

***Water Scarcity:  
A Global or Developing World Thing?***

Presented

at

**MWRDGC R&D Auditorium**

Stickney Water Reclamation Plant, Stickney, Illinois

Friday May 18, 2012

by

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# Access to Adequate Amounts of Safe Drinking Water

- Is This an Important Topic Today

From the Standpoint of the US?

From a Global Viewpoint?

From the viewpoint of Developing Countries?

- Does This Topic Deserve our Attention?

- According to the UN Definitions:

Water Stress = 1,000 to 1,700 m<sup>3</sup>pc/yr.

Water Scarcity = < 1,000 m<sup>3</sup>pc/yr.

Absolute Scarcity = < 500 m<sup>3</sup>pc/yr. ??

# Top 20 Engineering Accomplishments of the 20th Century

## From the Viewpoint of the United States – NAE

- Electrification
- Automobile
- Airplane
- Safe & Abundant Water
- Electronics
- Radio & Tele
- Ag. Mechanization
- Computers
- Telephone
- A C & Refrigeration
- Interstate Highways
- Space Exploration



## **All Waters;**

Ocean = 97%; All Freshwater = 3%

## **All Freshwater;**

Ice Caps-79%, Ground 20%, Easily Accessible 1 %

## **All Easily Accessible Surface freshwater – 1%**

- Lakes 52%
- Soil Moisture 38%
- Atmospheric Water Vapor 8%
- Accessible Water in Plants 1%
- Rivers 1%



# Some Areas With Critical Needs

- India
- Sub-Saharan Africa
- China
- N. America – California
- Central America
- South America, &
- Southern Europe

# **The Major Players in Developing Countries**

## **Have the Population, the Problem & Some Money**

- India – Population, Food, Industrialization – Coco Cola
- China – Population, Food, Massive Industrialization
- Africa – Poverty & Population+ Some Industrialization

# Some Causes Of Water Scarcity – Partial List

## Physical Scarcity & Economic Scarcity

- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>• Absence of Water</li><li>• Limited Access</li><li>• Demand &gt;&gt; Supply</li><li>• Arid Climatic Conditions</li><li>• Climatic Change &amp; Variabilities</li></ul> | <ul style="list-style-type: none"><li>• Poverty-Lack of Resources</li><li>• Poor Economic Policy</li><li>• Lack of Compassion</li><li>• Poor Political Policy</li><li>• Political Realities/Conflicts</li></ul> |
|---|---|



# INDIA – Impact of Industrialization

## Coco Cola v. People of India

### Coco Cola Plant at Plachimada, Kerala

- Largest Coke Plant in India - (Total ~ 60 Bottling Plants)
- Plant Property ~ 40ac
- Raw Water collected from 65 wells
- Product Capacity ~ 367,200 L/day
- Water Demand ~ 1.36 M L/day\*
- Efficiency 3.7 L water/ L of Coke
- About 70% water used goes to wastewater

\*Residents claim pumpage ~ 15ML/day

# China

## Areas of Predominant Scarcity & Causes

- Beijing, Tianjin, & North China areas
- North has ~ 50% Population
- N. Has 19% of Freshwater Resources\*
- Massive Industrialization
- Rapid population Growth
- Food Production- Poor Irrigation
- \*31% of Population ~ 400 Million PE

# China's Approach to the Problem

## Intra-state Water Transfer\*

- Massive Diversion of Water from South to North
- Three Routes – East, Central & Western
- Pumping Stations & Forced Mains
- Tunnels & Open Channels
- Western Route – Not Currently Active

\*Under Consideration Since ~ 1950 (Chairman Mao).



# Performance Specifications

• Diverted Volume	44.8 Bil.m <sup>3</sup> /yr.
• Eastern Route	14.8 Bil.m <sup>3</sup> /yr.
• Central Route	13.0 Bil.m <sup>3</sup> /yr.
• Western Route	17.0 Bil.m <sup>3</sup> /yr.
• Length – Eastern	1,156 km
• Length – Central	1,267 km
• Length – Western	Not Available

# Benefits of Transfer/Diversion

- Mitigate Crisis in Beijing, Tianjin & North China
- Increase Irrigated Area by 0.6 million ha.
- Add 3.0 Billion m<sup>3</sup> Water for Agriculture
- Add 6.4 Billion m<sup>3</sup> Water to Municipal/Industrial Supply
- About 350,000 People will be Relocated
- Compensation ~ US\$1,100.00/person

# Interbasin Transfers – Existing

- Africa – Lake Nasser > New Valley, W. Egypt
- Americas – Cutzamala R. > Mexico City
- Americas – Colorado R. > Southern CA
- Asia-Telugu Ganga Project, Krishna R. > S. India
- Australia – Supply to Perth; a 2,200 km pipeline from the Kimberley region was contemplated
- Europe – Spain, Ebro R. > Bilbao , Barcelona



# Africa

**Africa's Available Fresh Water Resources - Good**

**Continentially Only ~ 4% Currently Being Used**

Africa Renewal, United Nations: [WWW.africarenewal@un.org](http://WWW.africarenewal@un.org)

- About 160 Major Lakes – Many are Receding
- 17 Large Rivers
- Vast Wetlands
- Limited Groundwater ??
- Rainfall-Fluctuating < 100 to >3200 mm/yr.(4-130 in)
- Nubian Sandstone Aquifer System – Under Egypt, Libya, Sudan, Chad , & covers 2.2 million km<sup>2</sup> of NE Africa
- New Aquifer Discoveries (4.19.2012) under – Libya, Algeria, Egypt & Sudan .

# Africa

## Areas of Predominant Scarcity and Causes

- Africa – 10 Sovereign States - in Descending Order:
  - Somalia, Mauritania, Sudan ,Niger, Iraq, Uzbekistan, Pakistan, Egypt, Turkmenistan, & Syria.
- Poverty, Population Growth
- Food production- Poor Irrigation Practices
- Climate Change – Frequent Droughts
- Shrinking Lakes – Chad ~ 10% of Original Size
- Lake Tonga Dried up after 1999 Drought
- General Absence of Water Resource



# Current Sources of Assistance – Who Can & is Helping?

- **Many** Governments – UN + US AID +
- Private Foundations
- The Academic Community – EWB
- Private Technology Groups
- Professional Organizations/Societies
- NGOs
- Individuals – Like You – Celebrities – Scientists.



# The Power of The Individual

- ***Prof. Bernard Amadei***

- Civil Eng. – U. of Colorado
- Engineers W/O Borders

- ***Prof. Abul Hussam***

- Chemistry, George Mason U.
- The SONO Arsenic Filter

- ***Dr. Prakasam Tata***

- Civil Eng. – Bharathi Theertha, Naperville, IL
- Pedda Tank & 24/7 Water Supply and Sanitation Complex

# **Professor Amadei & Vision of Engineers Without Borders**

## **Chance Discussion with His Gardener from Belize**

- Invitation to Visit San Pablo Belize in 2000
- Fact Finding Trip to Belize in 2000
- No running water, electricity or sanitation
- Returned in 2001 with 8 CU Eng. Students
- Built a Clean-water System Powered by Waterfall
- Total cost ~ \$14,000; Pop.~ 600

# The Birth of EWB in 2002

- Inspired by University/Student/Villagers Partnerships
- EWM-USA Created & Incorporated – June 2002.
- Partnering with Communities in 60+ Countries
- Over 500 Projects in 60+ Countries
- 350+ US Chapters on 200+ Campuses
- Chapters Make 5 Year Commitment with Communities



# The NAE Grainger Challenge Prize for 2007 (1)

- **First Time Awarded**
- **The Challenge**
  - *Develop a water treatment system that would lower the arsenic content in groundwater from tube wells in developing countries*

# The NAE Grainger Challenge Prize (2)

## The Criteria –

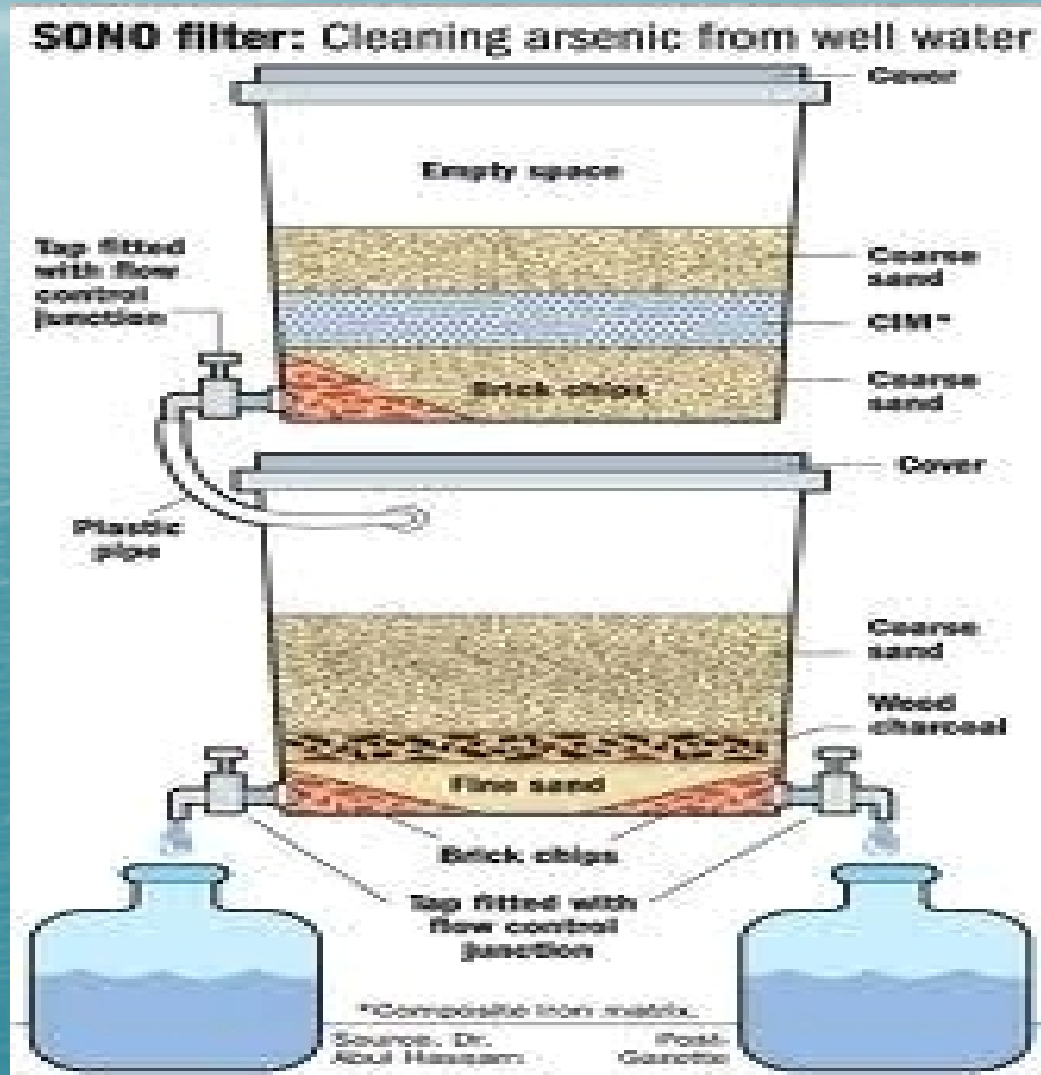
- *Low cost,*
- *Technically robust,*
- *Reliable and maintainable;*
- *Be socially acceptable and affordable;*
- *Be manufacturable and serviceable in a developing country;*
- *And not degrade other water quality characteristics or create a toxic waste disposal hazard.*

# The NAE Grainger Challenge prize (3)

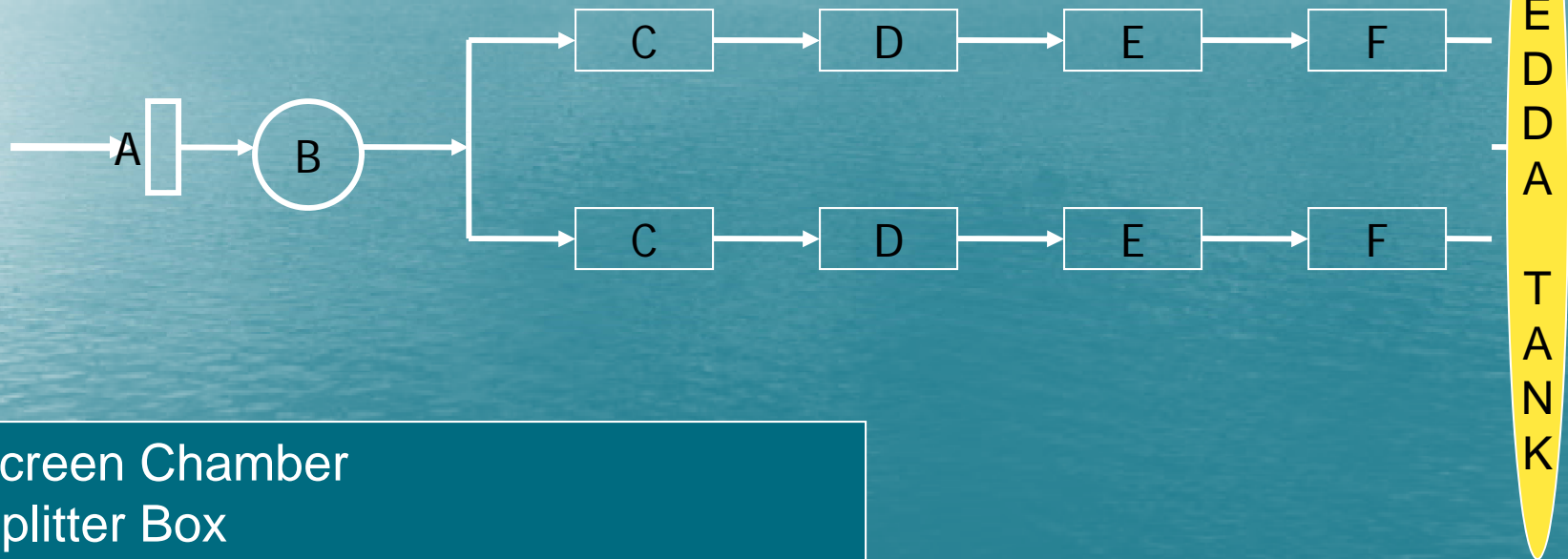
- Prof. **Hussam's The SONO Filter**
- Met the challenge head-on
- Satisfied all the Criteria, plus
- No need for electric power
- Cost \$35-40/ unit
- Capacity  $\sim 20$  L/hour
- Effective working life – 5 yrs.
- \$ 1.0 M & Induction Into NAE



# Sono Filter



# WASTE STABILIZATION POND SYSTEM TO REMEDIATE THE POLLUTION OF PEDDA TANK



A: Screen Chamber  
B: Splitter Box  
C: Deep Facultative Pond  
D: High Rate Algal Pond  
E: Algal Settling Pond  
F: Maturation Pond





# Pedda Tank Wastewater Stabilization Pond





# Full View of the 24/7 Bathroom and Latrine Complex with Park in Duppada Village, Viziananagram, A. P., India



# **The Great Lakes Eight States Compact- Restricts New & Additional Withdrawal**

- **NY, PA, OH, IN, IL, MI, WI, & MN**
- **Ontario & Quebec**
- **More Than 40 Tribes**
- **About 10% of US population**
- **20% of World's Surface Freshwater**
- **95% of US Surface Freshwater**
- **Signed by GWB – 10.3.08.**
- **Great Lakes – St. Lawrence River Basin Water Resources Compact**



# Singapore's Year 2060 Program Plan

**Strategy – Combine High & Low Technology to Eliminate Import of 40% from Malaysia**

- \* Rainwater Harvesting ~ 20%**
  - \*Reclaim Some Ocean Real Estate for Storage**
  - \*Protect 2/3 of Land area for Water Catchment**
  - \*Construct Rainwater Storage basins – Total 20+**
  - \*Blend with Tertiary Effluent & Treat for Potable Use**
- Direct Potable Reuse of NEWater ~ 50%**
- Desalination - 1.0M cum/d by 2060 ~ 30%**
- \* Eliminate Import from Malaysia ~ 00%??**



# **The Take-Aways From This Discussion**

*No Particular Order Of Priority*

**Water Scarcity/Stress is a Serious Issue**

**It is Global in Scope**

**It is Also Area/Region Specific**

**It is Means Driven**

**It is Aggravated by Poverty**

**The Poor Suffers Most**

**Severity is Site Specific**

**Affluent Communities Can Cope**

**Poor Communities are Stuck**

**It is NOT Technology Limited**

# The Poor Suffers Most

- **Sub – Saharan Africa**
- Singapore
- California
- Perth, Sydney – Australia
- Arab States – Dubai, Saudi Arabia
- Israel – Ashkelon - 3 + 2 more in 2013
- Tampa, FL
- San Diego

# Some Strategies to Reduce Scarcity (1)

Not in any Order of Priority

- **Show Me the Money** – Stronger Commitment to the Poor
- Empower the Poor to Fight Scarcity
- Desalination where Financial Resources Permit
- Rainwater Harvesting - Singapore
- Sequential Water use
- Reallocation Where Feasible
- Better Farming Technologies



# Some Strategies to Reduce Scarcity (2)

## Not in any Order of Priority

- Infrastructure Upgrade
- Conservation & Reuse
- Slowing the Population Growth – Says Who??
- Increase Water Storage Capacity
- Develop Better Trans-boundary Agreements
- Sponsoring of Water Development Projects Better
- Small-scale Agricultural Improvements

*Questions ?????*

*Thank you*



