A note on the presentation made by Dr. SPS Rawat on the occasion of World Environment Day on 06-06-2019 at New Delhi

Green Lungs of the Cities: Role of Urban Forestry

The urban areas in both developing and developed countries are emerging as a major form of human settlement. India is experiencing a massive trend towards urbanization. Such rapid urbanization led to massive unplanned geographical expansion of cities which ultimately led to the destruction of natural ecosystem and increase the gap between people and environment. Urban green or urban forestry is one of the prime ways to bridge the gap between city dwellers and environment in one hand and sustainable development in other. The biggest challenge for urban development is not only to ensure urban green but also to maintain the existing green cover.

In India, the forests contain 7083 million tonnes of carbon in living forest biomass, making it easy to envision exactly how forests serve as the "green lung" of the country and of the world. Trees, grasses and other vegetation are part of the city's infrastructure , woven into a complex network of shopping malls, power lines, roads, sewer lines etc. that together help to sustain human health and quality of life.

Trees purify the polluted air by absorbing large amount pollutants like carbon dioxide, sulphur dioxide by their leaves and releasing oxygen. Trees produce a healthy urban environment by providing clean air, water and soil. Broad leaves trapped aerosols and small particles and acts as dust filters. Tree covers absorb rain water and allow the drained water to percolate into the soil thus maintaining ground water table and reduces runoff. Based on various environmental benefits and services derived from a tree during its lifespan of 50 years, intrinsic value of a tree at the market rate that prevailed in 2012 was estimated to be Rs. 3,55,13,000.

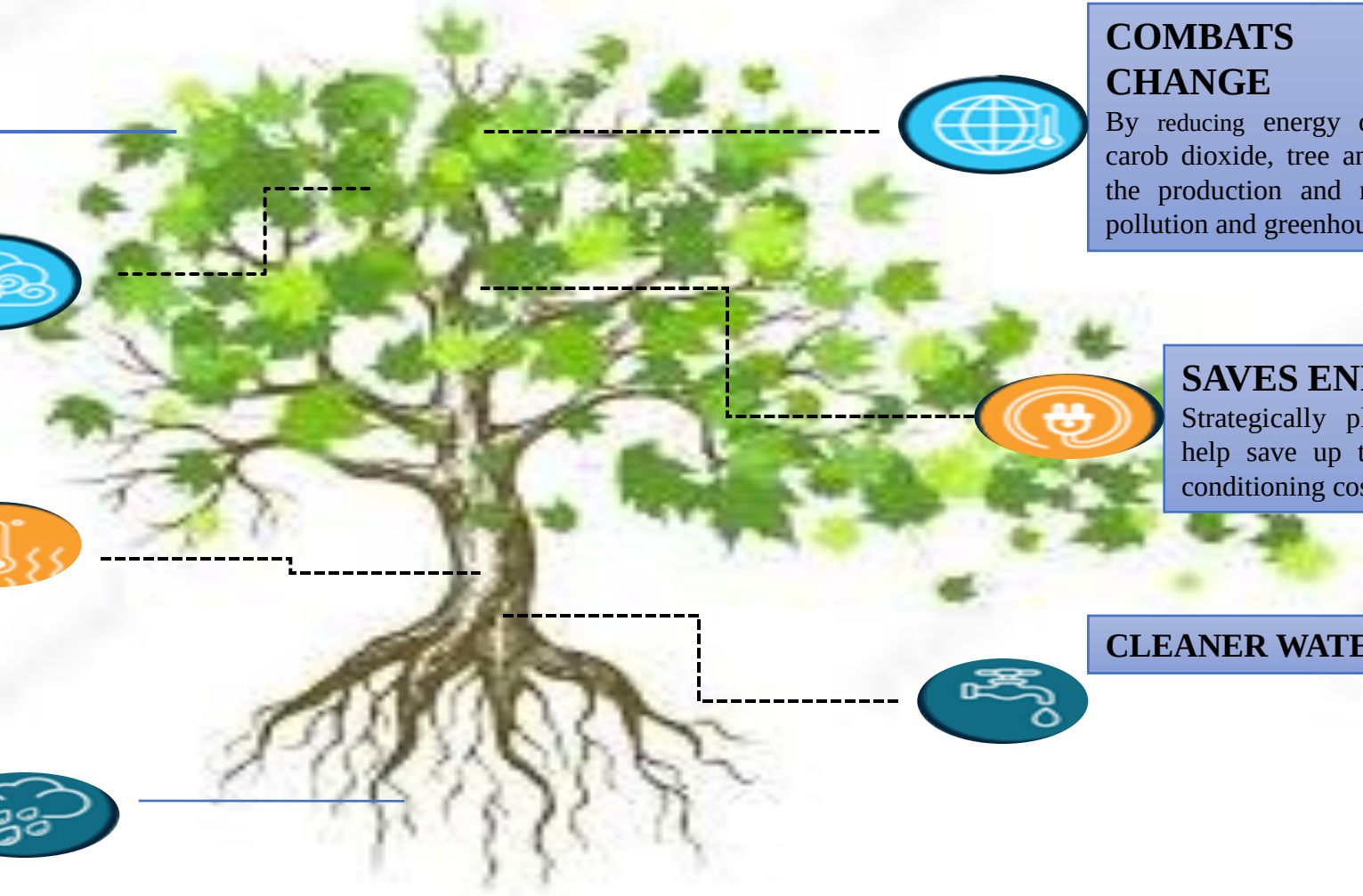
Many Indian ventures are coming up with the concept of vertical forests in the pillars of flyovers to cleanse the Indian capital and other cities of its air pollution. Vertical Forests reduces urban heat island effect and smog, cleans outside air of pollutants and dust and offsets the carbon footprint of people and fuel emissions.

Keeping in view of its enormous significance of urban forestry from the point of views of economic, social and ecological, Indian Council of Forestry Research and Education has also taken many steps in the direction of forestry interventions. Health assessment of the trees of Rashtrapati Bhavan was carried out and trees in bad shape were recommended for removal and replacement with tall saplings. The Maintenance of important trees were carried out like holy Bodhi tree at Bodhgaya, holy trees at Smriti Park, Patna and holy Pipal tree at Koteshwarnath Dham, Belaganj were regularly monitored for pathological, physiological and entomological problems and treatments were administered. Urban Forestry models for Technology (IITJ), Jodhpur, Rajasthan, Indian Institute of Management (IIM) Udaipur and New Campus of Rajasthan High court, Jodhpur were developed and inventorization and replacement plan for trees planted by New Delhi Municipal Council (NDMC) have been executed by ICFRE. Also studies on the biomonitoring of air pollutants and on the effect of elevated carbon dioxide on growth of forestry species were also made by Forest Research Institute, Dehradun. Some future research directions will be indicated.

The lungs of Cities: The Role of Urban Forestry

SPS Rawat, ICFRE

TREE OFFER MANY BENEFITS….



CLEANER AIR
tree remove carbon dioxide and other air pollutants

COMBATS CLIMATE CHANGE
By reducing energy demand and absorbing carob dioxide, tree and vegetation decreased the production and negative effects of air pollution and greenhouse gas emissions.

SAVES ENERGY
Strategically placed shade trees can help save up to 56% on annual air-conditioning costs.

REDUCES URBAN HEAT ISLAND EFFECT
Shaded surfaces may be 7 degres cooler than the peak temperatures of unshaded materials.

CLEANER WATER

CAPTURES RAINWATER
One hundred mature trees can capture and store about 139.000 gallons of rainwater per years.

INCREASES BUSINESS
Shoppers will spend 9% to 12% more for goods and services in business districts having high quality tree canopy

GREEN ECONOMY
urban forestry prvoide jobs

IMPROVES PUBLIC HEALTH
People living in polluted urban areas are far less likely to be admitted to hospital with asthma when there are lots of trees in their neighborhood.

IMPROVES MENTAL HEALTH
People living in neighborhoods with less than 10 percent tree canopy are much more likely to report symptoms of depression, stress and anxiety

The valuation of environmental and social benefits derived from a tree during 50 years of growth in 1979 and in 2011 (Ref. Indian Biologist,vol 12, 2012)

	During 50 years of growth	Original (1979)	Revised (2011)
1.	**Production of oxygen**	**Rs. 2,50,000**	**Rs. 5,25,000**
2.	**Conversion to animal flesh & bones**	Rs. 20,000	Rs. 1,50,000
3.	**Controlling of soil erosion & soil fertility**	Rs. 2,50,000	Rs. 5,00,000
4.	**Recycling of water and controlling humidity and Air temperature**	Rs. 3,00,000	Rs. 77,28,000
5.	**Sheltering of birds, squirrels & insects**	Rs. 2,50,000	Rs. 64,85,000
6.	**Removal of SPM, CO_2, SO_2 from air**	Rs. 5,00,000	Rs.2,01,25,000
	Grand Total	**Rs. 15,70,000**	**Rs. 3,55,13,000**

Some interesting numbers

- Forest Ecosystem – about 70-90% of land phytosphere carbon

determining role in the generation of atmospheric oxygen

- land phytosphere produces ~ 155 Gt O_2 (135 Gt biochemical processing including 5 Gt for animal and human breathing)
- Ocean flora production 80 Gt (78 Gt for biochemical processes in aquatic medium)
- HENCE state of flora determines the resource of survival of modern civilization
- FOREST – the most effective producer of the resource and environment forming functions with a considerable degree of their accumulation
- Ref. Mikhailov et. al. High Energy Chemistry, 2008, vol.42, no. 8 pp. 251-254
- Each technogeneic megapolis must have the regional ***oxygen phytofactory*** of its own
- Forest area that compensates for its oxygen demand

Urban Forestry: Importance

- ***a massive trend towards urbanization in INDIA 31.16% of the country's population in urban areas***
- ***massive unplanned geographical expansion of cities which ultimately led to the destruction of natural ecosystem***
- ***Urban green or urban forestry -one of the prime ways to bridge the gap between city dwellers and environment in one hand and sustainable development in other***

Urban Forestry Some examples

Bangalore

Greater Noida

Chandigarh

Gandhinagar

Vertical Forests: A new Concept in Urban Forestry

- Vertical Forests recently developed idea for increasing urban green cover
- Vertical Forests reduces urban heat island effect and smog, cleans outside air of pollutants and dust and offsets the carbon footprint of people and fuel emissions

A vertical Forest on Hosur Road , Bangalore

A vertical garden set up by Delhi Metro

A vertical Forest set up by Delhi Metro

Greening under a flyover in Noida

Steps taken by ICFRE and its Institutes in the field of Urban Forestry

- Health assessment of the trees of Rashtrapati Bhavan.
- The older trees of the presidential estate identified and their age assessed. Dalbergia sissoo located at Bal Vatika the oldest tree having the estimated age of 225 years.
- Two trees species Manilkara hexandra (Khirni) and Pongamia pinnata (Papri) recommended to be replaced. The trees in bad shape recommended for removal and replacement with tall saplings.
- Monitoring for pathological, physiological and entomological problems and Maintenance of important trees like holy Bodhi tree at Bodhgaya, holy trees at Smriti Park, Patna and holy Pipal tree at Koteshwarnath Dham, Belaganj.

An old tree of shisham (*Dalbergia sissoo) was* o b s e r v e d s h o w i n g expansion of crown for about 50 m and its girth at breastheight was 3.75 m. one of the oldest trees in the President
Estate.

Dying *Manilkara hexandra (Khirni) trees along Radhakrishnan Veethi*

Heart rot in *Ficus microcarpa* at Rashtrapati Bhavan

Prop support to large branches of holy Bodhi tree

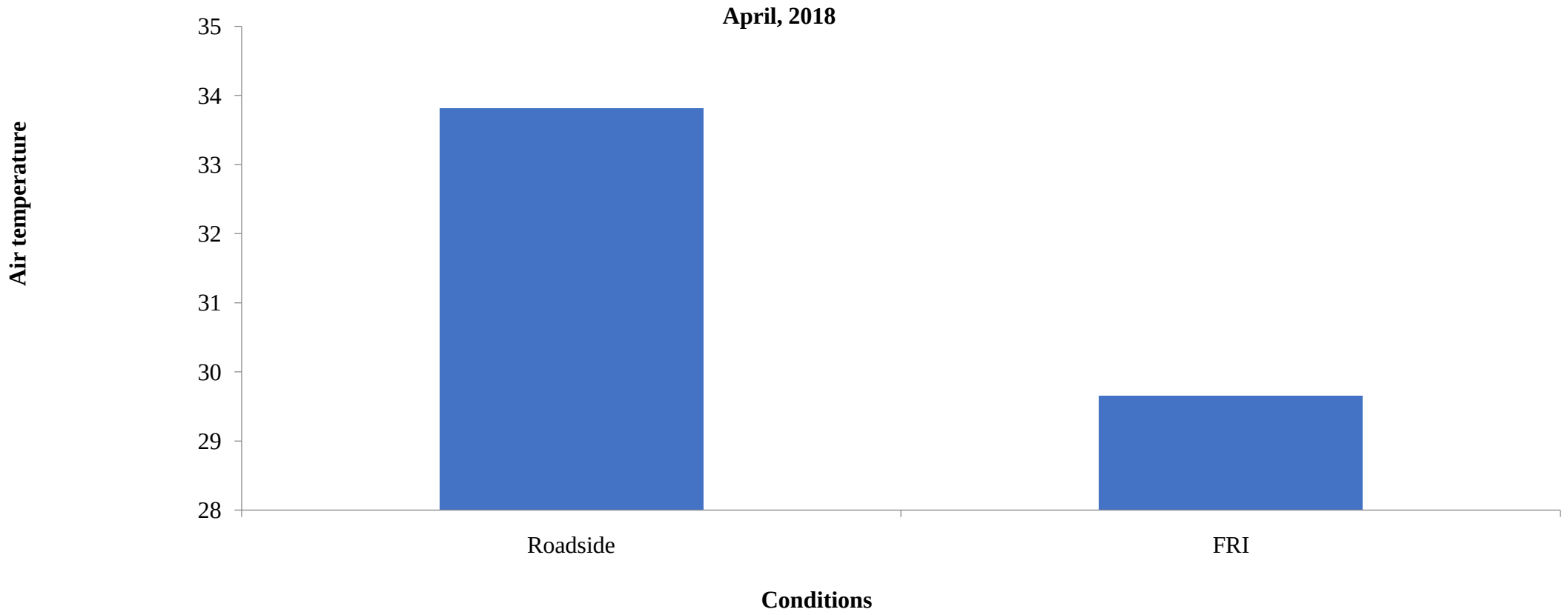
Vegetational Survey and Inventorisation of Species in the Ridge Forest of Delhi

- Ridge - Green patch – Breathing Lung or Green Lung
- Composition and structure of forest vegetation and its regeneration
- Pollution resistant species of Delhi Ridge
- Medicinal plants of Delhi

Inventorization and replacement plan for trees planted by New Delhi Municipal Council (NDMC).

- Inventorization of roadside plantations, diseased trees, identification of causative organism of disease, suggest control measures, demonstration of disease control, preparation of replacement plan for old and diseased trees, technical guidance and supervision in setting up of Herbal medicinal garden, identification and listing of trees in Lodhi garden, Talkatora garden, and identification of diseased trees, causative organism and suggestions of control measures in these gardens.
- Trainings conducted for the officials of NDMC at FRI to demonstrate disease control techniques.

Air temperature at roadside and FRI campus conditions of Dehradun



Development of Urban Forestry model for Indian Institute of Technology (IITJ), Jodhpur, Rajasthan

- a model shelterbelt plantation for urban forestry
- the bio- remediation effect of shelterbelt plantation on soil properties and
- increase in carbon stock of a land with low productivity
- plantation of trees and flowering shrubs in a stretch of 5000 m along roads and the institute boundary

PLANTATION ALONG BOUNDARY

Plantation of Neem seedling

Irrigated seedlings after plantation

Neem and Tecoma at the site

Nerium in flowering

Development and Performance of Urban Forestry Model for New Campus of Rajasthan High court, Jodhpur

A total number of 605 plants of 20 species planted during 2016-2019 along the boundary as well as roads sides of the High court Campus. Performing well at the campus site.

SPECIES PERFORMANCE

20–month-old *Millingtonia hortensis* plants

36 month old *Millingtonia hortensis*

20–month-old *Azadirachta indica* plants

36 month old *Azadirachta indica*

Some More Research Initiatives

Air Pollution Biomonitoring Stations for Air Quality Assessment

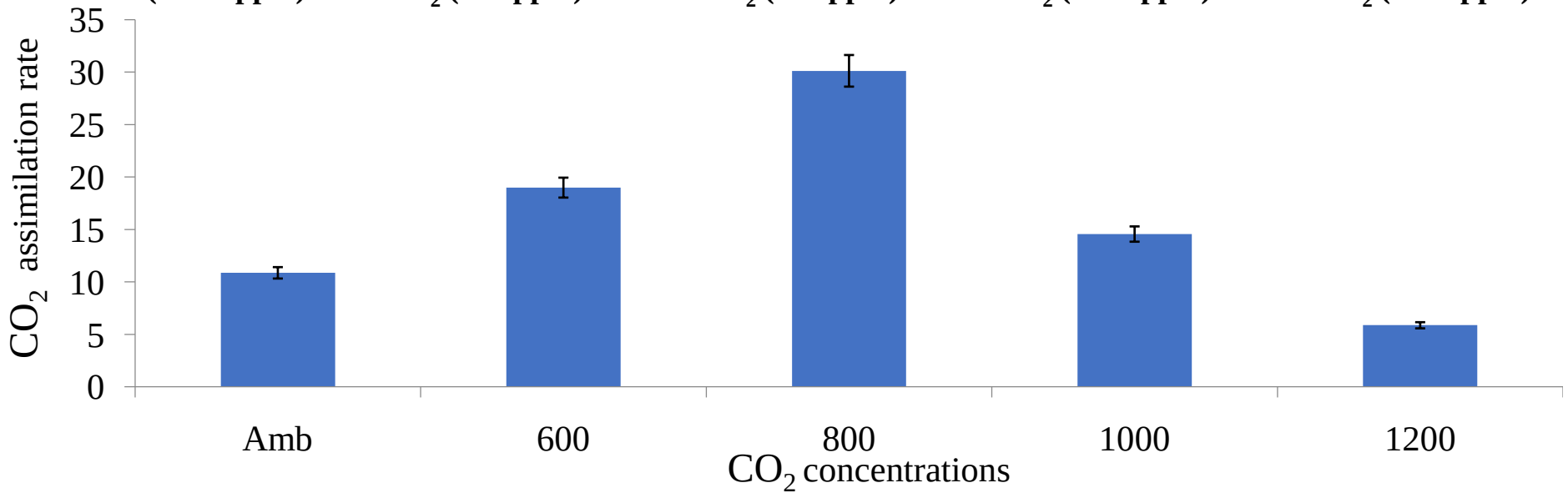
- Developed sensitivity index for plant species based on biochemical parameters
- can be used for prescribing the standards or framing the emission control policies based on response of plants to air pollution

AIR POLLUTION BIOMONITOR
STATION
FOREST ECOLOGY AND ENVIRONMENT DIV
F.R.I DEH

Open Top Chamber Facility (OTC) developed at FRI for conducting climate change related study

Effect of elevated CO_2 concentrations on growth of *Acacia auriculiformis*

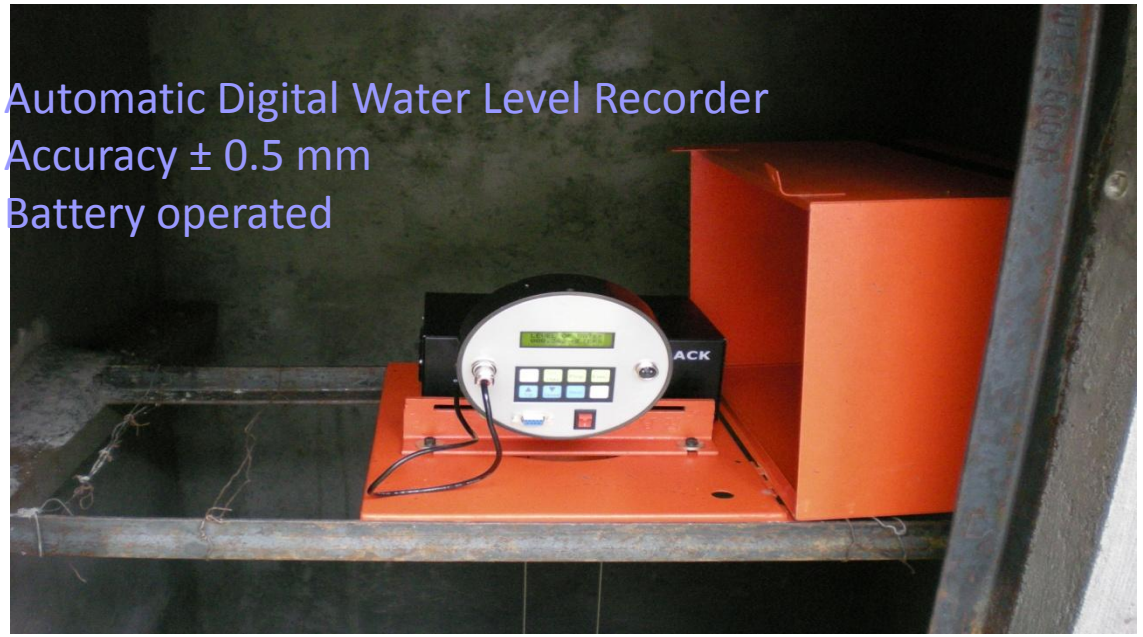
Ambient (~ 400 ppm) **CO_2 (600 ppm)** **CO_2 (800 ppm)** **CO_2 (1000 ppm)** **CO_2 (1200 ppm)**



A View of Degraded Oak Forest
In Bansigad Watershed

A View of Dense Oak Forest
In Arnigad Watershed

Broad – crested Triangular & Rectangular Weir



Automatic Digital Water Level Recorder
Accuracy ± 0.5 mm
Battery operated

Future Directions

- **Studies on Modelling of Air pollution removal of carbon monoxide (CO), nitrogen dioxide (NO2), ozone, particulate matter and sulfur dioxide (SO2)**
- **Studies in the field of Tree Biomechanics**
- **Wind tunnel experiments**

Serious root stress in Sector 39, Chandigarh due to construction activities

Major stem failure in *Grevillea robusta* tree, Sector 2A, Chandigarh

Damage caused by a fallen tree

Conclusions

The world will continue to urbanize for decades to come. Villages will become towns, towns will become cities, and cities will become megacities. Ensuring that these urban expanses are both liveable and sustainable is a massive challenge to which Urban and Periurban Forestry advocates and practitioners must rise. Safeguarding and sustainably managing forests and other green spaces in cities will be crucial for the health and well-being of the planet and its inhabitants **(Unasylva Vol. 69 2018/1)**

Thank
You