ParyAvaraN ShikshA Evam Jal PhasalIkaraN

i.e.,

Environmental Education And Water Harvesting

Venkappayya R. Desai

Professor; Department of Civil Engg.; Indian Institute of Technology (IIT), Kharagpur, West Bengal, India

Email:- venkapd@civil.iitkgp.ac.in ; venkapd@gmail.com

A:- HOLISTIC ENVIRONMENTAL EDUCATION THROUGH SUSTAINABLE HABITATS

PRESENTATION OUTLINE

- INTRODUCTION
- CASE STUDIES OF RECENT TRENDSETTING SUSTAINABLE HABITATS
  1. 'Sustainable House' in Sydney, Australia
  2. '**R**esource **E**fficient **T**ERI **R**etreat for **E**nvironmental **A**wareness and **T**raining' (RETREAT) in Gual Pahari, Haryana [near New Delhi], India
  3. '**G**reen **B**usiness **C**entre' (GBC) in Hyderabad, Andhra Pradesh, India
- CONCLUDING REMARKSS
- REFERENCES

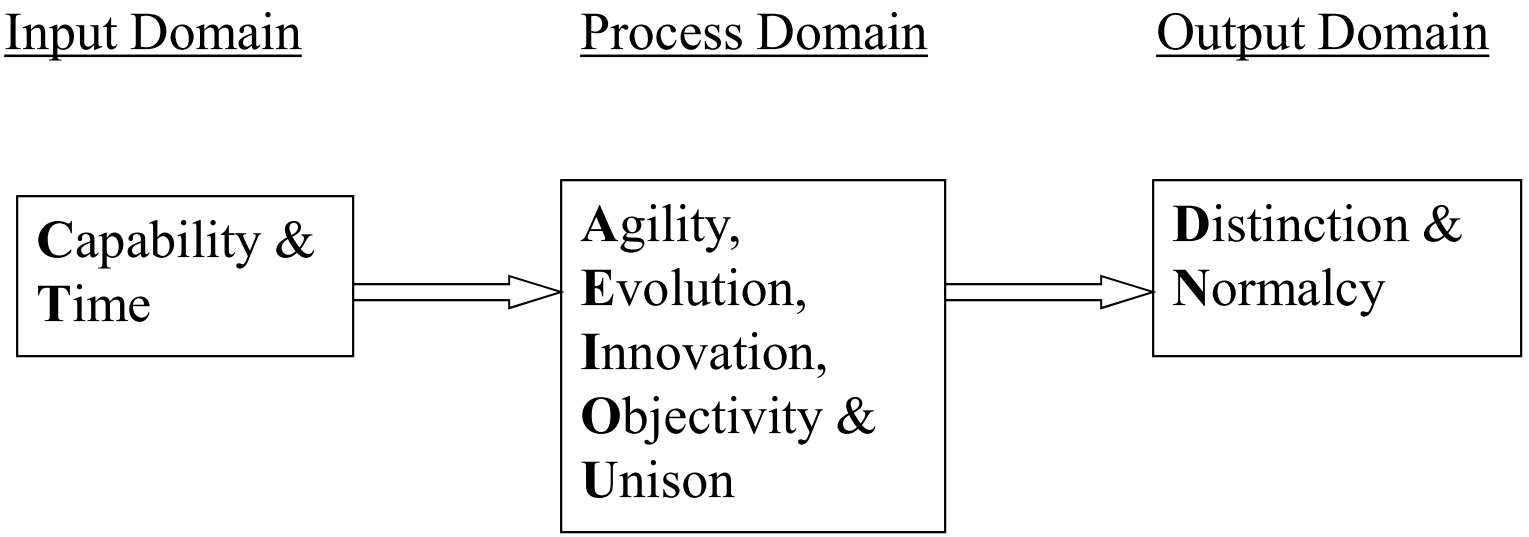


FIGURE 1A. Illustration of the Process of Transformation in Holistic Education (that aims at preparing a society that is aware of and is concerned about the total environment and its associated problems)

CASE STUDIES OF RECENT TRENDSETTING SUSTAINABLE HABITATS ['SUSTAINABLE HOUSE' IN SYDNEY, AUSTRALIA]

A sustainable habitat created after renovating a 100-year old terrace house in CBD of Sidney on a 35 m X 5 m plot area in 1996 with following 3 salient features:

-A **drinking water system** with an underground tank (10 m^3 capacity) getting potable water from rooftop rainwater harvesting (RWH).

-A **wastewater treatment system** with a concrete wastewater tank having three filter beds [Figure 2A] of soil-like medium (sand & peat).

-A **solar power system** having 18 numbers of 120 W solar panels on the rooftop.

‘SUSTAINABLE HOUSE’ IN SYDNEY, AUSTRALIA

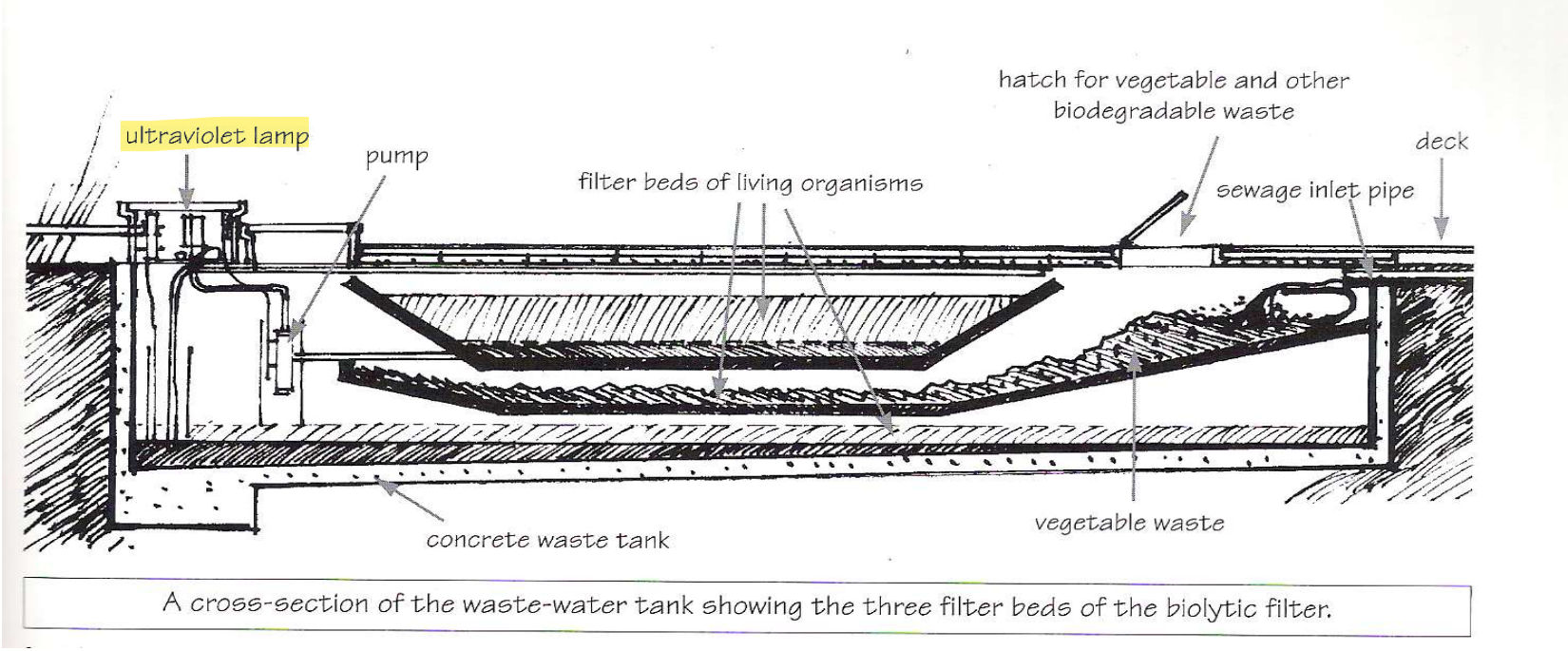


FIGURE 2A. Wastewater Treatment Tank with Filters and Ultraviolet Lamp [Source: Mobbs (1998)]

‘RETREAT’ IN GUAL PAHARI, INDIA

Haryana, 35 kms

- Commissioned in July 2000 by Tata Energy Research Institute (TERI), New Delhi, India.
- Total energy requirement is ~25% of other comparable buildings.
- Covered area of 3000 m^2.
- Cost at 2000 rates [in millions of Indian Rupees (M ₹)] :

  Civil works = 23.60 M ₹;

  Electrical works = 2.50 M ₹ and

  Various technologies = 18.54 M ₹

  Total cost = 44.64 M ₹.

MAJOR TECHNICAL FEATURES OF 'RETREAT' IN INDIA

- Orientation, insulation, and design of the building and the system. Cost of building at 2000 rates in Indian Rupees (₹) = 14,880 INRs/m^2.
- 50kW Gasifier to be run during daytime.
- Earth air tunnel (EAT) for the south block.
- Ammonia absorption chillers for the north block.
- 10 kW solar photo voltaic (PV) cells store energy (55kWH/d in summer) in batteries during daytime.
- 2000 liters per day (lpd) solar hot water system.
- A reduced lighting load of 9 kW as compared to a minimum of 28 kW.
- Wastewater management system by root zone treatment.
- Building Management System (BMS) to monitor building parameters.

WASTEWATER MANAGEMENT SYSTEM BY ROOT ZONE TREATMENT IN 'RETREAT', INDIA

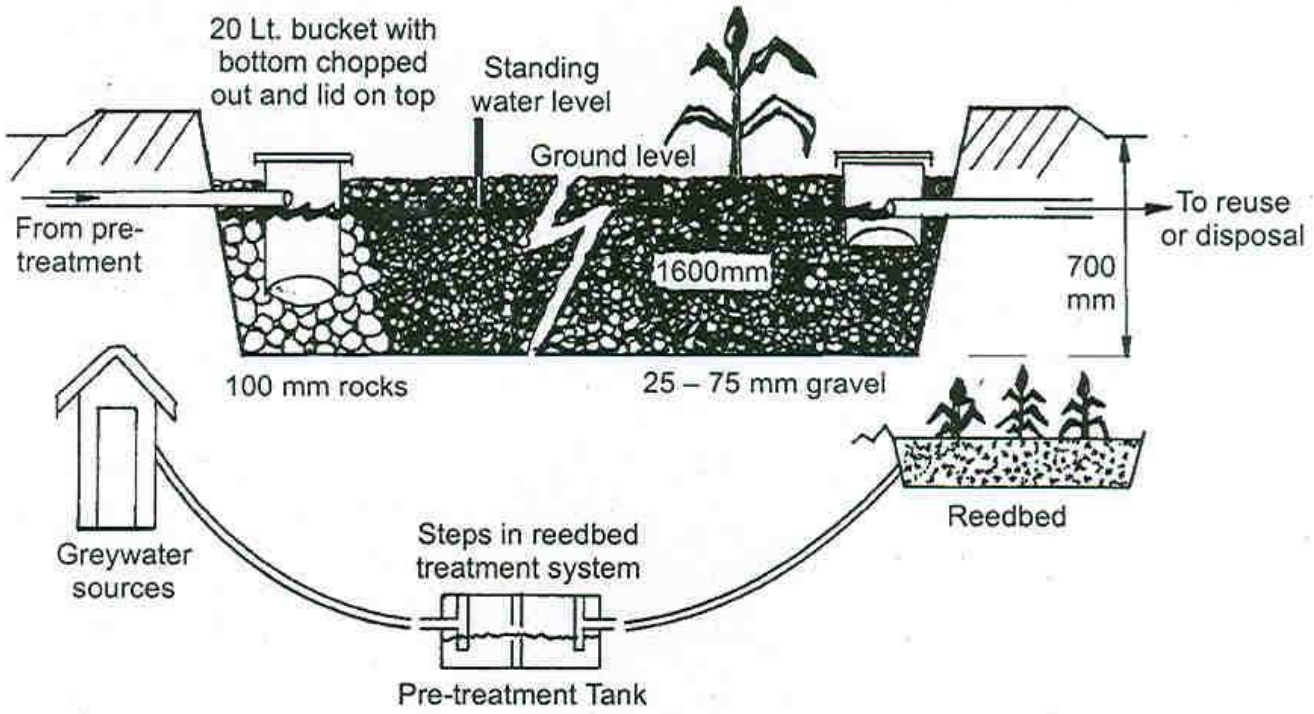
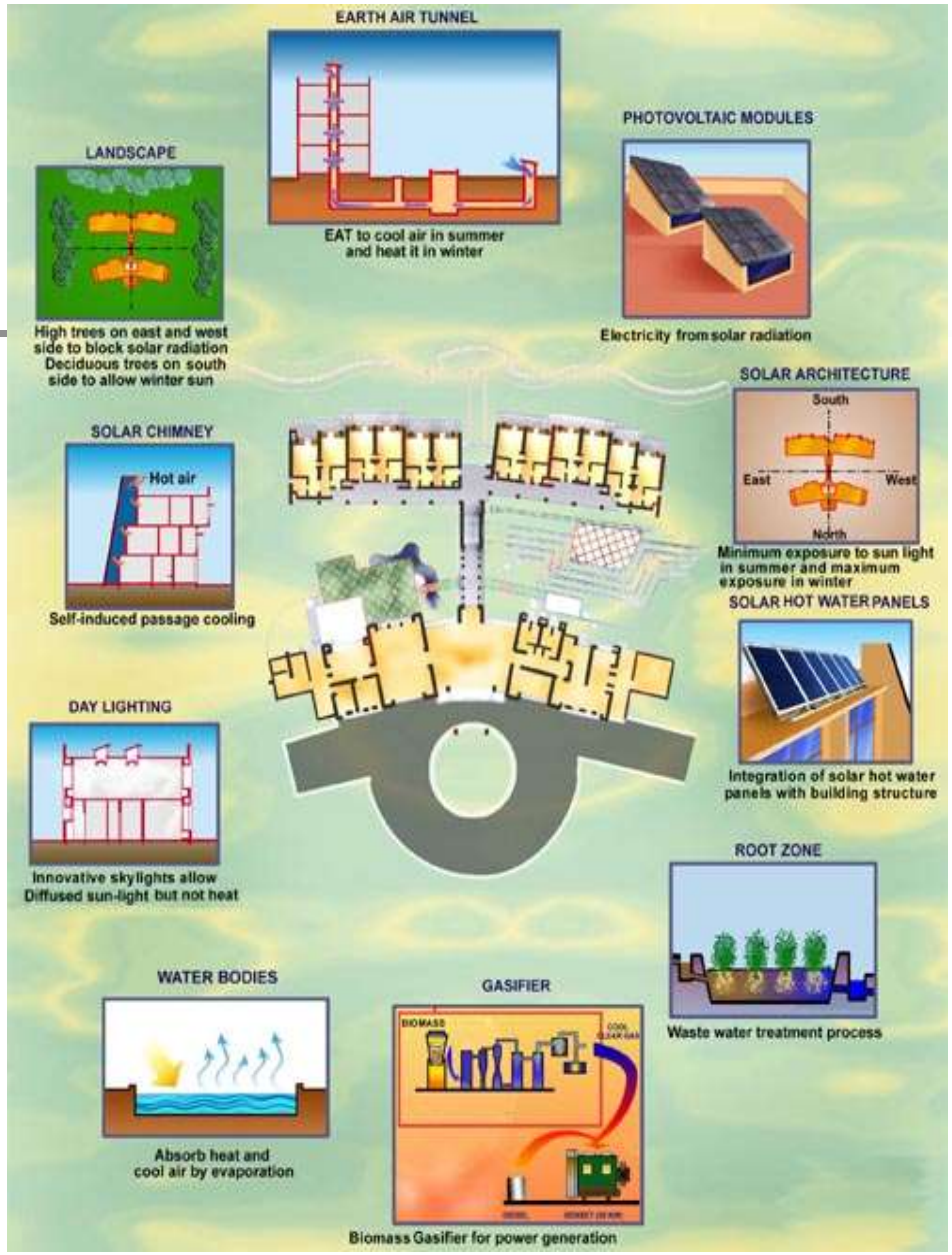
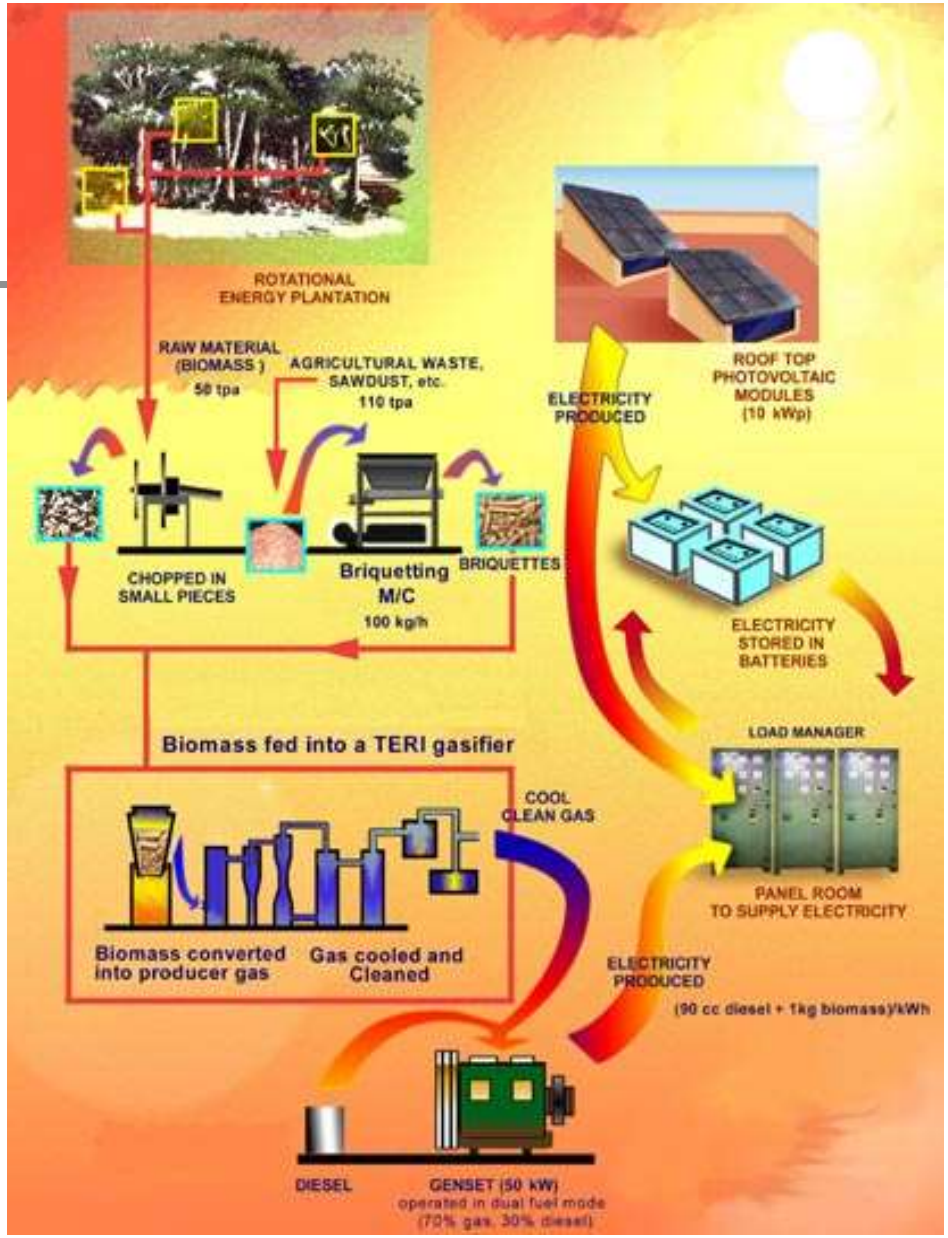


FIGURE 3A. Profile of a Reed Bed for Domestic Wastewater Treatment Locally [Source: Ghosh and Desai, 2006]

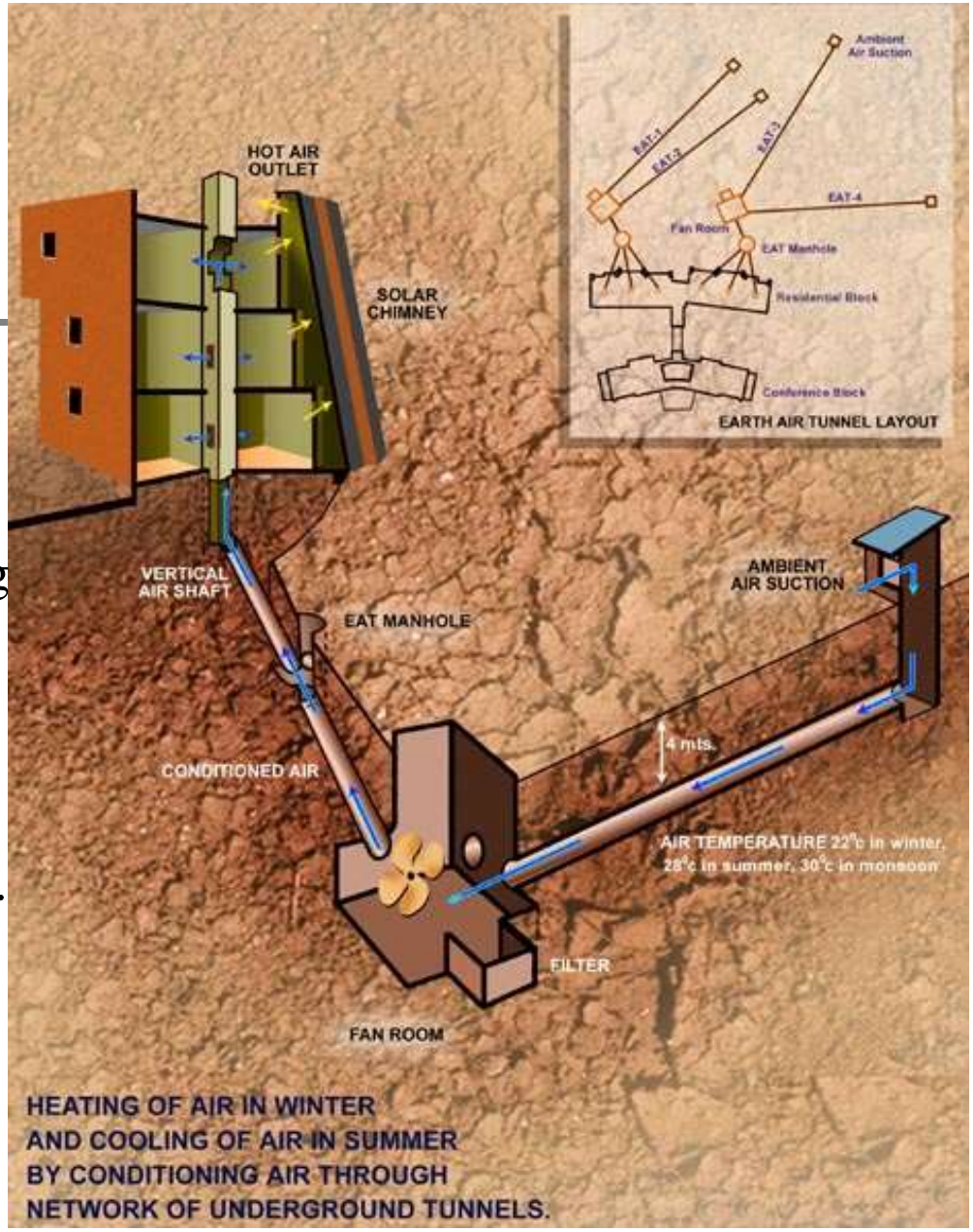
Schematic representation of the salient technical features of RETREAT, Gual Pahari, India [Source: http://www.teriin.org/retreat/tech.htm]



Schematic of photovoltaic, gasifier hybrid electricity generation system in RETREAT, Gual Pahari, India [Source: http://www.teriin.org/retreat/tech.htm]



Passive space conditioning (i. e., sustainable air conditioning) in RETREAT, Gual Pahari, India; [Source: http://www.teriin.org/retreat/tech.htm]



‘GREEN BUSINESS CENTRE’ (GBC) IN HYDERABAD, INDIA

- GBC- an example of the best coordination between a provincial government, a national level organization & an international agency.
- the first Leadership in Energy and Environmental Design (LEED) 2.0 Platinum rating for the GBC by LEED’s design certification team (which awarded 57 out of 69 points) in November 2003.
- LEED had to upgrade its standards to LEED 2.0 Platinum version, so as to be able to rate the GBC.

TECHNICAL FEATURES OF 'GREEN BUSINESS CENTRE' (GBC) IN HYDERABAD, INDIA

- Due to 100% wastewater recycling, GBC has zero wastewater discharge.
- There is a 55% reduction in energy consumption as compared to similar buildings because of 100% Day lighting and eco-friendly air conditioning (AC) plant.
- 20% of the power is generated through solar photovoltaic (PV) cells.
- A roof garden covering 60% of the roof area wherein 60% of the wastewater is recycled.
- No toxic paint or sealant has been used.
- Carpets with low volatile organic compound (VOC) have been used.
- a wind tower to supply naturally conditioned air from an optimum depth below the ground.

A TYPICAL VIEW OF THE GREEN BUSINESS CENTRE (GBC), HYDERABAD, INDIA

A. CONCLUDING REMARKS

- Green buildings are feasible & economically viable.
- An ancient nation like India or a modern nation like Australia are quite capable of setting new global environmental standards.
- In most of the temples of Lord Shiva (the Hindu god of potential and destruction), the deity is located at some depth below the ground possibly for sustainable air-conditioning through out the year in a tropical setting.
- Promotion & practice of sustainable technologies can reaffirm our commitment for holistic environmental education.
- When sustainable habitats gain a general acceptability among the public, they become more typical than being simply prototypical.

A. REFERENCES

- <http://www.ozemail.com.au/~mmobbs/ >. 1998.
- <http://www.sustainablebusiness.com/features/feature_template.cfm?ID=1144>. 2004.
- <http://www.teriin.org/retreat/tech.htm>. 2000.
- <http://www.youhelpindia.org/index.html> .2001-'02.
- Centre for Science and Environment (CSE). 2000. *Our Ecological Footprint*, CSE, New Delhi, India
- Ghosh, S. N. and V. R. Desai. 2006. *Environmental Hydrology and Hydraulics*, Science Publishers, Enfield, New Hampshire, USA
- Malick, P. 2004. *Environment Management Initiatives of CII-Godrej GBC*, Environmental and Recycling Council, CII-Godrej GBC, Hyderabad, India
- Mobbs, M. 1998. *Sustainable House*, Choice Books, Marrickville, Australia
- Tata Energy Research Institute (TERI). 2004. Representative Designs of Energy -Efficient Buildings in India, Ministry of Non-conventional Energy Sources, Government of India, New Delhi, India.

B:- SCIENTIFIC PROMOTION OF WATER HARVESTING THROUGH RAINWATER QUALITY ANALYSIS

INTRODUCTION

- Water is essential for plant &/or animal &/or human life. Mankind has a preference for rainwater over river water and for river water over groundwater & ideally, all three should have same acceptable water quality standards. Such water can be used as potable water, if it meets World Health Organization standards [WHO (2008)].
- The daily potable water requirement for human beings is 10 liters per capita per day (i.e., lpcd); it can be easily met by water harvesting (WH) at house level [CSE (2000)].
- Still many parts of the developing world / India, face potable water scarcity. This has resulted in many undesirable consequences like excessive school drop-out children, severe health related issues among women / children, reduction in the family income due inadequate working hours etc.
- Unfortunately, these problems are continuing in India in spite of the following facts:

✓ There are many evidences in AyurvEda & other traditional knowledge systems vouching on purity of properly collected rainwater.
✓ India has a strong tradition of region-specific WH, which is as old as the Indus Valley Civilization [Agarwal and Narain (Ed.) (1997].
✓ The normal annual pptn. of 1150 mm in India > corresponding values for all the continents except that of S. America {1596 mm} [CSE (1987)] & the global avg. of 857 mm [Chow (Ed.) (1964)].

This study aims at scientifically promoting WH in India / world through compiling the rainwater / water quality related documents obtained from various ancient texts & also from modern literature, in support of WH. It also presents results of a rainwater sample collection / quality analysis after 6 wks.

MATERIALS AND METHODS

- AyurvEda recommends rainwater devoid of impurities, microbes as potable water. This is called "*GangAmbu*". It can serve as drinking water. Rainwater must also be free from heavy metals, suspended particles and pathogens.
- Such potable rainwater is healthy, refreshing, cools body, increases alertness and satiates our taste buds. All these properties of *GangAmbu* are narrated in the following Sanskrit *slOka*:

"*JIvanam tarpaNam hridyam hlAdih buddhih prabodhanam* |
tanvavyakta rasam mruSHTam shItam laghu amrita upamam||"

- Water in acid rains is unpotable. In AyurvEda there is an emphasis on rainwater purity analysis. Water contaminated with mud, weeds, algae & microbes is referred to as "d*uSHTa jala*" which should be discarded [Suri (2008)].
- *YajurvEda*, describes the benevolence of water as follows:

"*ApO hi SHThA mayO bhuvah ….*"

-which means pure water can transform this universe into a comfort zone. Similarly in the following *slOka of atharva vEda*, an ideal situation is stated that let the rivers carry pristine rainwater & let there be abundance of vegetation:

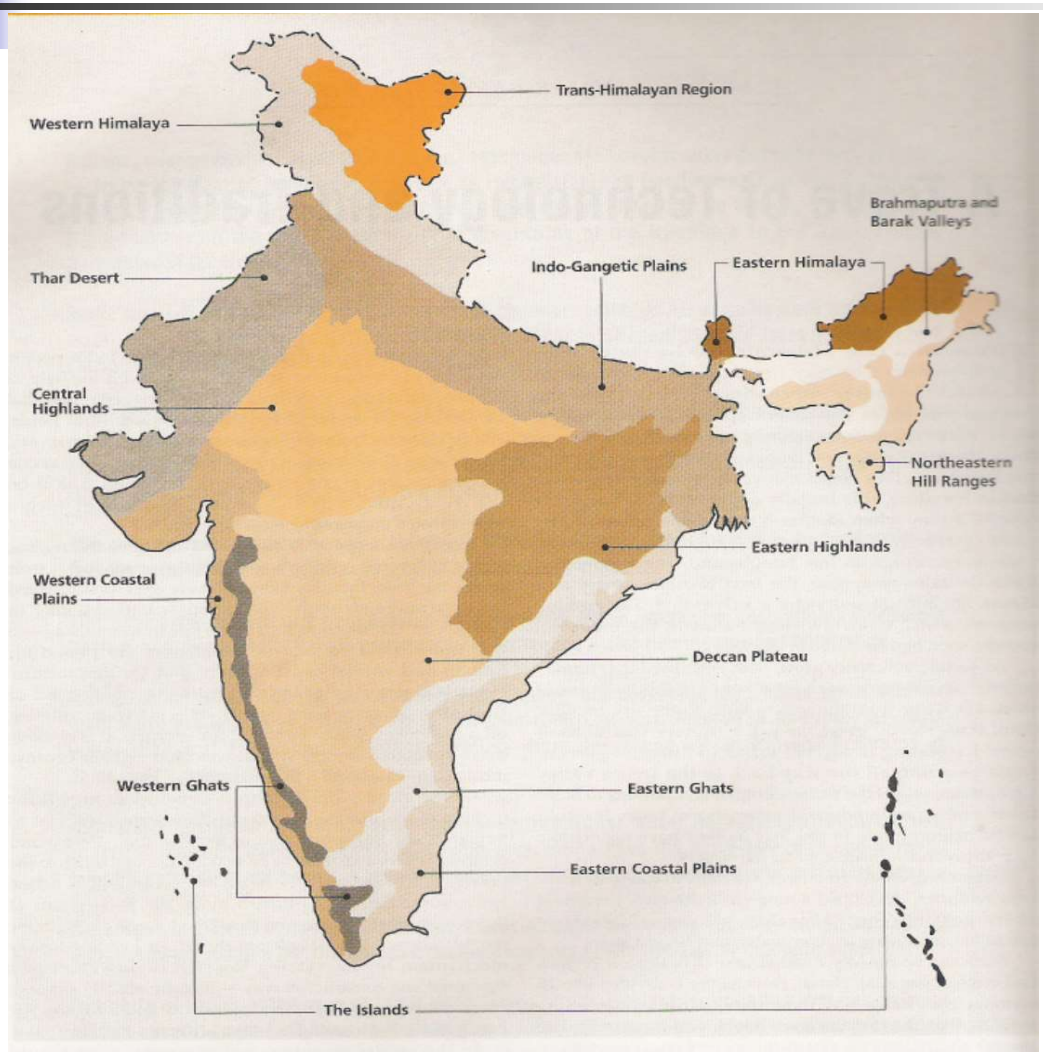
"*Yantu nadayO varshantu parjanyAh supippalA OshadhayO bhavantu……*" .

- There is a custom of smelling water before offering *arghyam* to the Sun God [along with chanting of *GAyatrI Mantra]* in *SandhyA vandan* –a Hindu daily ritual of *SandhyA Vandan*. There is another custom of maintaining general hygiene in the area where *PUja* is planned by sprinkling clean water & chanting the Mantra

'*SarvE sthaLAni shuchinO bhavantu*'.

- These examples emphasize the importance of water quality, general cleanliness in India. This Indian tradition of promoting pure rainwater / river water / groundwater led to the development of WH traditions specific to each of the ecological regions of India, shown below:

Fig 1B. Ecological regions of India [Source: Agarwal & Narain ('97)].



MATERIALS AND METHODS [Cont'd.]

- The arsenic / fluoride problems in groundwater (GW) [pumped out from deeper confined aquifers, not getting adequate natural &/ or artificial GW recharge on an annual basis.
- On the other hand, there are at least two best management practices (BMPs) adopted in Western Rajasthan, India [normal annual rainfall ~ 100 mm], using traditional technology(ies) and in the Negev Desert, Israel [normal annual rainfall ~ 105 mm using the modern technology(ies) [Agarwal et al. (2001); Schwarz et al (2000)].
- Adopting such BMPs can ensure a sustainable freshwater supply, in spite of low/ deficient rainfall. These facts need to be utilized to scientifically promote water harvesting globally & in India.
- To achieve this, rooftop rainwater sample was collected in Noida, UP, India, in 2001. After filtration through two layers of thick cotton clothes, rainwater was stored in a stainless steel container & was treated with alum. The relatively clear rainwater sample was taken in 1- liter PET (i.e., Poly ethylene Terephthalate) bottles.
- Its quality analysis was done in the Environmental Engineering Laboratory, Civil Enginering Department, IIT Delhi, after ~6 wks. The following paragraphs describe the results of this analysis.

MATERIALS AND METHODS [Cont'd.]

- As communities shifted from decentralized to centralized municipal water supply systems [involving long distance transport of water through pipelines / canals in 19th Century], these time tested WH traditions became the first casualties.
- On one hand, these centralized municipal water supply systems ensured easy water availability, many villages/ communities were left with inadequate backup plan, in case of failure of the centralized systems.
- These centralized systems have resulted in responsibility shifting from individuals at village/ community level to local self governments. As a result, people have taken freshwater availability for granted leading to a tendency of excessive water use &/ or wastage of municipal water supplied.
- Additionally, centralized municipal wastewater systems were also introduced. These systems are generally having an uncontrolled release of untreated / partially treated wastewater into the rivers / other water bodies, in many villages / towns / cities in India / many parts of developing world has severely affected the water quality resulting it contaminated river water, which is unfit for drinking/ other uses.
- Many other villages/ communities have adopted other unsustainable means such as overexploitation of GW. This has led to many problems like arsenic or fluoride contamination and their associated health problems as shown in Figure 2B and Fig. 3B [Jamwal and Manisha (2003)].
- Villages/ communities, who have judiciously stored the rainwater &/ or have substantially prevented water quality degradation in nearby rivers / water bodies, have ensured a sustainable freshwater supply through rainwater / river water / lake water/ pond water.

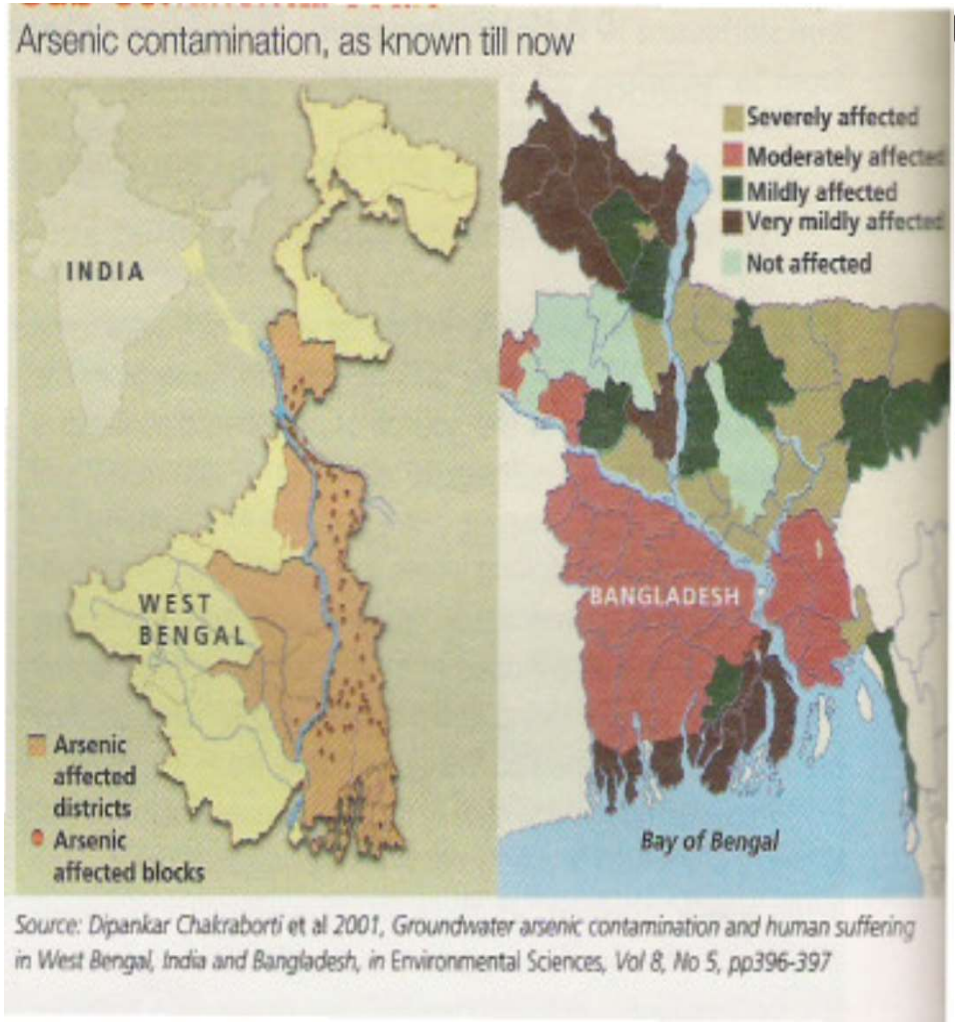


FIGURE 2B. Arsenic affected areas in West Bengal, India and Bangladesh in 2001.

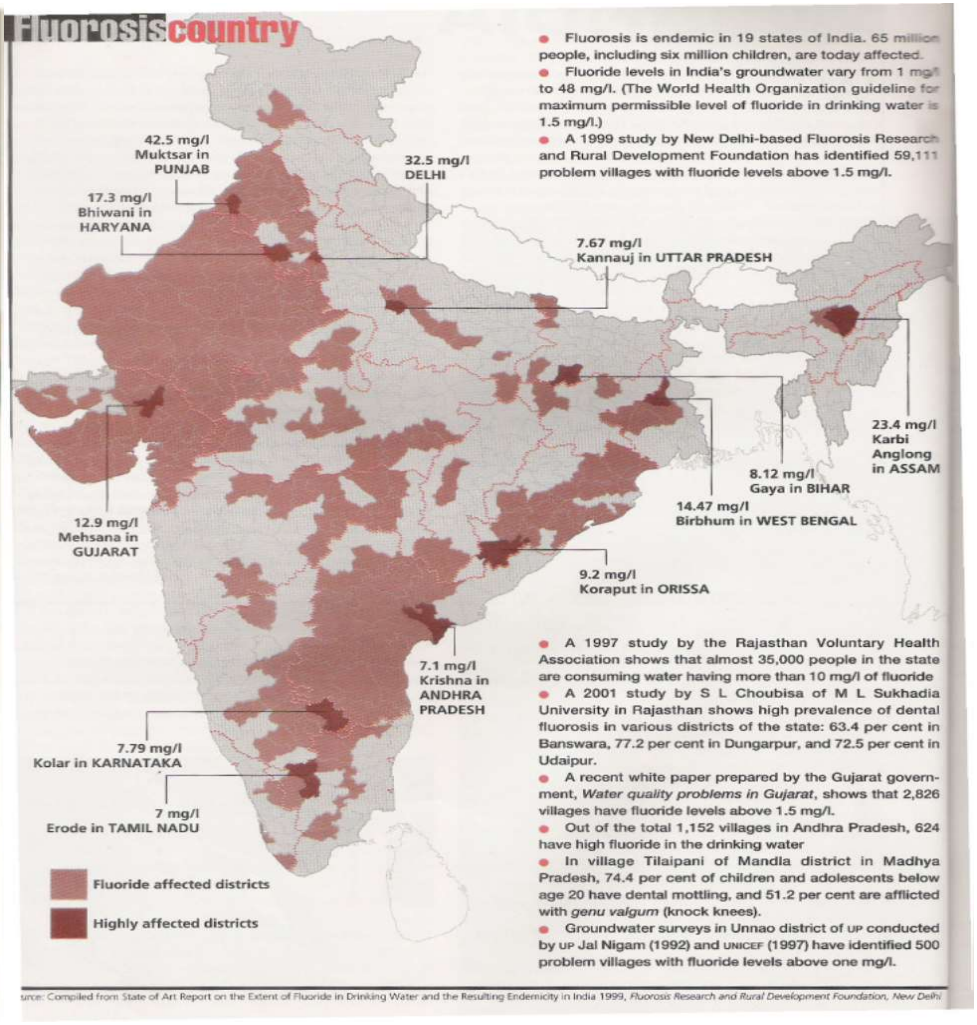


FIGURE 3B. Fluoride affected areas in India in 1999.

B. RESULTS AND DISCUSSION

- Rainwater collection: on June 30, 2001 by Dr. V.R.Desai, presently Associate Professor, Department of Civil Engineering, IIT Kharagpur (on leave at RM Software India Ltd., Noida, Uttar Pradesh, India during 2001-‘02).
- Rainwater sample analysis: during the 3rd week, Aug. 2001 in Environmental Engg. Laboratory of IIT, Delhi by Prof. B J Alappat, Department of Civil Engineering, IIT, Delhi.
- The results of the rainwater quality analysis are presented in Table No. 1B below. These results are very much in agreement with the findings of Gould (1999).
- In this connection, an earnest desire of Sri. Vishwanath –an activist from the Rainwater Club, Bangalore, Karnataka, India, for propagating rainwater harvesting (RWH) through 4 minutes television commercials similar to the propagation of the ‘Pulse Polio Programme’ is worth mentioning here [Padre (2004)].

TABLE 1B. Rainwater Quality Analysis Results

Sl.No.	Parameter	Results (mg/l)	Iindian Standards (IS) Limit Desirable (mg/l)	IS Limits Permissible (mg/l)
1.	pH	***7.16***	6.5-8.5	No relaxation
2.	Colour	***Colourless***	5 Hazen Units	25 H.Units
3.	Taste	***Agreeable***	Agreeable	-
4.	Odour	***Absent***	Unobjectionable	-
5.	Turbidity	***0.5 NTU***	5 NTU	10 NTU
6.	TDS	***417***	500	2000
7.	Total Hardness	***210***	300	600
8.	Chlorides	***110***	250	1000
9.	Residual Free Chlorine	***Absent***	0.2	-
10.	Sulphate	***47***	200	400
11.	Alkalinity	***52***	200	600
12.	Oil & grease	***Absent***	0.01	0.03
13.	Calcium	-	75	200
14.	Iron	-	0.3	1.0
15.	Nitrate	***3.0***	45	100
16.	Fluoride	-	1.0	1.5
17.	Cyanide	***Absent***	0.05	No relaxation
18.	M.P.N.	***Negative***	10	No relaxation
19.	B.Coli	***Negative***	0	0

B. CONCLUDING REMARKS

- India is blessed with a rich traditional knowledge base on water harvesting (WR) techniques.
- This traditional knowledge should be combined with the modern best management practices (BMPs) related to water through scientific promotion of rainwater harvesting (RWH).
- Such fine blend(s) can provide lasting solutions to quantity as well as quality related water problems in remote communities, towns as well as busy metropolitan cities in India as well as in many developing countries.
- RWH is becoming more relevant now with the manifestation of water resources related impacts of climate change, which have led to an increase in the rainfall intensity leading to an increased frequency of floods and droughts.
- Proper storage of even small quantities of flood waters can overcome the drinking water problems both during the floods and droughts.

B. REFERENCES

- Agarwal, A. and Narain, S., (1997), Dying Wisdom, State of India's Environment- A Citizens' Report 4, Centre for Science and Environment (CSE), New Delhi, India
- Agarwal, A., Narain, S. and Khurana, I., (2001), Making Water Everybody's Business, Practice And Policy of Water Harvesting, Centre for Science and Environment (CSE), New Delhi, India
- BIS, (1993), Drinking Water Specifications: IS 10500, 1992, Reaffirmed in 1993, Bureau of Indian Standards (BIS), New Delhi, India
- Chow, V. T. (Ed.), (1964), Handbook of Applied Hydrology, McGraw Hill Book Co., New York, NY, USA
- CSE, (1987), The Wrath of Nature- The Impact Of Environmental Destruction On Floods And Droughts, An unpublished presentation by CSE to the Parliament of India, New Delhi, India
- CSE, (2000), A Water Harvesting Manual for Urban Areas, Case Studies from Delhi, Centre for Science and Environment, New Delhi, India
- Gould, J., (1999), Is rainwater safe to drink? A review of recent findings, In: The Proceedings of the 9th International Conference on Rainwater Catchment systems, Petrolina, Brazil
- Jamwal, N. and Manisha, D. B., (2003), The dark zone, Pumping out poison, Down to Earth, 11(22), 27-41, Society for Environmental Communications, New Delhi, India
- Padre, S., (2004), Here are the Solutions for Water Problems [In KannaDa], Margadarshi Publishers, Mangalore, Karnataka, India
- Schwarz, J., Gablinger, M. and Shalev, Z., (2000), Management and development of integrated water resources (Rajasthani and Israeli experience, Addendum to the Proc. Eighth National Water Convention, Udhagamandalam (Ooty), Tamil Nadu, India
- Suri, S., (2008), Water- the elixir of life, in http://www.ayurhelp.com/articles/water-health_benifits.htm
- WHO, (2008), Guidelines for Drinking-water Quality, 3rd Edition incorporating the 1st & 2nd Addenda, World Health Organization (WHO), Rome, Italy.

B. ACKNOWLEDGEMENT

The assistance provided in the analysis of rainwater quality by Prof B J Alappat, Civil Engineering Department, IIT Delhi, is sincerely acknowledged.
