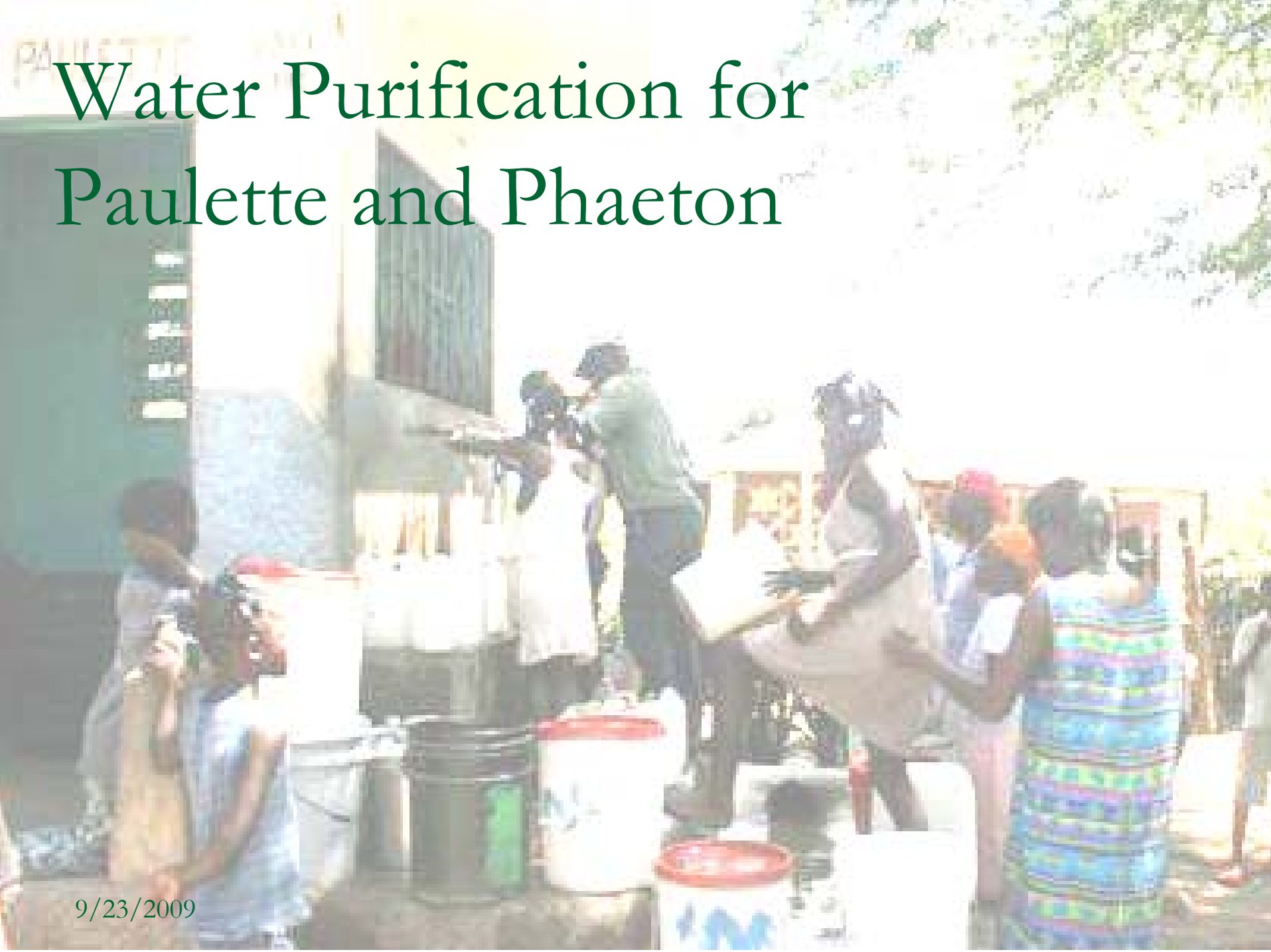
2.500 Desalination and Water Purification

Spring 2009

Water Purification for Paulette and Phaeton



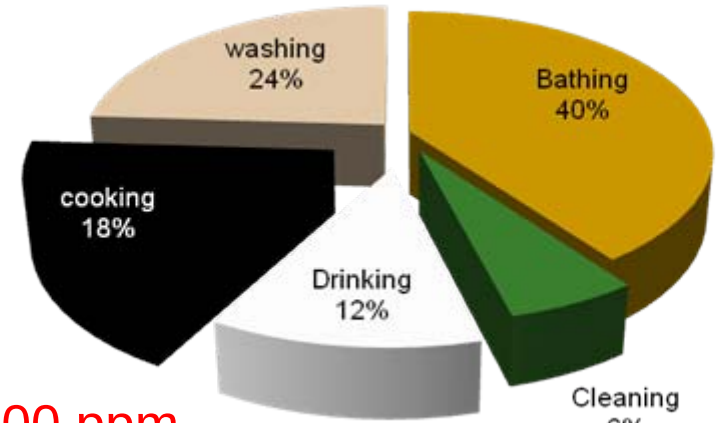
9/23/2009

History

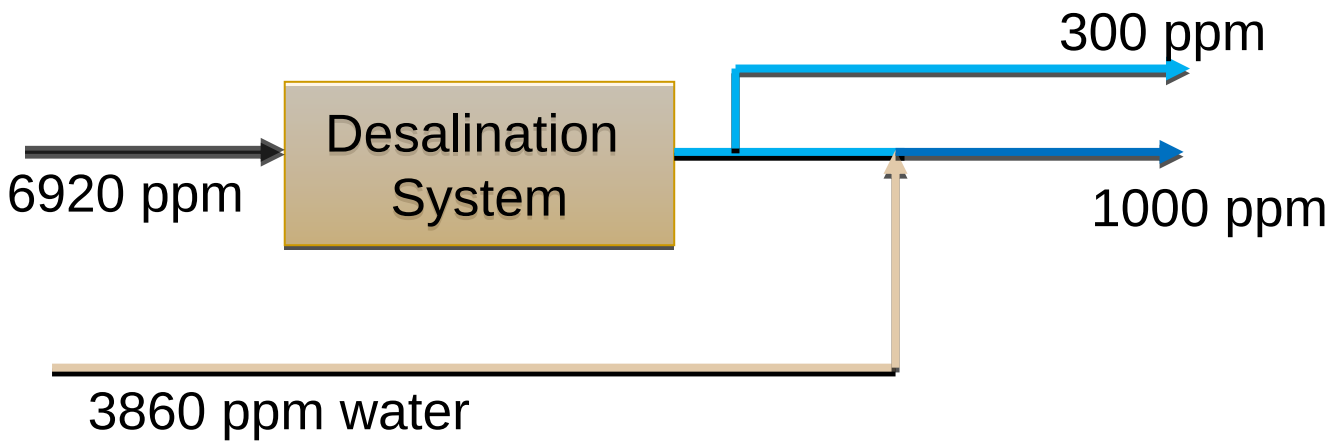
Solar distillation unit (300 m^2) built in Source-Phillip near Port-au-Prince in Haiti.

Water usage

1000 ppm



300 ppm



Desalination options

Criteria	Complexity	Appropriate for small-scale	Availability of Energy type	Energy Efficiency
RO	-	++	-	++
EDR	-	-	-	++
MVC	N*	++	-	N
MSF	-	--	-	-
MEE	-	--	-	N
HDH	+	++	+	-
Solar still	++	++	+	---

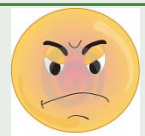
* N stands for neutral

Energy options

All values are in $/m^3	Generator (PPO)	Windmill	Kites	Solar thermal
RO	0.20	0.03	0.03	NA
MVC	3.74	0.53	0.50	NA
HDH	NA	NA	NA	0.96

A cost analysis which estimates the total energy cost (the energy system cost + the fuel cost was carried out).

Desalination cost

	RO with Kite power	Solar HDH	VCD with Kite power
Equipment cost[1]	12,460	273,375	363,000
Energy system cost	5694	182,250	94,900
Total Cost (US$)	18,154	455,625	457,900
Water cost[2] (US$/m³)	0.096	2.4	2.412
Cost-to-villagers[3] (US$/m³)	0.03	<0.96	0.5 
Level of Maintenance	High	Low	Medium
Skill required	High	Low	Medium

[1]Assuming membrane replacement every 2 years.
[2]Assuming 20 years life time.
[3]Assuming a benefactor pays the initial investment.

Design – RO with Kite power

→ Polyamide Thin-Film Composite spiral wound 8” element, 40 bar feed pressure, 34 m^2 active area, 99% Salt rejection.

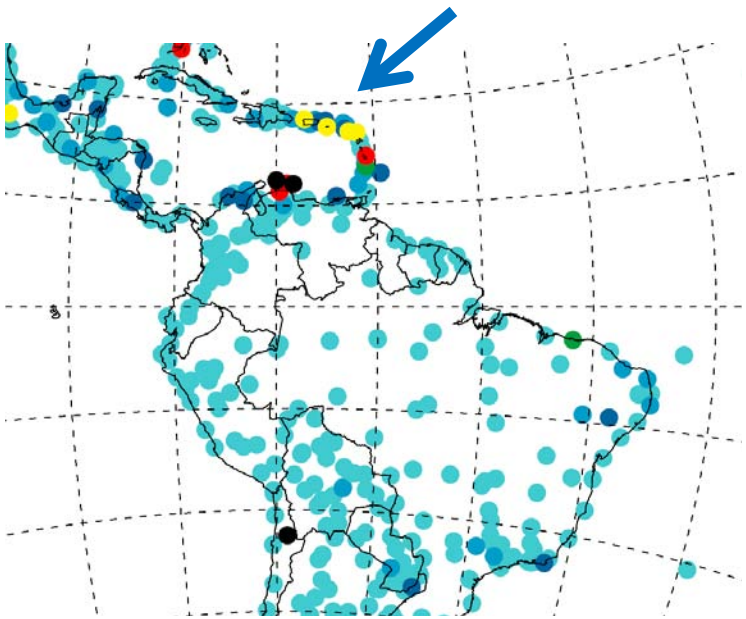
Images removed due to copyright restrictions.
Please see
http://www.dow.com/liquidseps/images/element_family.jpg
http://www.catpumps.com/select/photos/pump/6020.jpg
http://www.naturalhealthland.com/catalog/images/1962.jpg

→ 60 GPM, 100-1000 psi, 500 rpm Frame piston pump.

→ Pre-filter contains a coconut shell, activated carbon filter to remove excess sediment and chlorine to extend the life of the reverse osmosis membrane.

Kite power

High average wind speed



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Please see Fig. 5 in: Canale, Massimo, Lorenzo Fagiano, and Mario Milanese. "Power Kites for Wind Energy Generation." *IEEE Control Systems Magazine* 27 (December 2007): 25-38.

jeppmagic. "Kitegen Stem." July 6, 2009. YouTube. Accessed November 5, 2009. http://www.youtube.com/watch?v=Zl_tqnsN_Tc

Why Kites?

- High altitude wind
- More efficient

Realization: Kite power

One kite
(A=4m^2)

Haitian Textile factory

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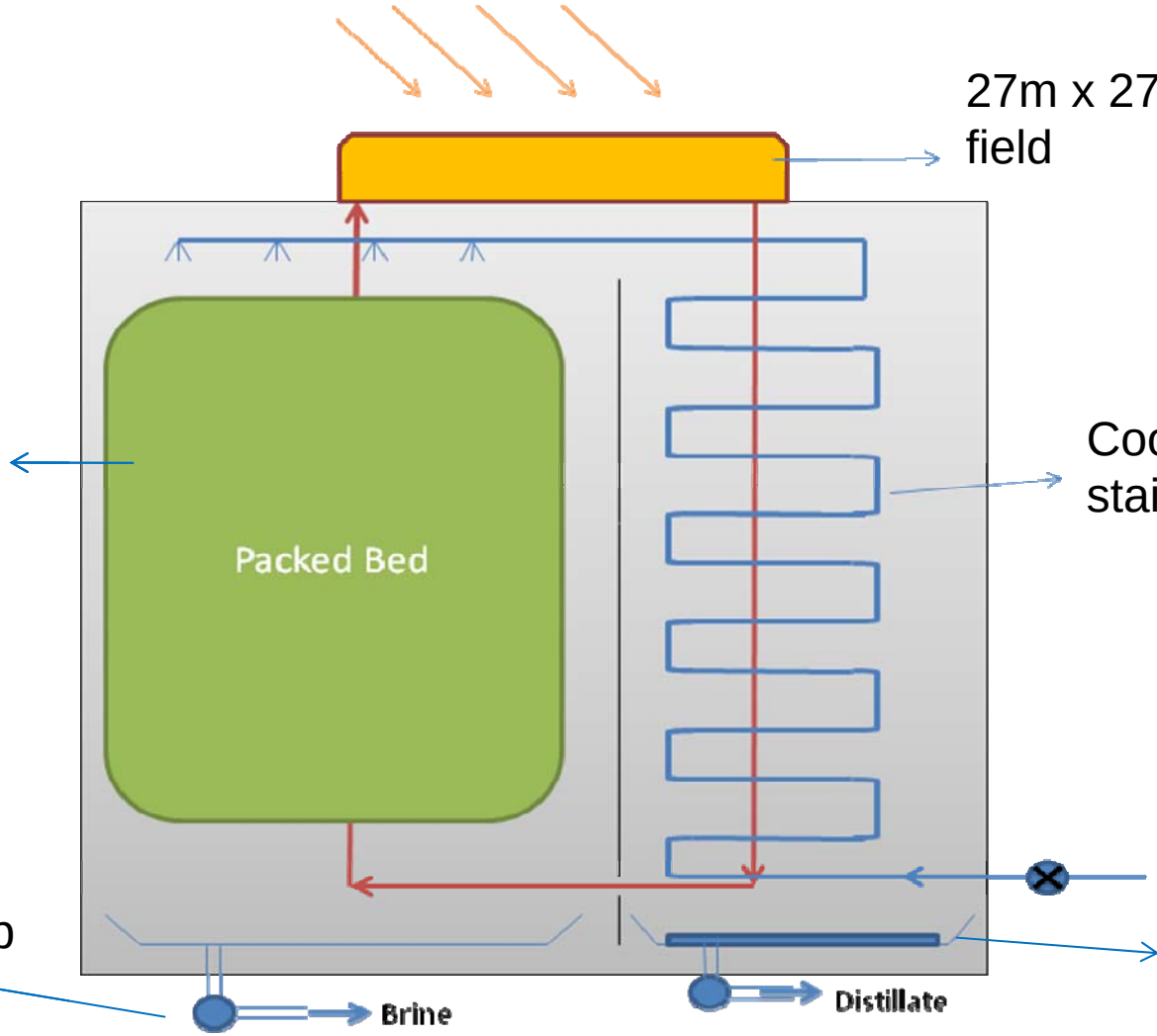
Please see Fig. 2 in: Canale, Massimo, Lorenzo Fagiano, and Mario Milanese. "Power Kites for Wind Energy Generation." *IEEE Control Systems Magazine* 27 (December 2007): 25-38.

Main Components:
- Metal Spool
- Generator (min. 2kW)
- Car Battery

KiteGen 40kW @ 15 m/s

Operation:
1 person to operate the system

Design –HDH



27m x 27m solar collector field

Packed bed made from local materials

Cooling coils made from stainless steel

60 GPM pump

Plastic collection trays & cistern for storage

Design – Solar FPC

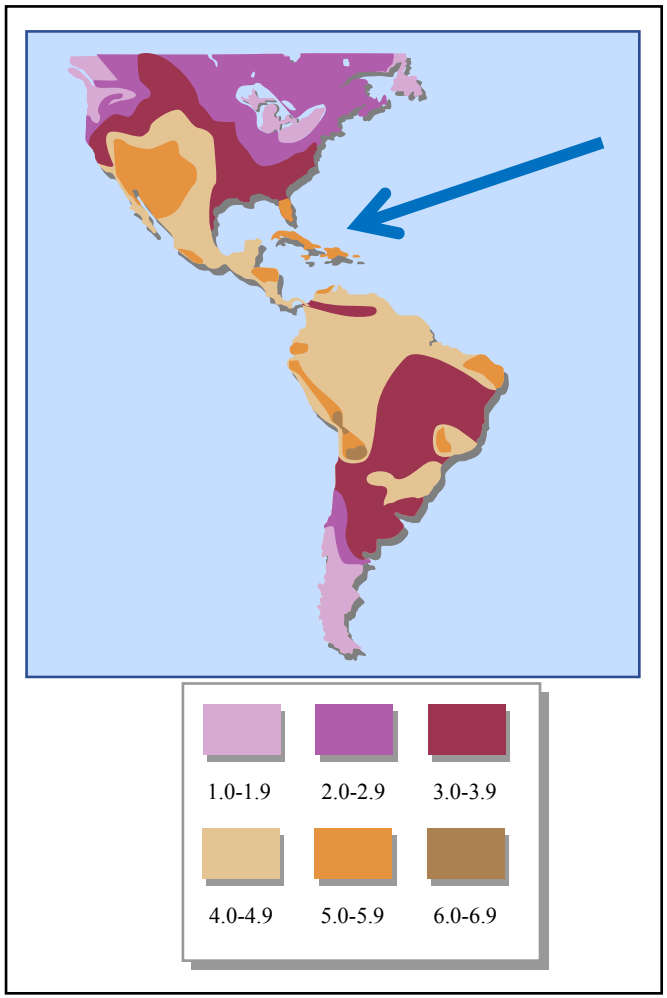
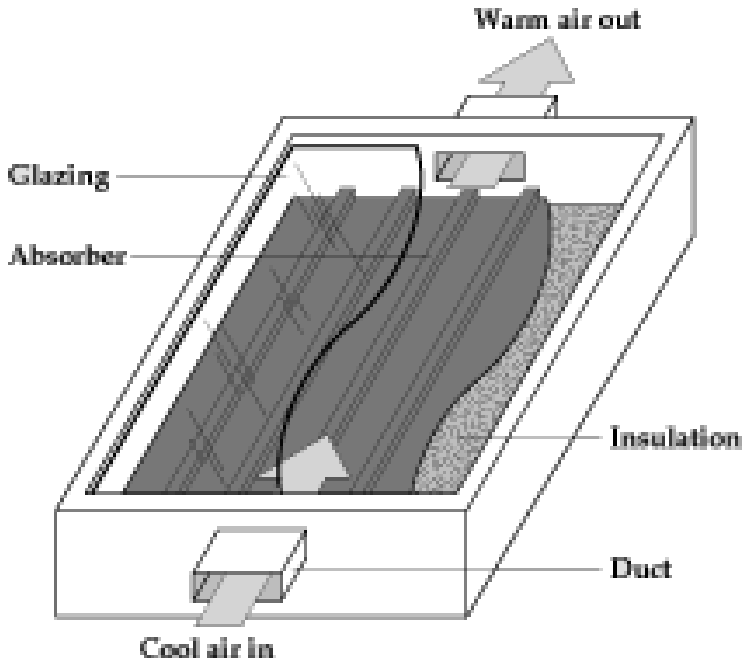


Figure by MIT OpenCourseWare.

Average Insolation ~4-4.9 kWh/m^2/day



Courtesy of EERE.

Easy to manufacture using local materials

Conclusions

- **Optimized water usage**
- **RO with kite power**
  - + Possible low cost option (min. capital investment)
  - - Requires training of localites for skilled labor
  - - Dependence on imports
- **Solar HDH**
  - + Highly sustainable option (min. imports)
  - - Costlier in terms of water cost (US$/$m^3$) and capital investment

Thank you!