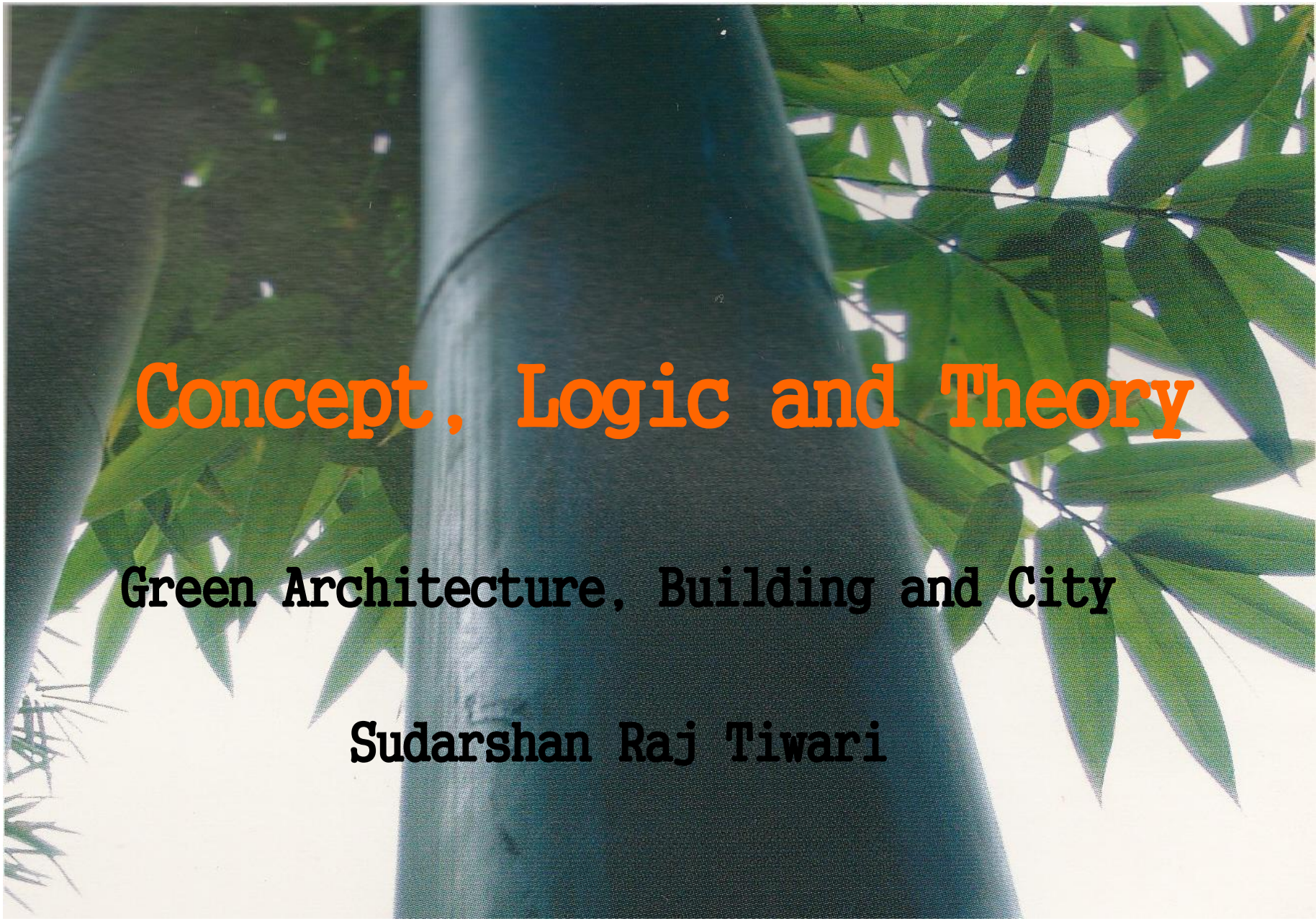


Concept, Logic and Theory

Green Architecture, Building and City

Sudarshan Raj Tiwari

Key Topics in Discussion

- Challenges Defining Green Architecture
- Traditional Wisdom: elements of nature and ecology
- Traditional architecture and its responsiveness to modern concepts of sustainability, ecology and efficiency
- Properties of materials and energy inclusiveness
- Traditional versus Modern - comparative look at Materials, technology and design of buildings

Origins of the Modern Green

- Modern Day Concepts drawn from Resource/Nature Conservation to meet the challenges
- Sustainable Development
  - WCED 1972
  - Ozone hole, depleting forests and fossil fuel resources
  - Green house gases
  - Global warming
  - Climate Change
  - Accelerating pace
- Sustainability applied to Architecture

Green Architecture

- Sustainability applied to Architecture
- Natural Architecture
  - An approach to building that minimizes harmful effects on human health and environment
  - Environmentally conscious architectural design
    - Safeguards air, water and earth through eco-friendly building materials and construction practice
    - Health of the living aspects of site, soil, plant and animal inter-relationships
    - LEED

Green Architecture

- The greening of architecture is driven by sustainability concerns on
  - Resources (materials)
  - Energy (technology and life style)
  - Environment (earth and its ecology)

Global Environmental Challenge

- What can architecture do and how, for positively addressing these?
  - Global Warming
    - Caused by CO_2 Emissions
    - Green house gases
  - Global Ice and Snow Melt
    - Rising Seas
    - Bursting Glaciers and Flooding Mountains
  - Climate Change

    Human suffering - change of habitat

    Catastrophic Consequences to all life forms

Global Resources Challenge

- What can architecture do and how, for positively addressing these?
- Depletion of material resources
  - Share of future generations?
- Deforestation, Vanishing habitats and extinction of species
  - Earth as a resource of other life forms
  - Other life forms as a resource for humans
- Food security
- Waste

Global Energy Challenge

- What can architecture do and how, for positively addressing these?
- Energy intensive lifestyle and technology
  - CO_2 Emissions
- Depletion of fossil fuel energy reserves
  - Forest and Wood
  - Coal, Petroleum and Natural Gas reserves
- Solar radiation and Thermal trapping
  - Manage fossil fuel
  - Use Clean Energy and Technology

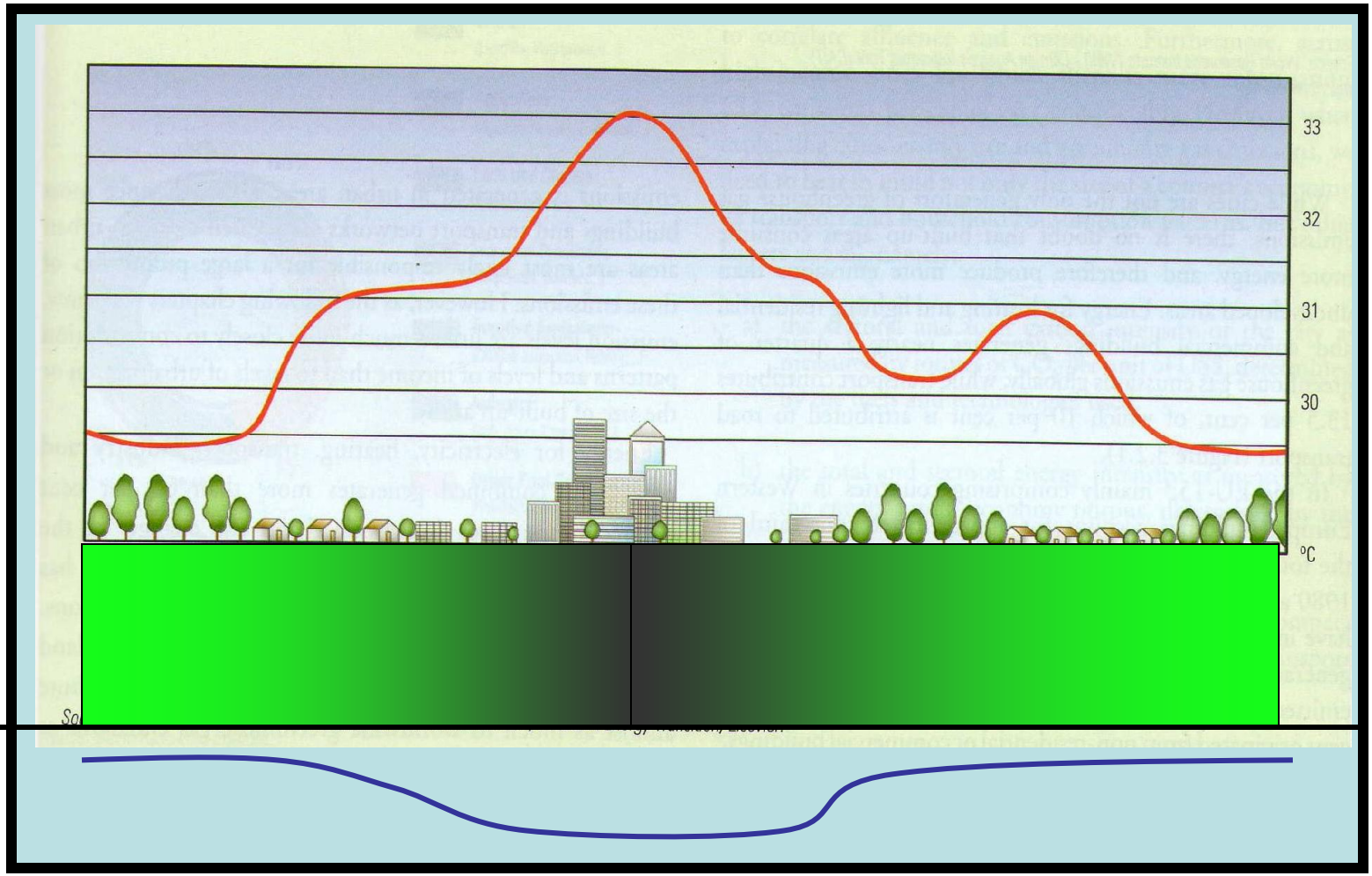
Building & Urban Desertification

- Making Towns hotter
  - Buildings, human activities and machines have heat-holding and heat-generating character.
  - Umbrella of waste products discharged into atmosphere (haze hood) traps heat there.
  - Masonry,cement and bitumen surfaces absorb solar energy/ slower release than natural ground cover.
  - Natural elements convert sensible heat into other forms of energy: sensible heat remains as such in urban areas.

Building & Urban Desertification

- INSPITE OF HUGE WATER SUPPLY FROM OUTSIDE AND ITS SHARE OF RAIN

- Making towns drier
  - Buildings and building materials based on exclusion of water and water proofing
  - Paving and Road surfaces: impervious to water (cf. natural cover/ sub-surface water) and falling ground water table
  - Water collecting system and drain-off outside town (discharging system)
  - Instant floods (cf. natural system of recharge)



Urban Exclusion of Heat, Moisture and Plant Life

Green Architecture

- Doing Green Architecture is seeking to
  - Keep the Human Health
    - Physical Health
    - Psychical Health (vaastu)
    - Spiritual Health (vaastu)
  - Keep the earth's Health
    - Environment
    - Eco-system (earth, animals, plants and human inter-relationship)
    - Conserving resources

Green Architecture

- Reduce CO2 emissions
- Sequester carbon from air
- Reduce energy dependence, use clean energy, zero energy
- Reduce waste, zero waste
- Recreate habitat for other livings
- Zero water, recharge ground with rain/waste water
- Build these into DCOMD of building

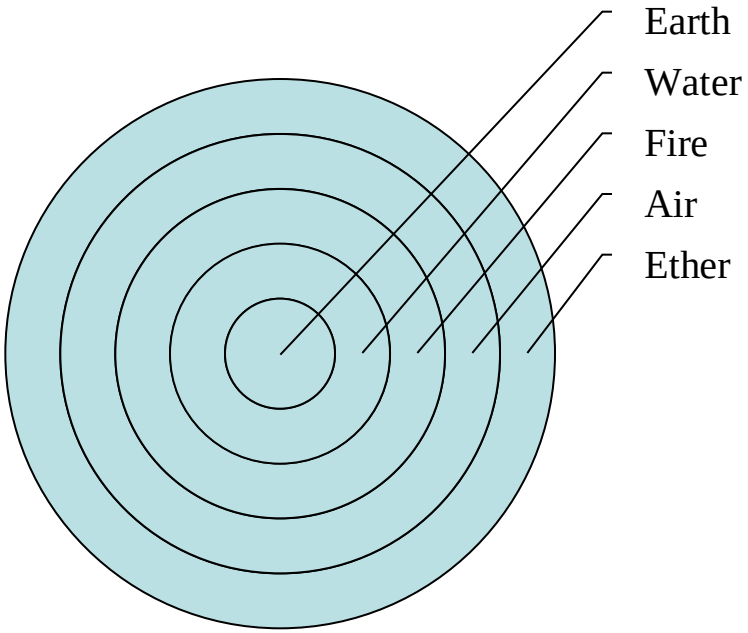
Nine Earth-System Processes in Challenge

- Stratospheric Ozone layer
- Biodiversity
- Chemical Dispersion (Persistent Bio-accumulative Toxics)
- Climate Change
- Ocean acidification
- Freshwater consumption and global hydrological cycle
- Land system change
- Nitrogen and Phosphorus into atmosphere
- Atmosphere aerosol loading

- Stockholm Resilience Centre

Nature and Ecology in Traditional Wisdom

- The Physical Nature
  - an interplay of space, energy and matter
- Elements and The Environment
  - Pancha-tatwa
  - sky (space), air, heat (energy), water and earth (matter in three states?)
  - Interrelation, Interpenetration and Interaction



Everything consists of *Pancha-tatwa*, the five transformation modes/elemental principles. In *bhuta* their characteristic quality (*guna*) is expressed - that is universal (*nitya*). … There should be no tampering of the *tatwa* Environment - This has to be the universal ecological imperative.

ब्राह्मण आकाशंभिपन्नं, ग्रसितं परामृष्टम्, आकाशेन वायुरभिपन्नो ग्रसितः परामृष्टो, वायुना ज्योतिरभिपन्नं ग्रसितं परामृष्टम् । ज्योतिषायोऽभिपन्ना ग्रसिताः परामृष्टा । अदिभर्भूमिरभिपन्ना ग्रसिता परामृष्टा, भुम्यान्नभिपन्नं ग्रसितं परामृष्टम् । अन्नेन प्राणोऽभिपन्नो ग्रसितः परामृष्टः । प्राणेन मनोऽभिपन्नं ग्रसितं परामृष्टम् ।मनसा वागभिपन्ना

Air arises in the sky and is consumed and wholly contained in it

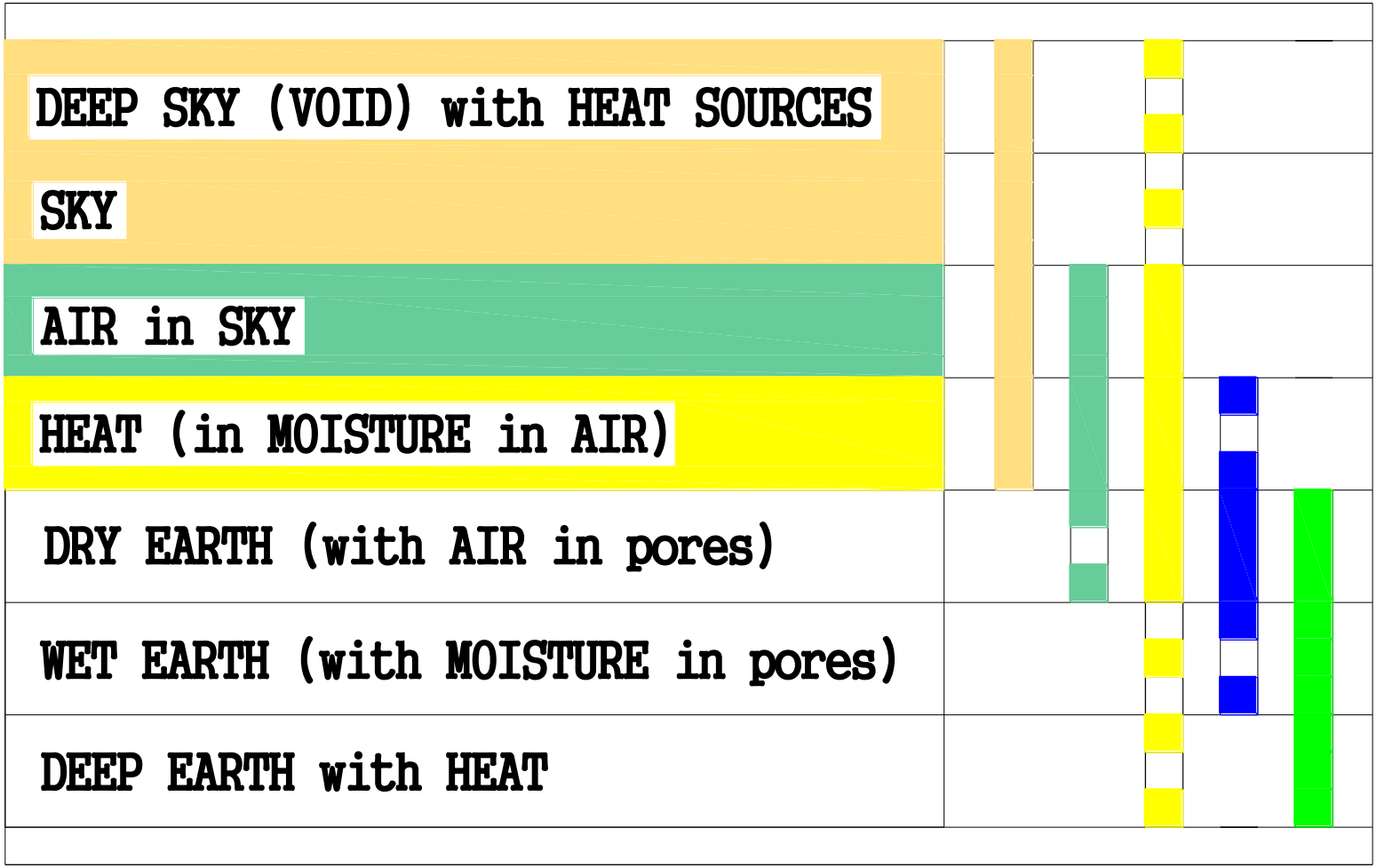
Air gives rise to, consumes and wholly contains heat (agni and within it light or *jyoti)*

In heat is water expressed, consumed and contained wholly

In Water is the Earth expressed, consumed and contained wholly

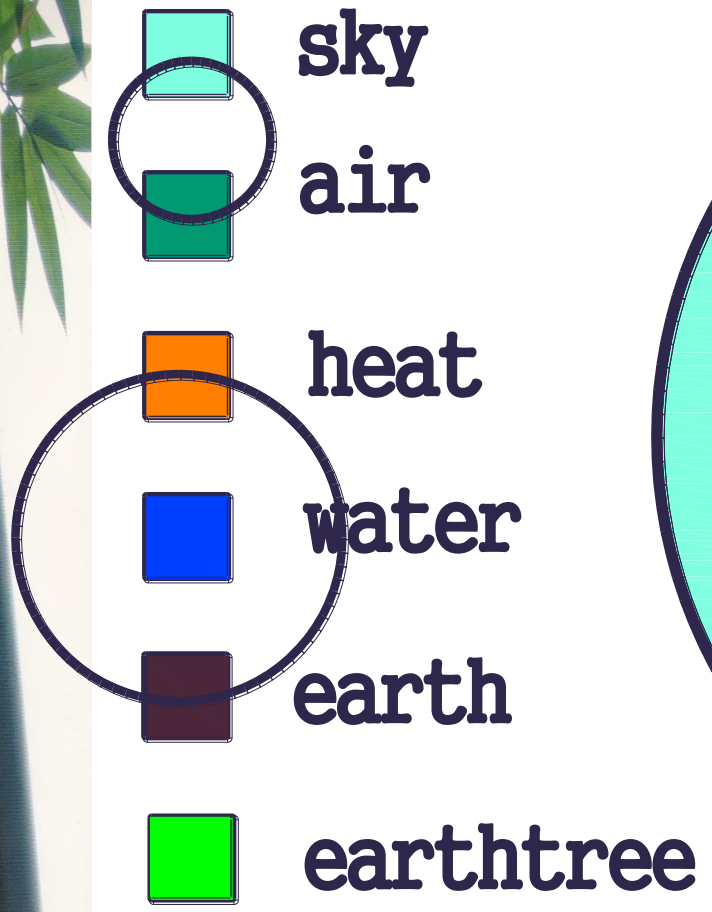
from atharva veda

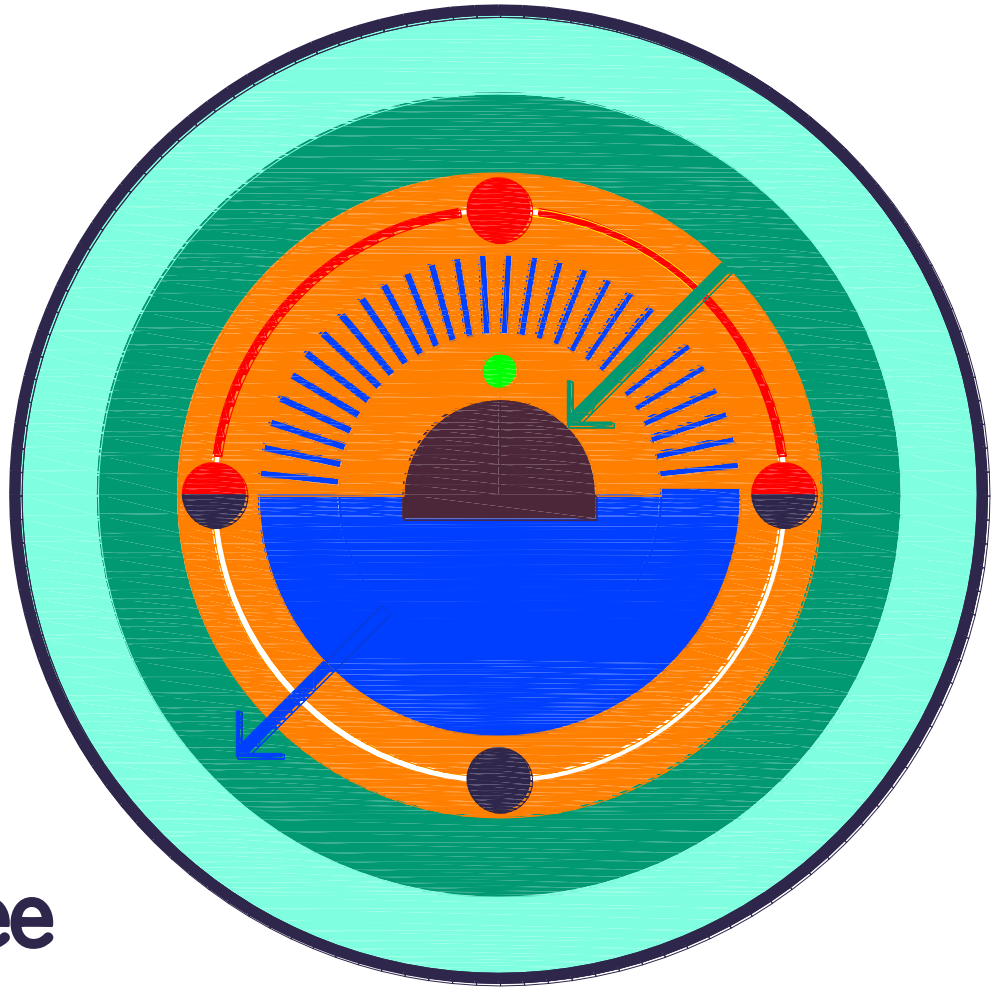
Interpenetration



Global Environment

Heat and Earth, the couple- Yete dve yoni yekam mithunam





Nature introduces new cycles

- High C02 content and Hot atmosphere deep in Earth's ecological history
  - Carbon fixing organisms developed to take out C02 fix C and release 02, using solar energy: Plants
  - Organisms developed that used plant products as food and used 02 to extract energy
  - Balance reached through interplay of life forms: plants and animals

अन्तरीक्षेण यजुः समदधात्, यजुषा वायुम्, वायुम अभ्रम्, अभ्रमेण वर्षम्, वर्षेणौषधि-वनस्पतीन्, औषधि-वनस्पतिभिः पशुन्, पशुभिः कर्म, कर्मणा तपः तपसा सत्यम्, सत्येन ब्रह्म, ब्राह्मणा ब्राह्मणम, ब्रह्मणेन व्रतं, व्रतेन वै ब्राह्मणः संशितो भवति अशुन्यो भवत्यावाच्छन्ना भवति ।

… In air is cloud germinated, nourished to fullness and preserved continuously
In cloud is the rain realized, nourished to fullness and continued
From rains herbs and plants are materialized, nourished to fullness and obtain survival
From herbs and plants are the animals characterized, nourished to fullness and obtain survival …

-from atharva veda

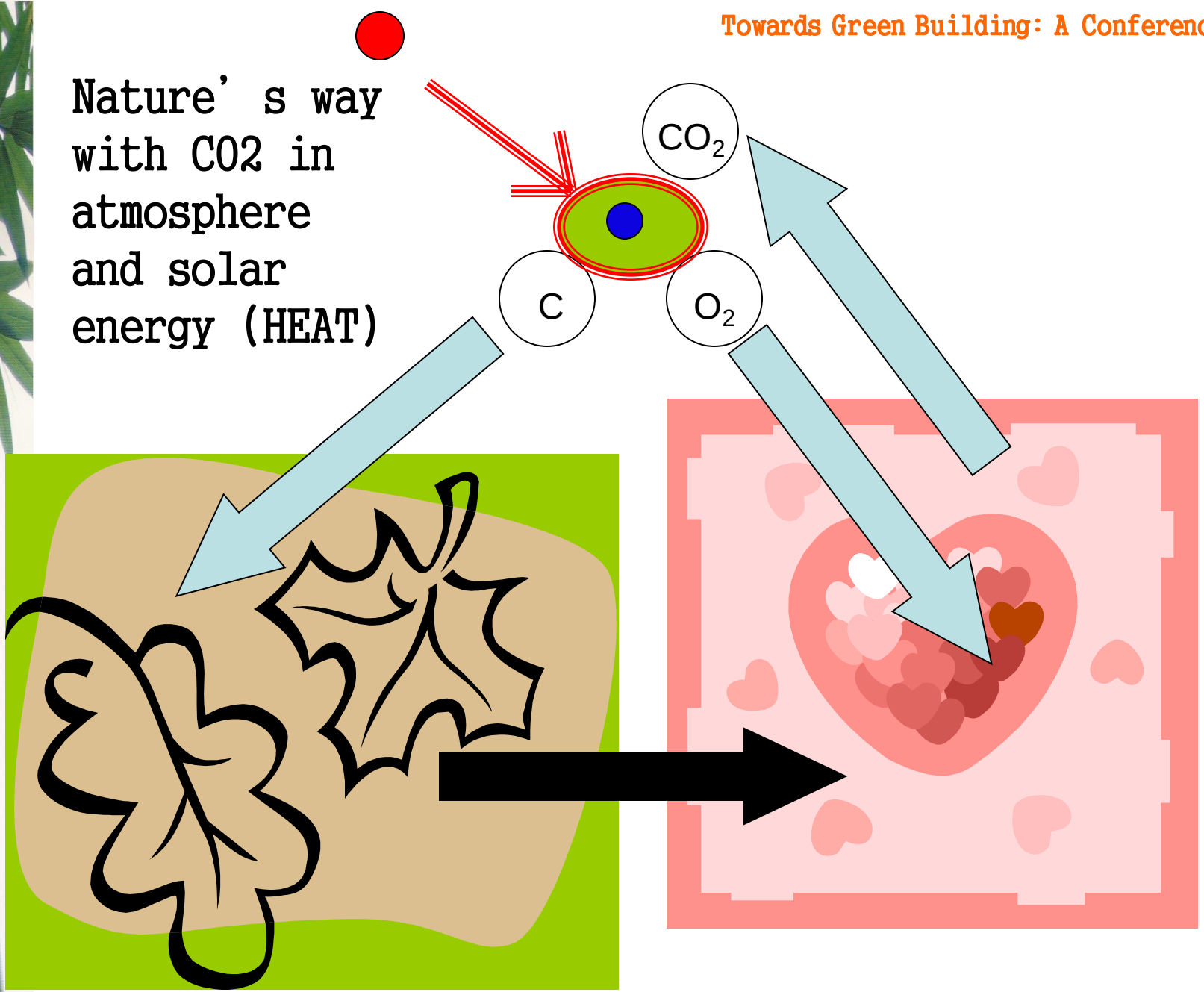
Architecture, Environment & Ecology

- The Earth becomes the abode of all beings because of the sun. - Manasara 3.14
- The Sun defines the Physical Environment: Land - Sun, Wind, Rain
- Site, hydrogeology, climate and vegetation
- Ecology
  - material and environmental cycles in Nature, ex. Water cycle

Green Lessons from Plants

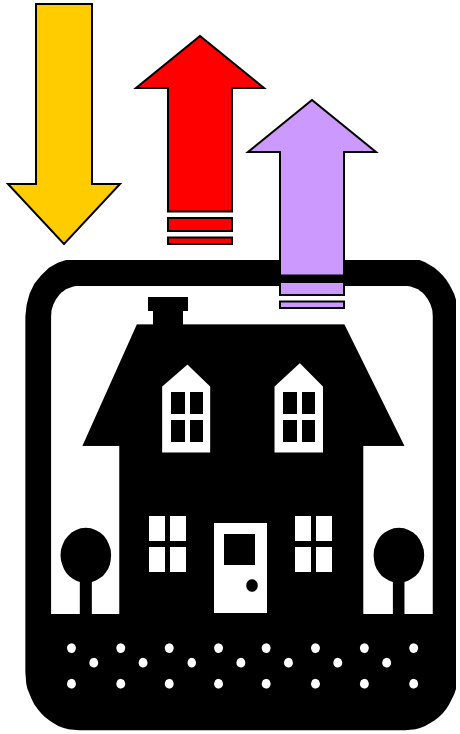
- Leaf, Chlorophyll and Photosynthesis
- Heat, transpiration and leaf
- Solar energy to organic energy
- Carbon sequestering CO_2, C, O_2
- Moisture, roots and earth
- Fixed on earth and dealing with inclement weather
- Support to other lives
  - habitat, food

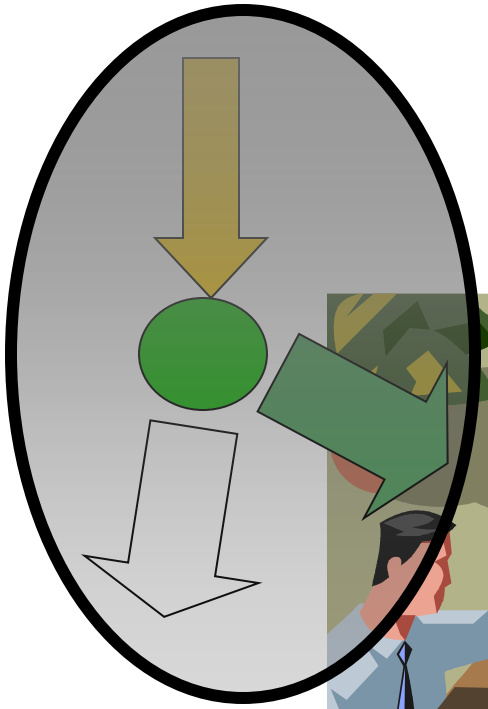
Nature's way with CO2 in atmosphere and solar energy (HEAT)

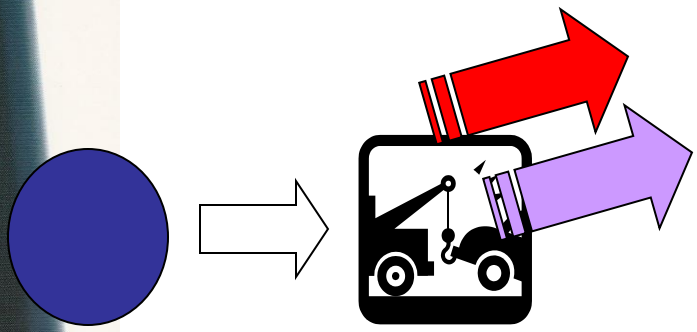


Nature

air,
water,
land







Materials of Construction: Modern

- Chemistry
  - 103 Elements
- Eight of them make up 98% of the observable portion of the Earth's Land
  - Oxygen (O), Silicon (Si), Aluminum (Al), Iron (Fe), Calcium (Ca), Sodium (Na), Potassium (K), Magnesium (Mg) … in order of abundance
- Oxides, silicates (simple and complex) and Calcite and Kaolinite make the building materials (minerals, rocks, sand, clay etc)
- Trees, shrubs and grass
- Building Materials
  - Metals, ceramics and polymers

Materials of Construction

- Family of Materials
  - Metals, Ceramics, Polymers (and composites)
  - Natural, Man-made
- Structure of Materials/ strength
  - Atoms, Molecules or Unit Cells and grains or crystals
  - Metallic, Ionic, Covalent and van der Waals Bonds
- Properties of Materials
  - Hardness, strength, electrical and magnetic properties, optical and thermal properties, resistance to corrosion, failures (stress and strain), temperature stresses, wear, tear, fatigue etc
- Phases > Gas, Liquid and Solid
  - Pressure and temperature

Ceramics is telling

- Cement and Plasters
  - Crystallization with water, setting, concrete
- Bricks and Tiles, Glass
- Processing of non-glass ceramics
  - Pressing the raw materials into shape, molding (green or sundried bricks)
  - Heating to reach a desired 'structure' in the shape (fired bricks - 1), Sintering/diffusion (2), Fusion (3)
- Earthenware > Semi-vitreous earthenware, stoneware, ovenware, porcelain, china
  - More Heat > Higher temperature > higher strength
  - More Heat > lesser porosity > higher strength
- Polymers/Plastics
  - Carbon backbone
  - Strength, flexibility and toughness

Built from ground, Localism

Energy in material: embodied, transport & use

Technological Obsolescence

- Technological Obsolescence
  - Objects becoming useless economically, no physical aging, long residual material life
  - Plastic bags: economic life ONE HOUR, physical life ONE THOUSAND YEARS
  - Concrete: economic life of buildings 30 YEARS, structural life 100 YEARS, material Life 300 Years?
  - Concrete that can last 16000 years?
- Waste and its accumulation
  - Can earth tolerate as much concentration of solid waste?
  - Is it only a case of shifting site of limestone hill?
  - Can we afford to make limestone hills of URBAN deserts?

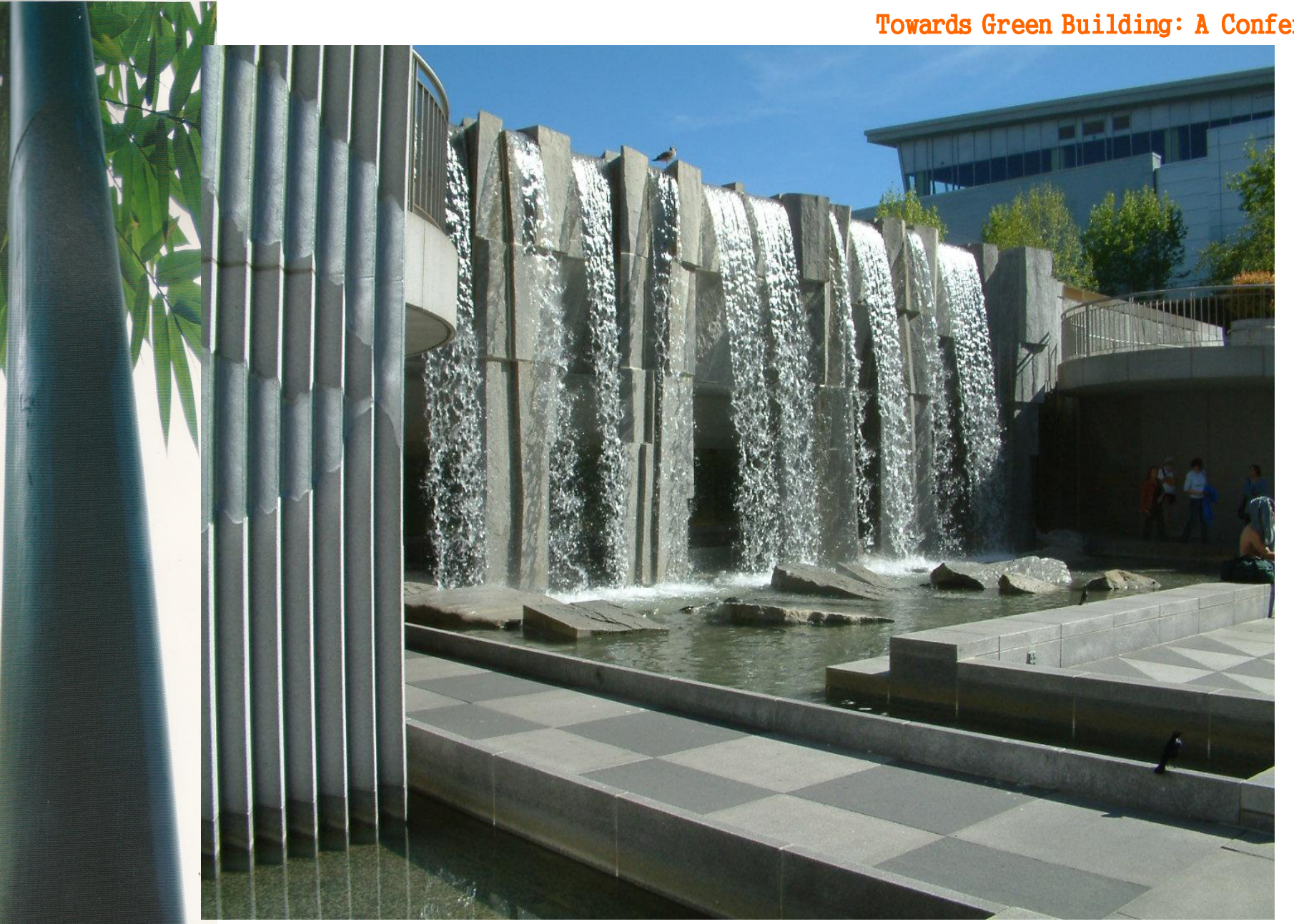
Disposability of Materials

नैनं छिन्दन्ति शस्त्राणि नैनं दहति पावकः।
न चैनं क्लेदयन्त्यापो न शोषयति मारूतः॥२३॥

It is not cut by arms, nor burnt by heat
Also water cannot soften it and air cannot dry it
the gita 2.23

Inclusive materials and methods

- Architecture and indoor environment
- Water excluding property
  - Density, porosity
  - Is moisture unhealthy?
- Inclusiveness, performance and disposal, life-friendliness
- Building inclusiveness
  - material and technology



Reframing an approach

- Key Issues
  - CO2 emission, heat emission, energy intensive lifestyle
  - Technological obsolescence and waste
  - Heat holding and water excluding property
- Key Approaches
  - Interaction between Land, Air, Heat, Water plus Plant and Animal Life
  - Reduction of Co2 and Heat
  - Water inclusive architecture and technology
  - Making land COOL, MOIST and GREEN
  - Increasing disposability/Reducing Obsolescence

Tree on Earth - Making Grey Green

- West
  - Ebenezer Howard's Garden City
  - Le Corbusier's *Les 5 points d' une architecture nouvelle, 1926*
  - Green Architecture
- Kathmandu
  - Paved squares, no central public green
  - Khyo, green lots on the periphery

Jointly Organized by Department of Architecture & VSBK/CESEF Project 11 Nov 2011

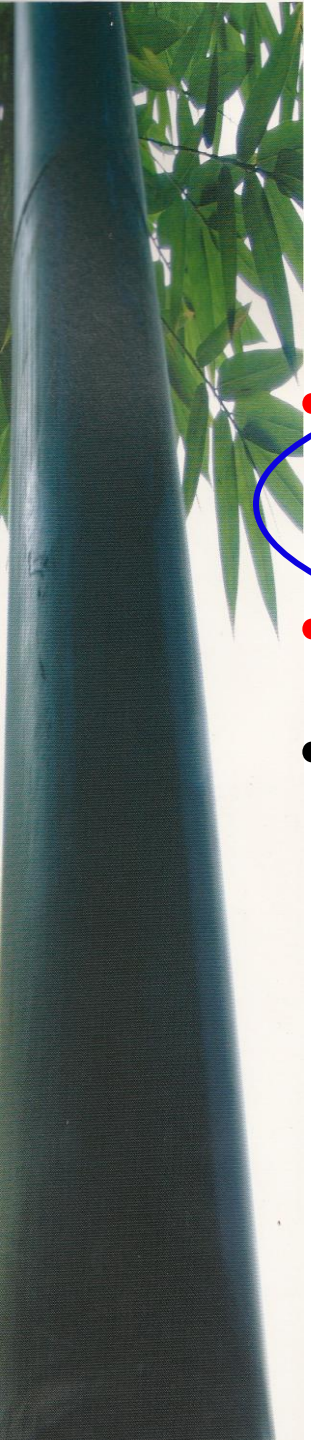
Earth on Water-Making dry Moist

- Modern City
  - Urban system takes no action to put moisture into the ground
  - Water proof piping for supply and drainage
  - Wetness and dampness - a public health hazard!
  - Surface drains and sealed pavements
- Recently-
  - Rain water harvesting
  - Recharging wells, holding storage
  - Porous asphalt for paving has been developed!

Earth on Water-Kathmandu

- Water accepting technology
  - Open jointed Brick or Stone slab paving
  - Surface drains harvesting neighborhood waste water
  - Use of Porous seams - *Bahrabarse Inar*
  - Jhingati roof

- Town inclusive towards Moisture



Cooling the Earth, using excess heat

- Earth is expressed in Water, water in Heat, Heat is expressed in air
- Heat and earth cohabit!
- Towns working towards using heat
  - Jhingati tiles (earthenware not glazed/stoneware)
  - Saaga and composting
  - Waste chain linked to Food chain

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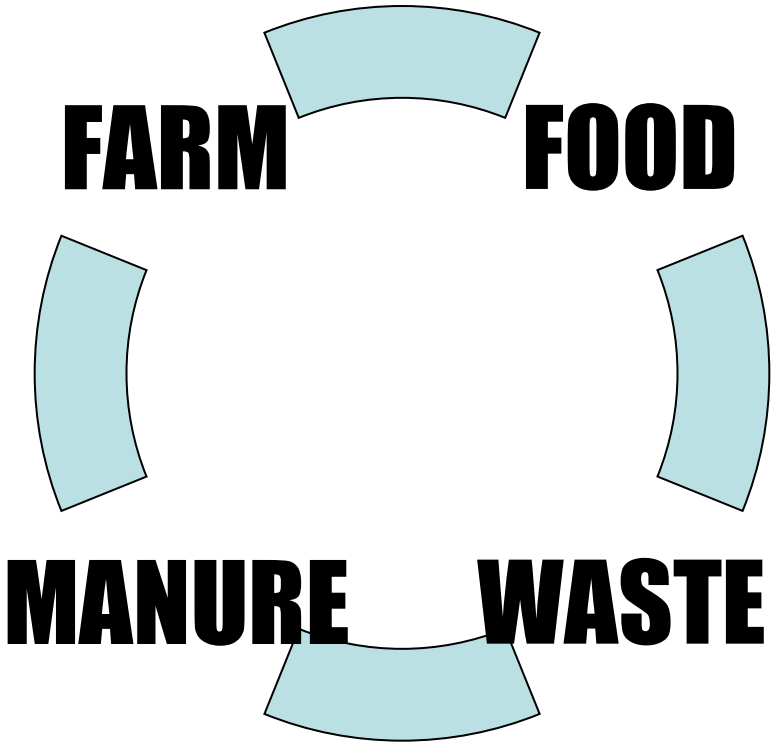

Recycling Through Use of Extra Urban Heat

* Compost and Sagah

Using Perishable materials

- Degradability of materials
  - Action of heat, air, solid matter (abrasion)
  - Action of water
- Nepali Traditional architecture
  - Based on wood, brick
  - Wet Monsoons and tradition of conservation by replacement
  - Generally water inclusive material and technology
  - Dachiapa Glazing material (red moss)

Living together with Plants and Animals

- Dhungedhara
  - Supply side
  - Filters Regulators and Deep pit
  - Drainage side
- Maintenance free architecture
  - Fish, frog and snakes at work
  - Plankton feeding the fish, frog feeding on fish, snake feeding on frogs!
  - Ecozoic technology of flushing deep closed darins?

The Pit Conduit: *Dhungedhara*

A manuscript drawing of Dhungedhara