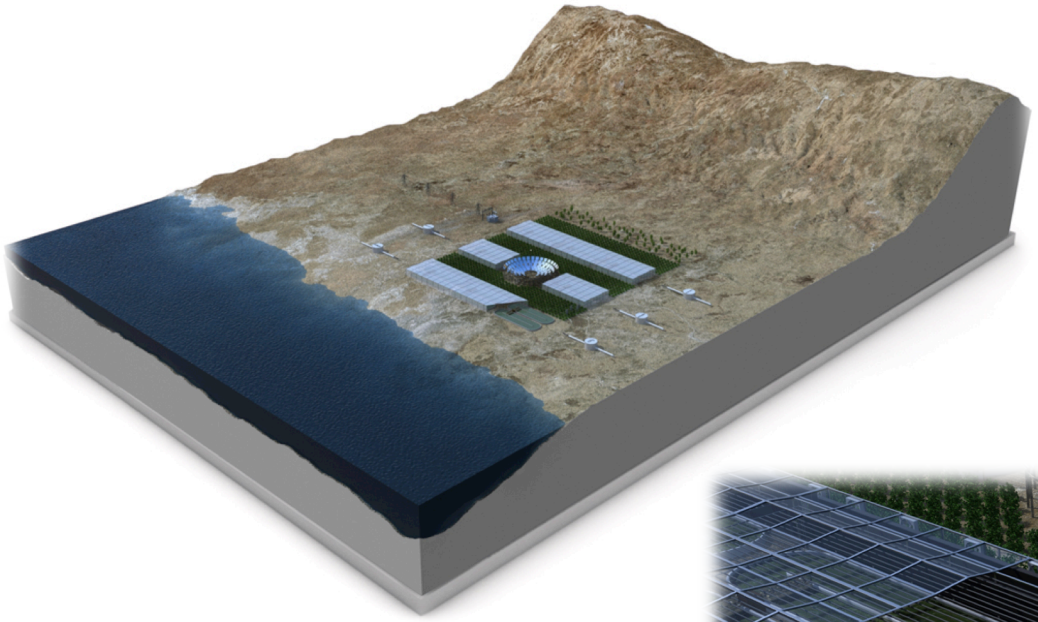
Rendimiento potencial (a mitad del flujo)

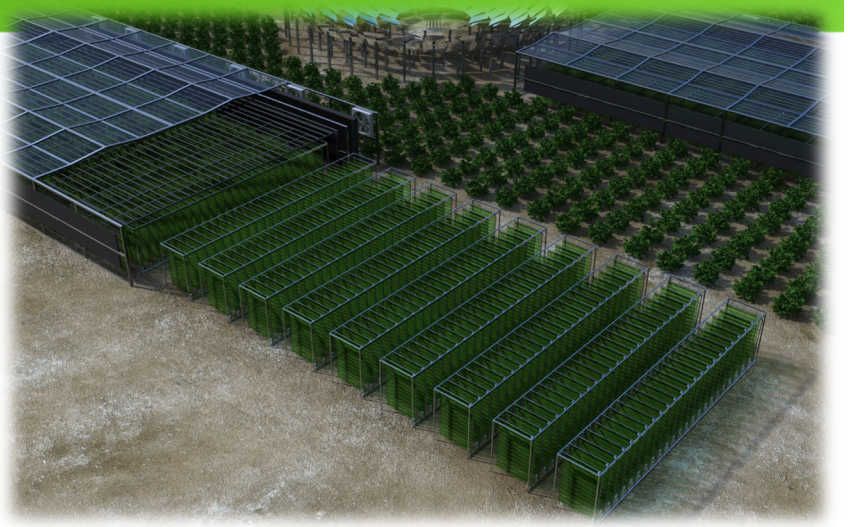
15 km^3 agua de mar/ año en IAAB

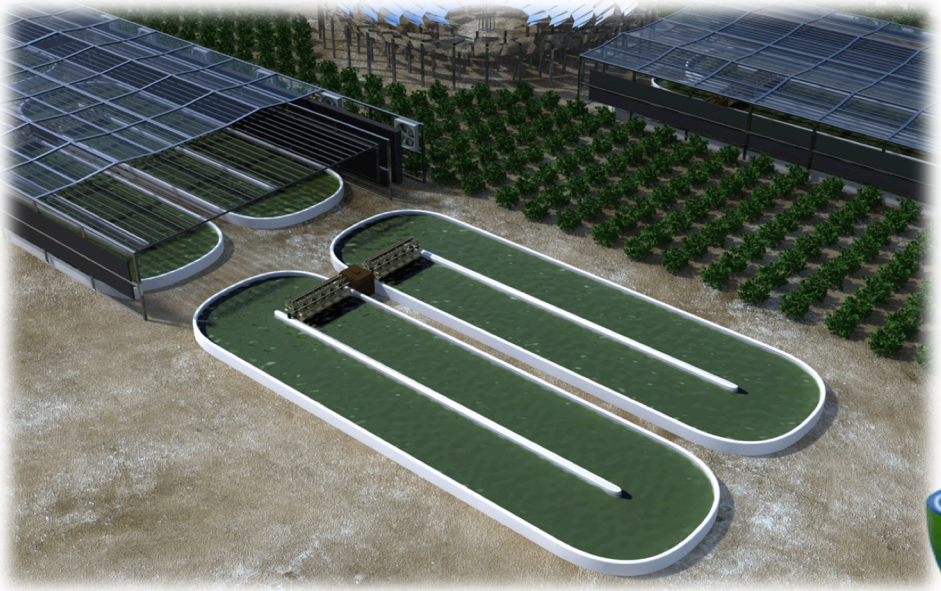
	Yield (tons/year)	Area (Km$^{2)}$	World increase
Fish	136.000	10	***10%*** (marine-f)
Seaweed	1.300.000	20	***41%*** (Japan swd)
Abalone	110.000	11	***38%***
Sea urchin	165.000	17	***271%***
Sea cucumber	3.000 (DW)	107	***35%***
Sea asparagus	42.000 (DW)	4,2	***8000%***
Microalgae		4.000	***1.000.000.000%***
Artemia (crustac.)	14.000	5.000	***100%***
Dunaliella (algae)		5.000	***500%***

How to achieve the *GDP* ?

Planta piloto costera (5 tipos de aguas)







International IAAB-Center (Gran Canaria island)

- Private R&D Foundat. (non-bureaucratic)
- University “umbrella”
- *Pilot-plant scale (**10 ha**)*
- **ALL kind of waters**
- *Saharian-data (trustability)*
- Algae Bank and Marine Biotech Center (at 10 km)

International IAAB Center (Gran Canaria, Canary Islands)

- Ensambling techniques, pilot plant, joint-ventures, FAO-umbrella, EABA, ABO, CGIAR-World Bank,……
- Other islands: Fuerteventura, Hierro,…..... & countries

Open to companies & institutions

CENTRO TECNOLOGICO DE ACUA-AGROBIOTECNOLOGIA INTEGRADA

Bioagramar FUNDACIÓN

LEYENDA

1- PARQUE EMPRESARIAL
2- ZONA DE ESTACIONAMIENTO
3- LABORATORIO PRINCIPAL
4- TANQUES DE ENGORDE x11 (990m3)
(Tilapia, Langostinos o ambos en agua salada salobre y dulce)
5- RACEWAYS DE CULTIVO
5a Raceways de cultivo de Lenbajes x8 (55mx30m x 0,45m)
5b Raceways de cultivo de Macroelgas x4 (55mx30mx 0,45m)
5c Raceways de cultivo de Macroelgas x2 (33mx30m x 0,45m)
6- CULTIVO DE LOMBRICES
Insitu en los tanques de engorde x8
individual (para los tanques de agua salada)
7- HOLOTURIAS
8- CULTIVOS DE ABALON
9- ZONA DE CULTIVO DE HALOFITAS
10- ZONA DESTINADA A SEAWATER-GREENHOUSE

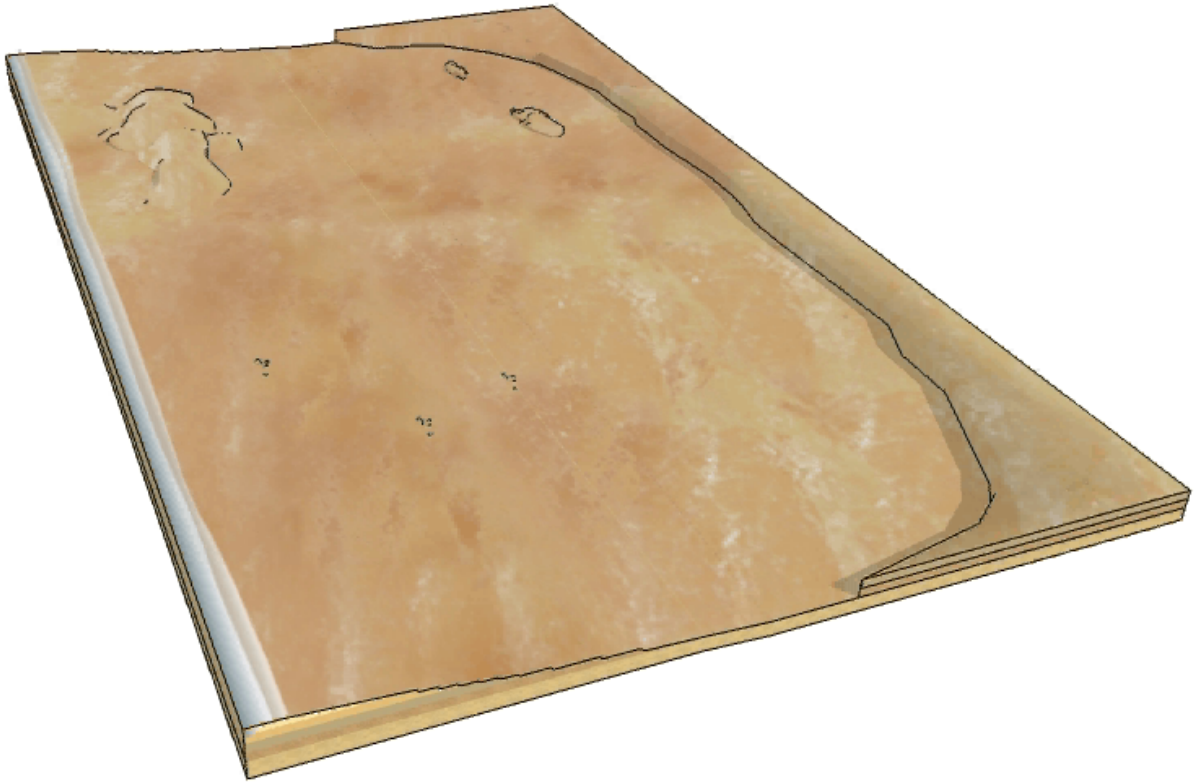
11- ZONA DESTINADA A HIDROPONIA MARINA
12- MANGLARES Y ULTIMOS FILTRADOS NATURALES
13- CULTIVO DE PATOS
14- CULTIVO DE RANAS
15-HIDROPONIA TERRESTRE
16- ZONA DE CULTIVOS CONVENCIONALES
17- BIOREFINERIA
18- GRANJA DE CABRAS
19- FABRICA DE FILETEADO, ENVASADO, PRODUCTORA DE RENSO Y ALMACEN
20- GRANJA DE GRANDES LAGARTOS

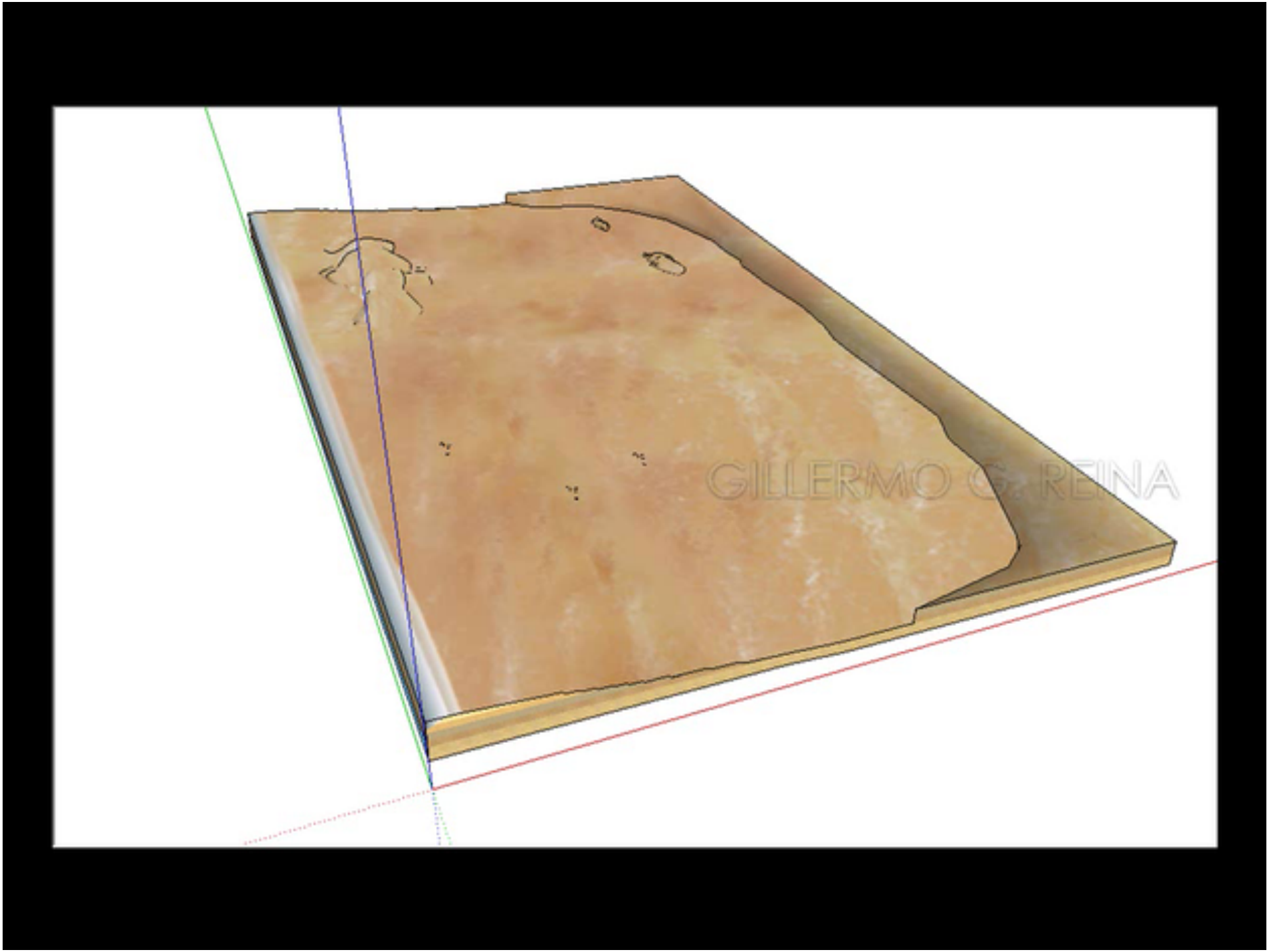
21- DESALADORA DE AGUA SALOBRE
22- DEPOITO DE AGUA HIPERSALINA
23- DEPOSITO DE AGUA DULCE
24- DEPOSITO DE AGUA SALADA Y GRUPO DE BOMBEO
1 Deposito
2 Deposito (Principal)
25- CULTIVO DE MICROALGAS EN FOTOBIORREACTORES
26- LABORATORIOS CONTROL DE CALIDAD
27- INSTALACION Y ACCESO DE EDAR
28- DEPOSITO DE EDAR
29- NAVES DE OSCURIDAD, INCUBACION, ALIMENTACION Y LARVICULTURA
(Una instalacion para Tilapia y otra para Langostinos)
30- POZOS Y SISTEMAS DE BOMBEO DE POZO PLAYERO Y MARINO

31- ACUAPONIA
32- CENTRO DE FILTRADO QUIMICO
33- CONDENSADORES PUNTO ROCIO
34- ESPACIO LIBRE
35- VIVIENDA DEL VIGILANTE DEL COMPLEJO
36- FUTURA UBICACION BANCO NACIONAL DE ALGAS

betancor&partners, S.L.P.

GDP: secuential development (model for Mauritania)




GILLERMO G. REINA

Green Deserts

“Imagination is more important than knowledge" *(A. Einstein)*

… but on Earth you must follow the laws of physics and biology…

… and this vision does.

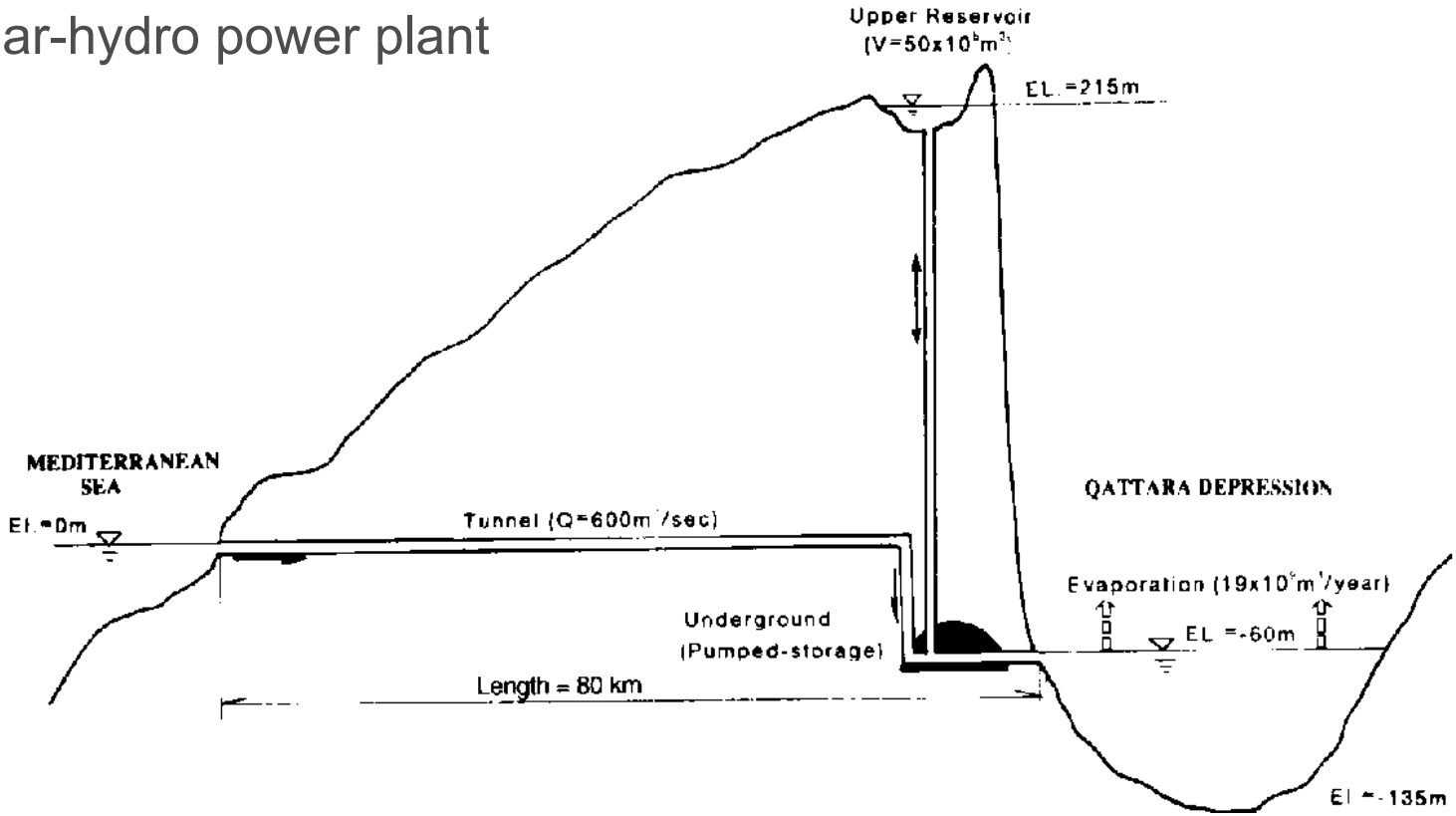
Green Deserts: UN-approach only for energy

(Our 4 sebkhas do not need to drill mountains, and are closer to the sea)

Sebkha of Qattara, Egypt

(-120m, 40.000 km2)

1995. UNU solar-hydro power plant



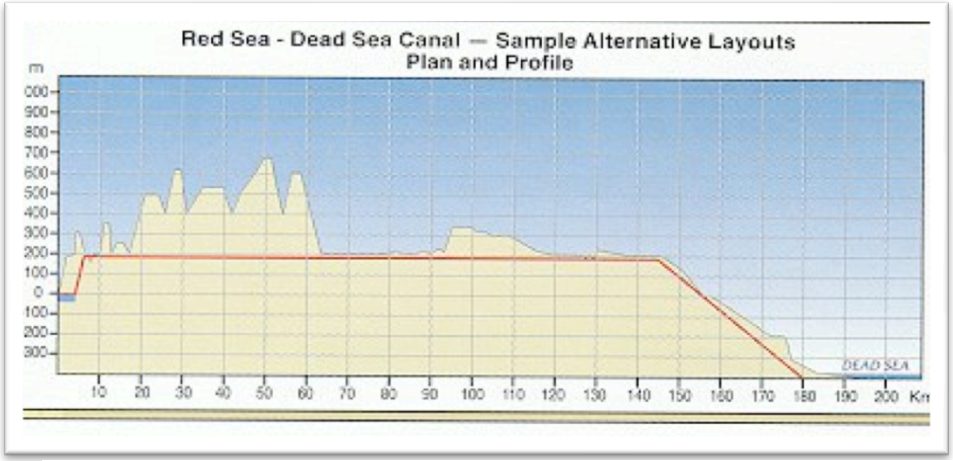
Green Deserts: Israel pioneered flodding deserts ?

1980.- A **hydro-power** scheme for a Mediterranean-Dead Sea canal was proposed by Israel in 1980 (convey water from the Mediterranean to the Dead Sea, via tunnels *to generate 480 MW*)

1995.- ***UN***: *Managing Water for Peace in the Middle East: Alternative Strategies,* © The United Nations University

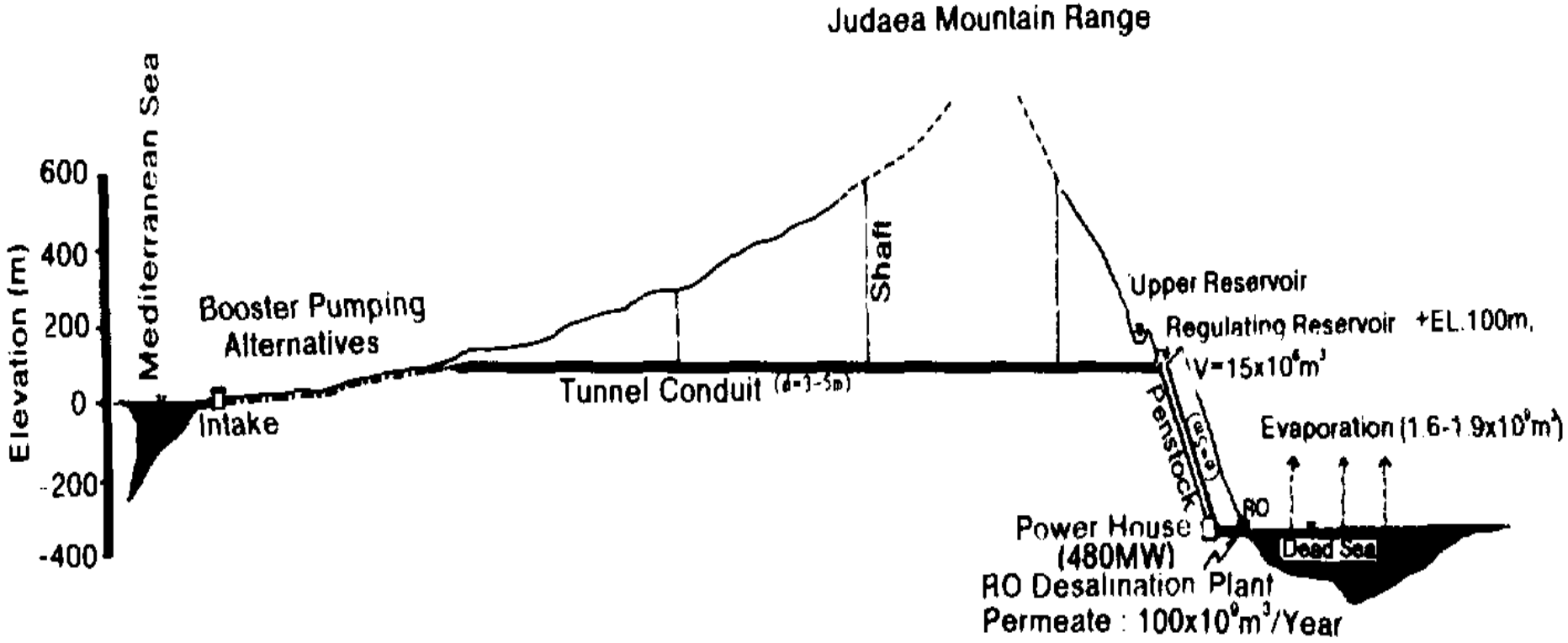
1855.- William Allen: '*The Dead Sea - A new route to India', to trade* (before Suez canal)

Green Deserts

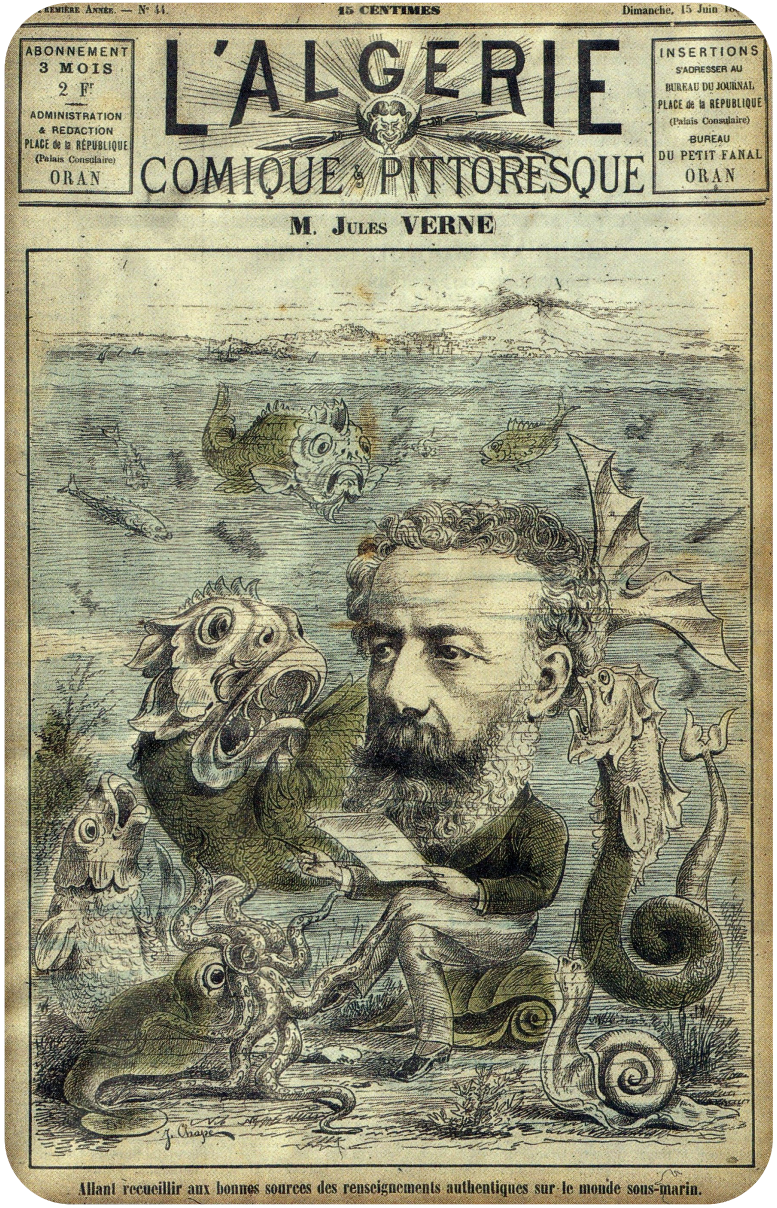


Dead Sea Canal

www.unu.edu



Green Deserts: fiction-vision of the father of future

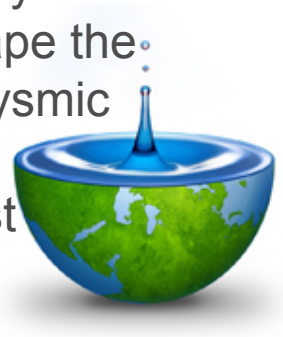


"Invasion of the Sea" (1905)

Jules Verne

- The purpose of the Westerners' visit to Africa is to study the feasibility of flooding a low-lying region of the Sahara desert to create an inland sea and open up the interior of Northern Africa to trade.

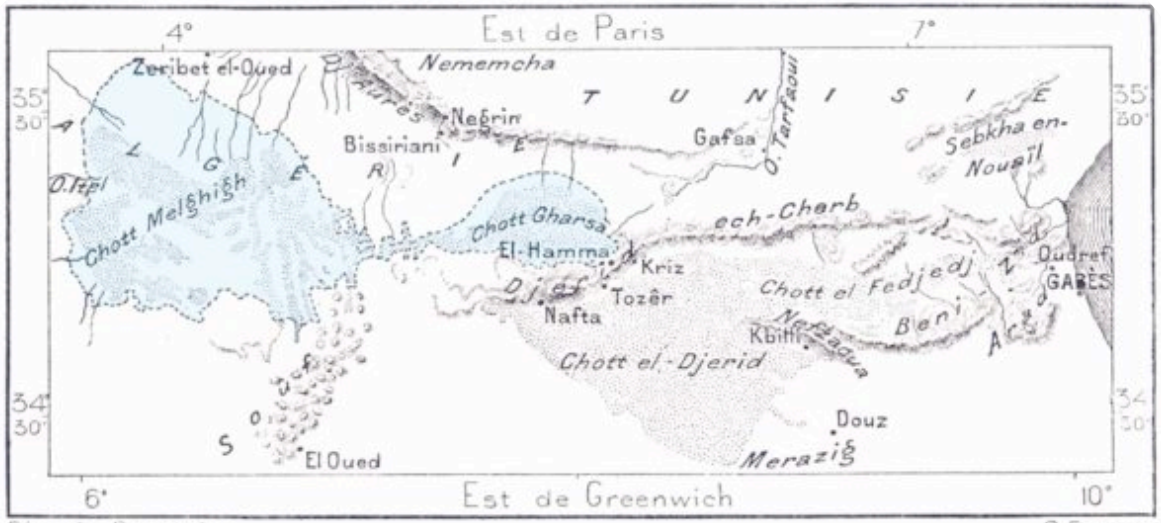
- In the end, however, the protagonists' pride in humanity's potential to control and reshape the world is humbled by a cataclysmic earthquake …. which results in the natural formation of just such a sea.



Green Deserts: … the real pioneer (1874)

Le commandant ***François Élie Roudaire***

Il est le promoteur du projet de mer intérieure saharienne auquel Ferdinand de Lesseps a attaché son renom.



Green Desert Project: …. really nothing new?

Vision: *20,000 km² saharian sebkhas (bsl) , for multipurpose, flexible & sustainable sources of richness & wealth*

MARINE BIOMASS

Integrated acua-agrobiotecnology: food, feed, employment, chemicals, bioindustries, biofuels, biorefineries,..

ENERGY & WATER

Hydroelectric power = freshwater: reforestation, food, feed, biofuels, biorefineries,..

CLIMATE

Sea level rise mitigation: climate bioengineering (6 - 20% of Mississippi)

Carbon credits: climate market

Seminario práctico

APRENDER A VER LA VIDA REAL

Visión del Sahara desde la biotecnología sostenible y la agronomía marina

Impartido por:
Dr. Guillermo García-Blairsy Reina
Presidente de la Fundación BIOAGRAMAR
Director del Centro de Biotecnología
Marina-Banco Nacional de Algas
Universidad de Las Palmas de Gran Canaria

Fechas:
7, 8 y 9 de enero de 2011
Salida y regreso desde Gran Canaria

Lugar:
Sahara · El Aaiún y alrededores costeros
(unos 300 km al norte y 100 km al sur)

Dirigido a:
Ciencias del Mar, Biología, Ingeniería Agrícola, Ciencias Ambientales, Biotecnología, Bioquímica, Ingeniería Ambiental, Geología, Teología, Bioconstruccion, Sociobiología, Microbiología, Ingeniería Industrial, …

Abstenerse: Sufridores de lumbalgia, agorafóbicos, creacionistas y dogmáticos

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www.bioagramar.org