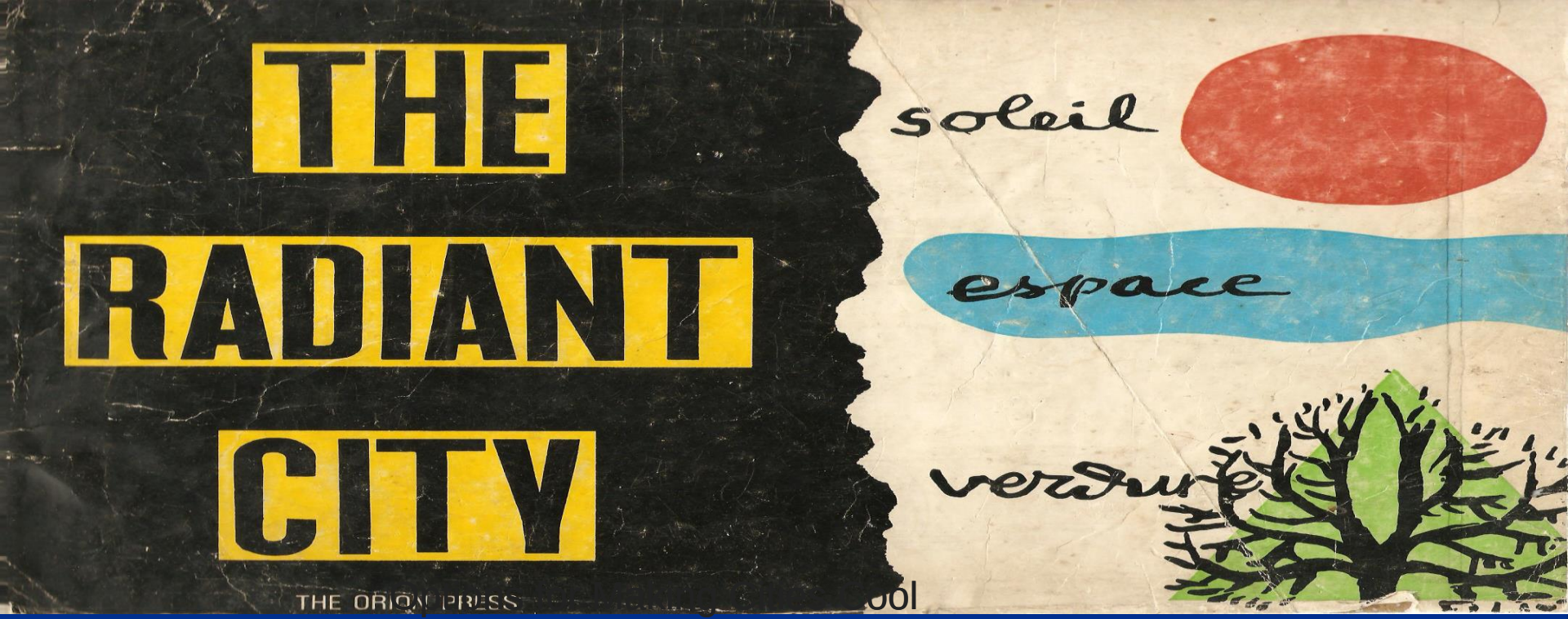


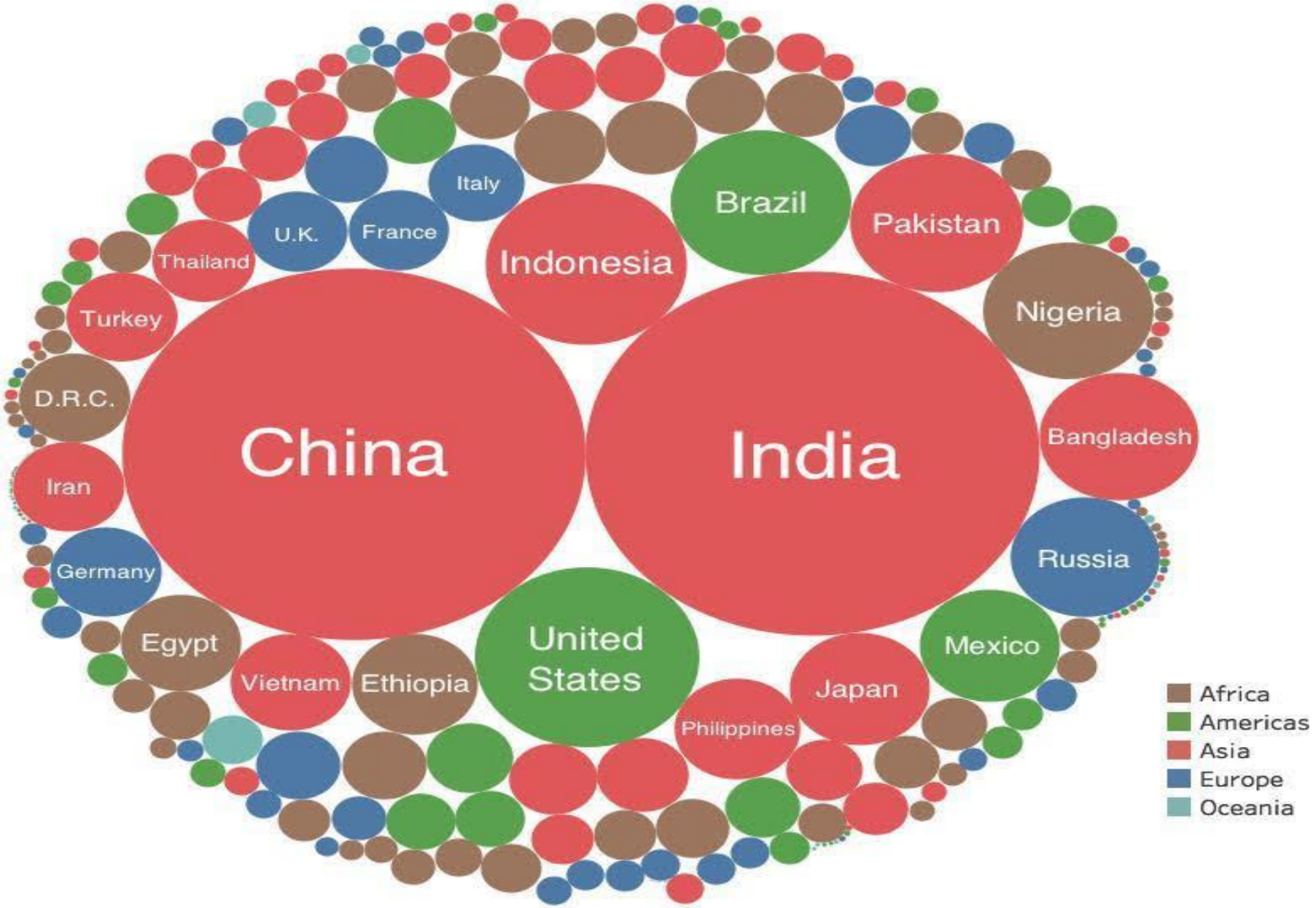
Options for Making Cities Cool

Ar. J.K.GUPTA,
Email---- jit.kumar1944@gmail.com, Mob- 90410-26414

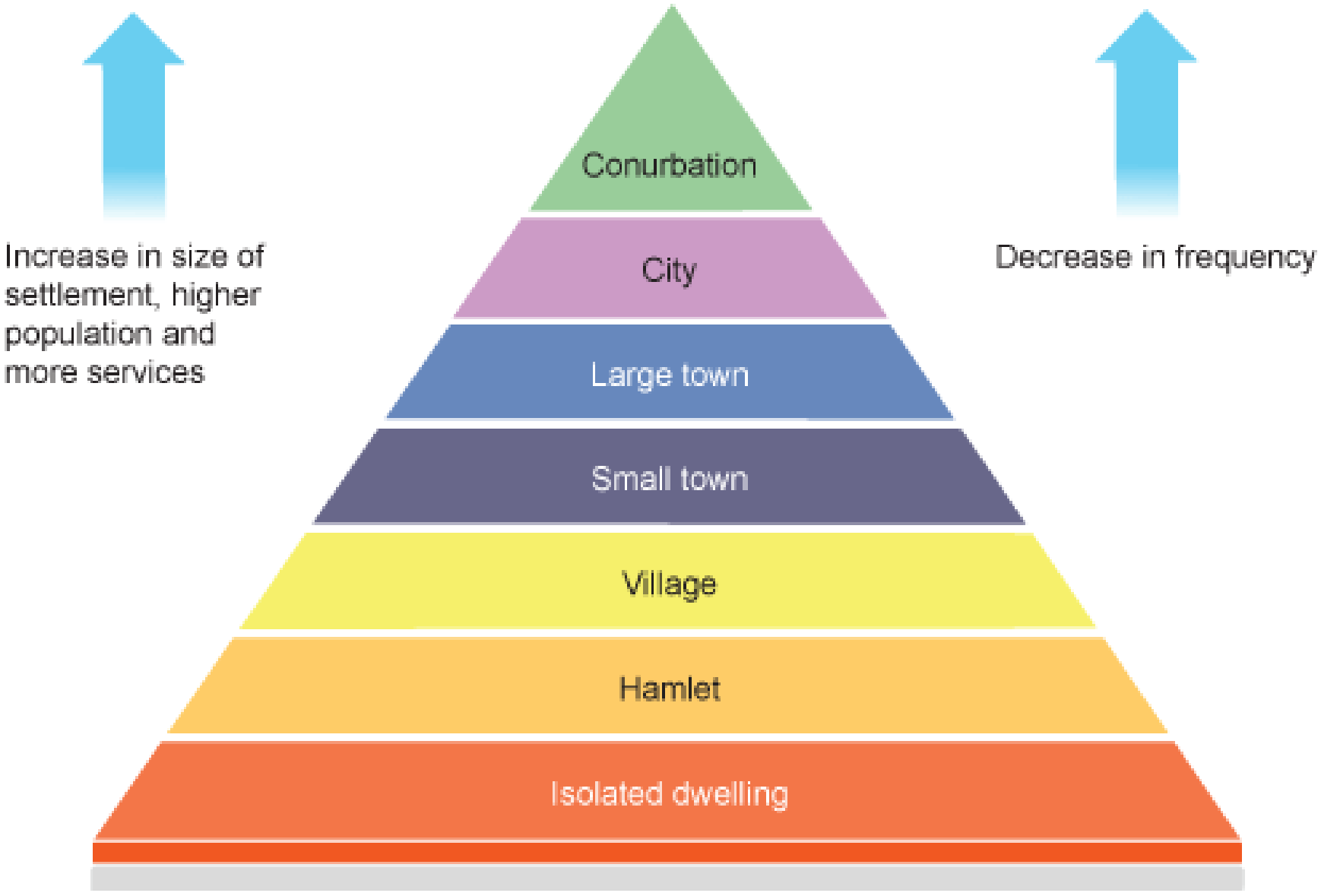
Cities and their Context

- *Cities have been part of human history.*
- *- Cities- known to command power and authority*
- *Cities -- known for their dualities and contradictions.*
- *Cities- known for both -- positivities and negativities*
- *Cities -- known to be areas of concentration of population/ activities, infrastructures, services, healthcare, education*
- *Cities -- known to be Engines of economic growth-70%*
- *Cities - generators of employment , wealth and prosperity,*
- *Cities – also known for their negativities,*
- *Cities – large consumers of resources/energy*
- *Cities – large generator of waste*
- *Cities – large generators of heat*
- **--98% /56% cities in low& middle/high income economies - fail to meet air quality WHO norms**
- *Cities- remain a manmade , mechanical habitat*
- *Cities- destroy natural habitat-anti-thesis to bio-diversity*
- *Cities- known to be creator of best/ worst living conditions*
- *cities – also known to promote poor quality of life*

Countries by Population Size

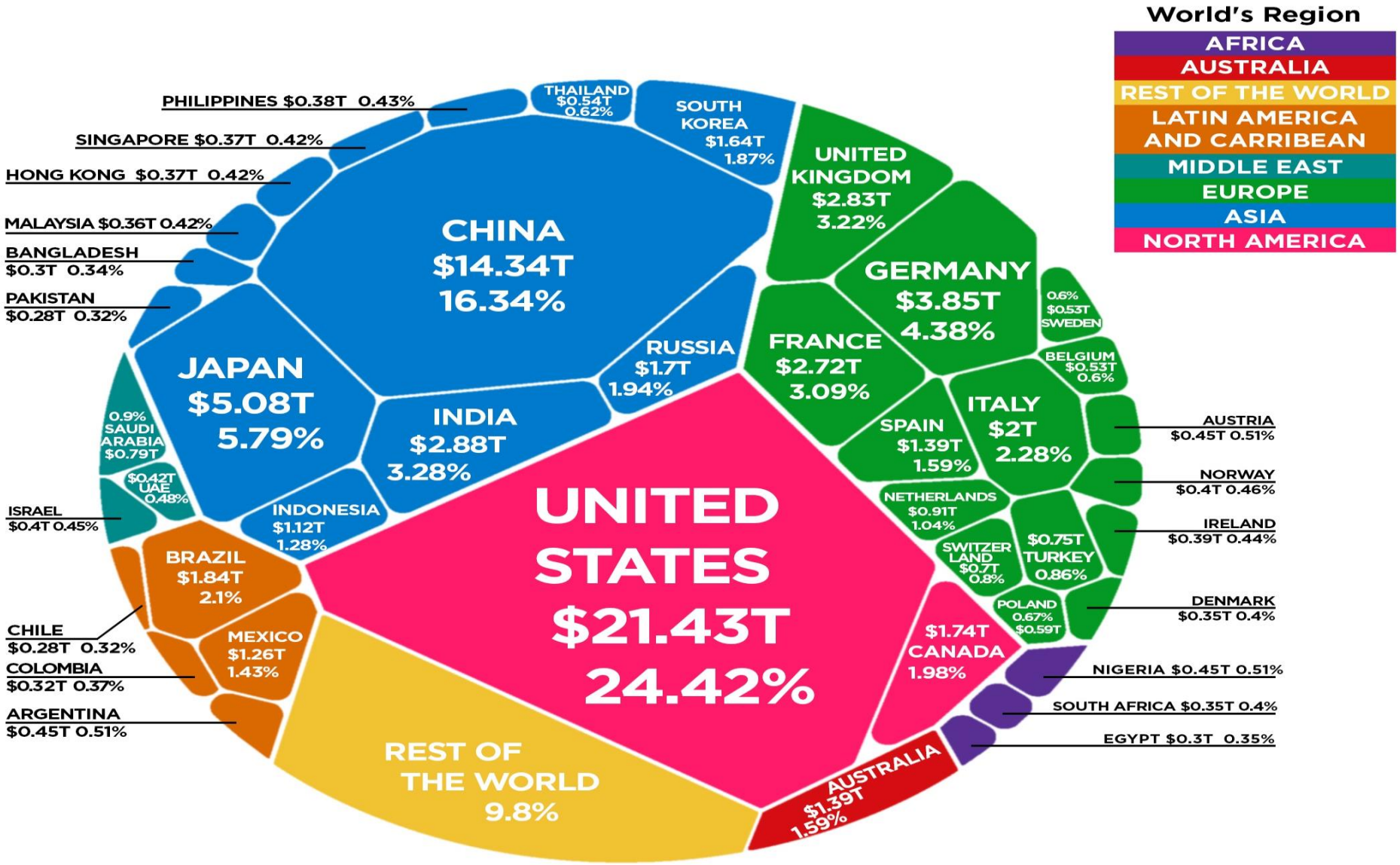


Hierarchy of Human Settlements



The World Economy

Gross Domestic Product (GDP) by Country 2019



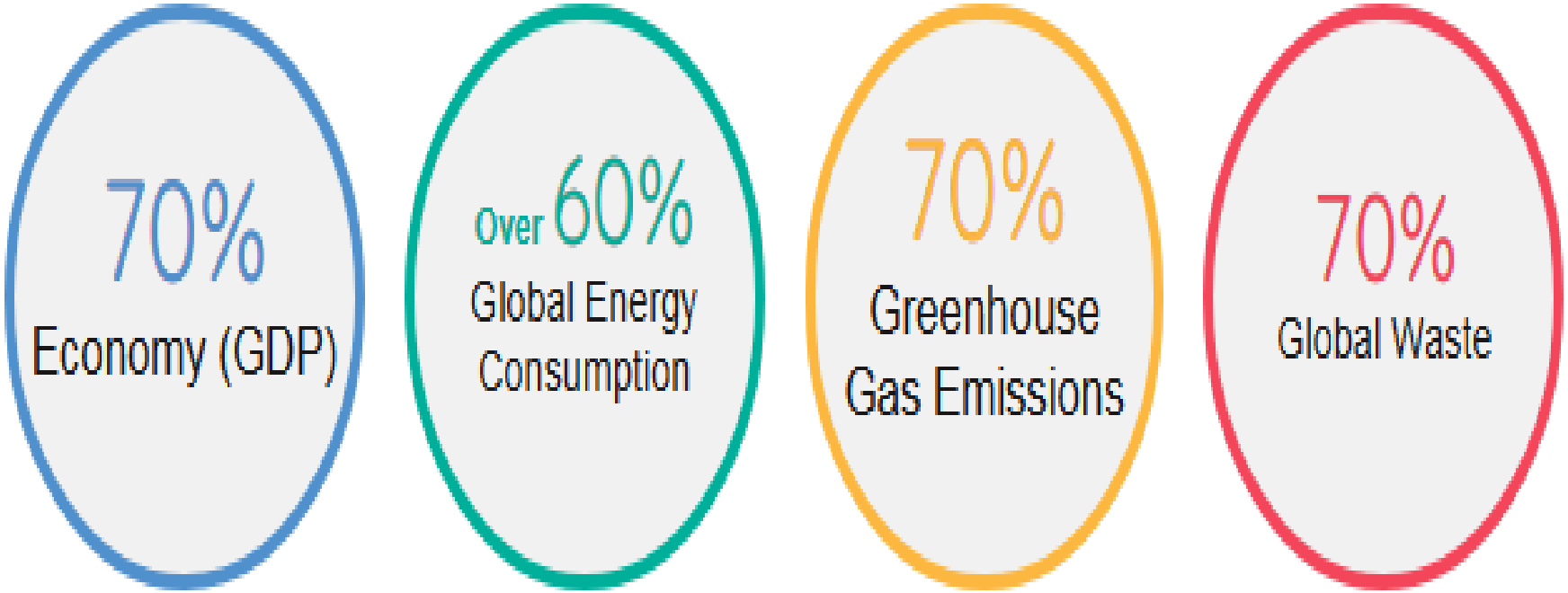
Article & Sources:
https://howmuch.net/articles/the-world-economy-2019
https://databank.worldbank.org

howmuch.net

Global Context of Cities

THE GLOBAL CONTEXT

Cities today occupy approximately **only 2%** of the total land, however:



2018 EMISSIONS BY SECTOR

BUILDINGS & ENERGY
- COMMERCIAL 70%
- RESIDENTIAL 30%

TRANSPORTATION
- PASSENGER VEHICLES 83%
- TRUCKS & BUSES 10%
- TRANSIT 7%

WASTE
- LANDFILL 55%
- COMBUSTION 36%
- WASTEWATER 8%

BEFORE COVID-19

SHARE OF URBAN POPULATION LIVING IN SLUMS ROSE TO 24% IN 2018

ONLY HALF

THE WORLD'S URBAN POPULATION HAS **CONVENIENT ACCESS** TO PUBLIC TRANSPORT (2019)

COVID-19 IMPLICATIONS

OVER 90% OF COVID-19 CASES ARE IN **URBAN AREAS**

AIR POLLUTION

CAUSED **4.2 MILLION** PREMATURE DEATHS IN 2016

47% OF POPULATION LIVE WITHIN 400 METRES WALKING DISTANCE TO OPEN PUBLIC SPACES

SUSTAINABLE DEVELOPMENT GOALS

11 SUSTAINABLE CITIES AND COMMUNITIES

MAKE CITIES AND HUMAN SETTLEMENTS INCLUSIVE, SAFE, RESILIENT, AND SUSTAINABLE

GLOBALLY

MORE THAN HALF OF HUMANITY LIVES IN CITIES TODAY

AND BY 2030, 6 OUT OF 10 PEOPLE WILL LIVE IN CITIES

IN INDIA

BY **2030** INDIA WILL HAVE 7 MEGACITIES WITH POPULATIONS OVER **10** MILLION

13% OF URBAN HOUSEHOLDS DON'T HAVE SANITARY TOILETS

31% LIVE IN URBAN AREAS

62 MILLION TONNES PER ANNUM WASTE GENERATED IN CITIES

17% OF URBAN POPULATION LIVES IN SLUMS

OVER **1.2 MILLION** POLLUTION RELATED DEATHS IN 2017

Urban Crisis

- **Urban crisis/ problems --has genesis in--**
- **– uncontrolled/ unplanned rapid growth /development**
- **- way buildings/ built environment-- created**
- **-Way people - made to travel large distances**
- **--Urbanization & global warming remain positively related,**
- Cities getting warmer --with rising temperature
- Research made - urban areas -- 20 F hotter- surrounding/Rural areas
- - within cities-- one neighborhood - 15 F hotter than another.
- -- Poor neighborhoods-- hotter than rich neighborhood.
- - Intensity/duration of heat waves increasing
- - Majority of cities on boil
- - Large causalities - due to excessive heat
- **Globally cities getting into crisis.**
- **--Jakarta -- sinking;**
- **--New Delhi-- shutting down due to air pollution;**
- **- Marseille, France- residential buildings collapsing - poor maintenance**

Impact of Urban Crisis

- By 2050; seven in 10 people will live in cities
- **Rising urban temperature impact -humanity/communities /cities--**
- - Making human beings most vulnerable
- --Rising Mortality- when temperatures head above 25C.
- - Cities exposure to extreme temperatures-- Triple over next decades.
- -970 cities-- experiencing average summer temperature of 35˚C (95°F).
- • Additional 125 mil- People exposed to heat waves --bet 2000 -2016 (WHO)
- Extreme heat --killing more Americans-- than other natural disaster.
- Tokyo - Heatwave 2018--declared natural disaster --thousands hospitalized
- • Moscow- 11,000 people died- heatwave in 2010.
- • India- lost 4.3% working hours -1995; & 5.8% in 2030- due to excess heat(IMD).
- UK-heat-related deaths - to increase 257% by 2050 & 535% by 2080.

Elements Making Cities Warmer

Lack of vegetation, lack of evaporative cooling, shading

Anthropogenic heat released from heated or cooled buildings

Heat released by traffic

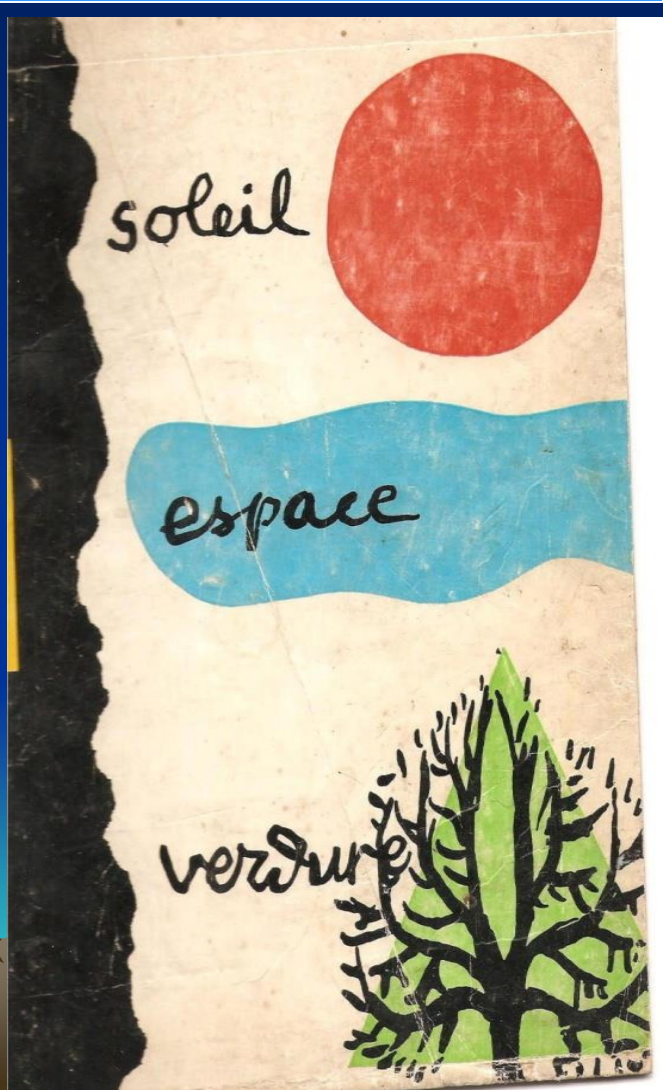
Building materials store solar heat and release it at night

Tall buildings trap air in to the street canyons and reduce wind speed within the city

Long-wave radiation is reflected from walls back to street level

Due to the UHI a city centre can be over 10 degrees warmer than the surrounding countryside

Options for Making Cities Cool



SDG 11- Make cities and human settlements inclusive ,safe, resilient and sustainable

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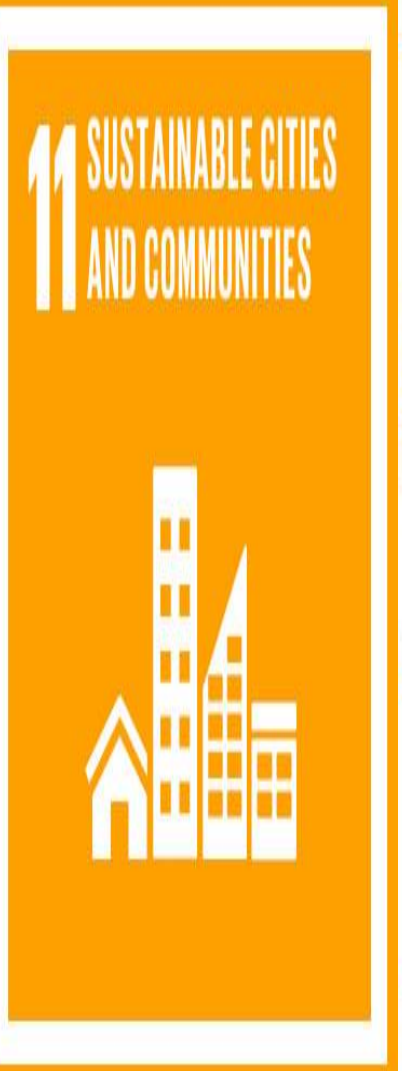


Options for Urban Sustainability

- Empowering cities- for resilience to climate change by;
- -Redefining Urban Planning- Making urban planning responsive to Urban cooling
- -Fostering decarbonization across energy, transport, building •
- -Planning with Nature-- Sun , Space, Greenery
- -Undertaking Heat & vulnerability mapping -
- - Opting Heat mitigation Solutions
- - Greening Cities
- -Rationalizing/Re-ordering Transportation
- - Valuing Orientation/ Wind
- -Making Cities Porous
- - Making Buildings Green
- - Greening/ Making Roof Cool
- -Creating Urban forests
- - Making optimum use of water
- - Managing Heat wave emergency --- creating Cooling Centers
- - Using Alternative cooling techniques.

Re-defining Planning/Development Agenda

- --Reviewing planning tool
- New order of planning -to focus on Regional Planning:
- -for Synergizing urban and rural areas

--Making cities compact

-- Making cities energy efficient

--Planning cities for bio-diversity

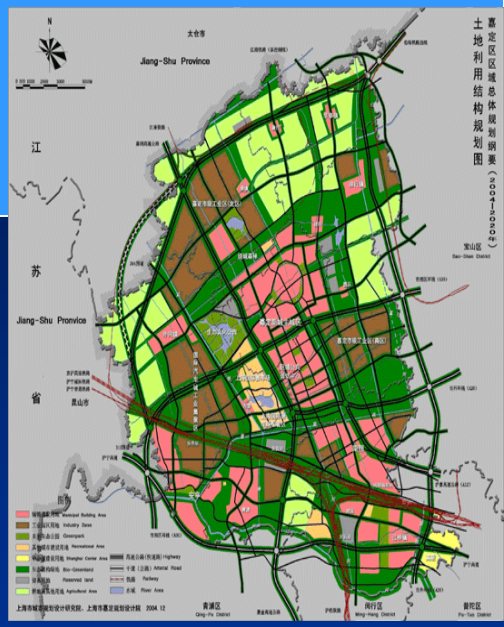
– -- Avoiding Urban Sprawl

-- Stopping melting of cities

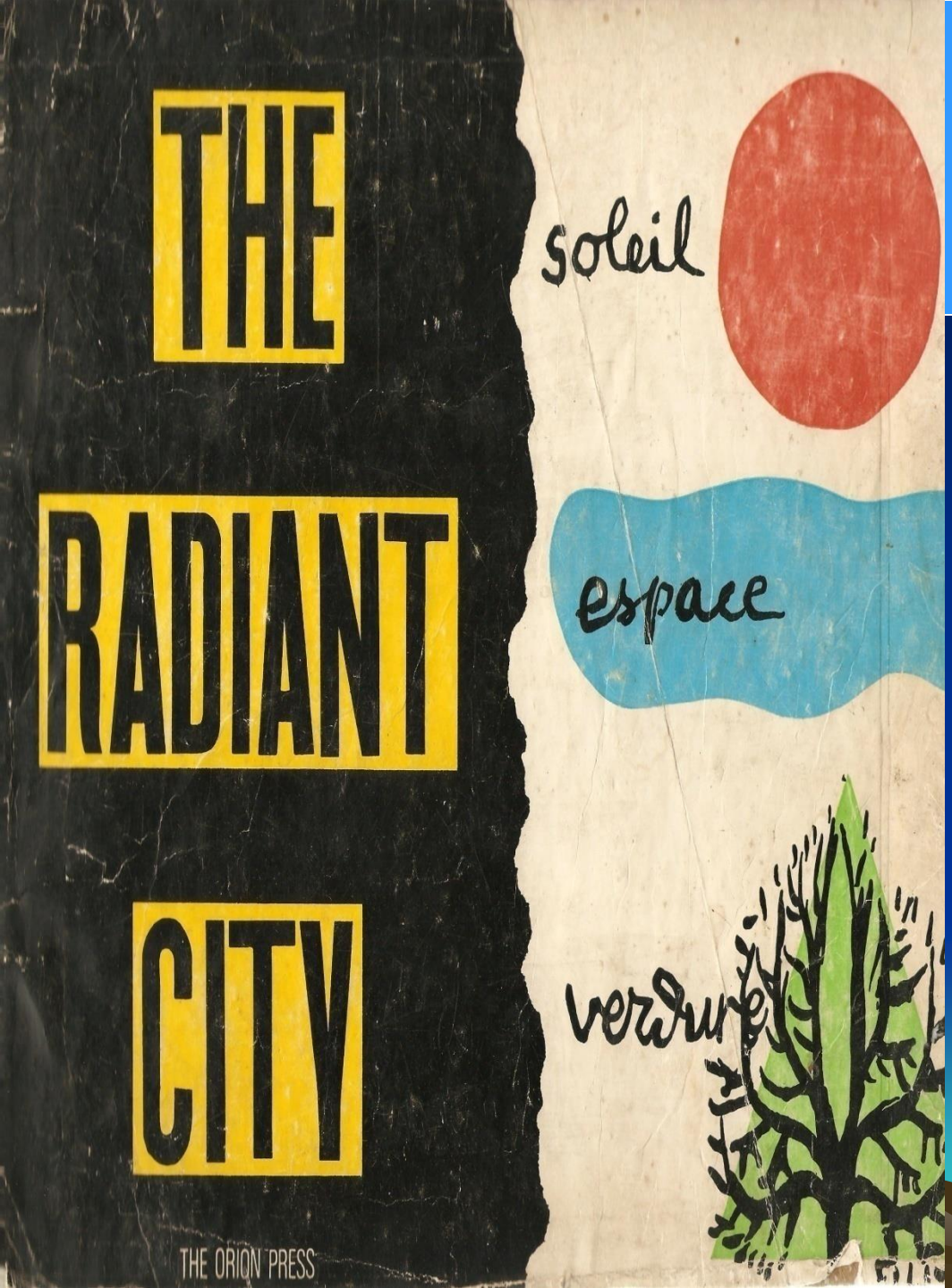
– - Empowering villages – productive, self-sufficient in daily needs..

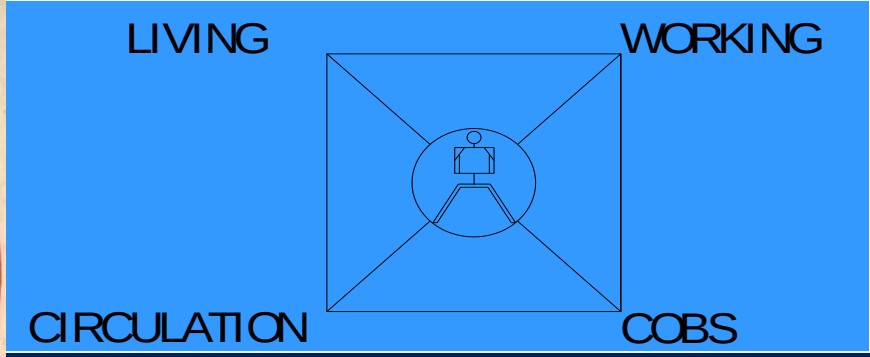
– -- reducing carbon footprints

– - Reducing global warming



Regional Planning- NCR





- The Radiant City
  - •An organism capable of housing the works of man of machine-age society.
  - • placed under the masterful government of natural conditions:
    - •Sun
    - •Space
    - •Greenery
  - •And its mission is the service of mankind:
    - •To live
    - •To work
    - •To cultivate body and spirit
    - •To travel about

    (in this order and obeying this hierarchy)

COMPACT CITY-MODEL

PLANNING COMPACT CITIES

Make cities compact by;

– promoting High-density development

-- adopting Transit oriented development

-- Raising Height and

-Rationalizing land uses / Building bye-laws

-Building inside not outside

--- Building vertical not horizontal

--- Building High not low

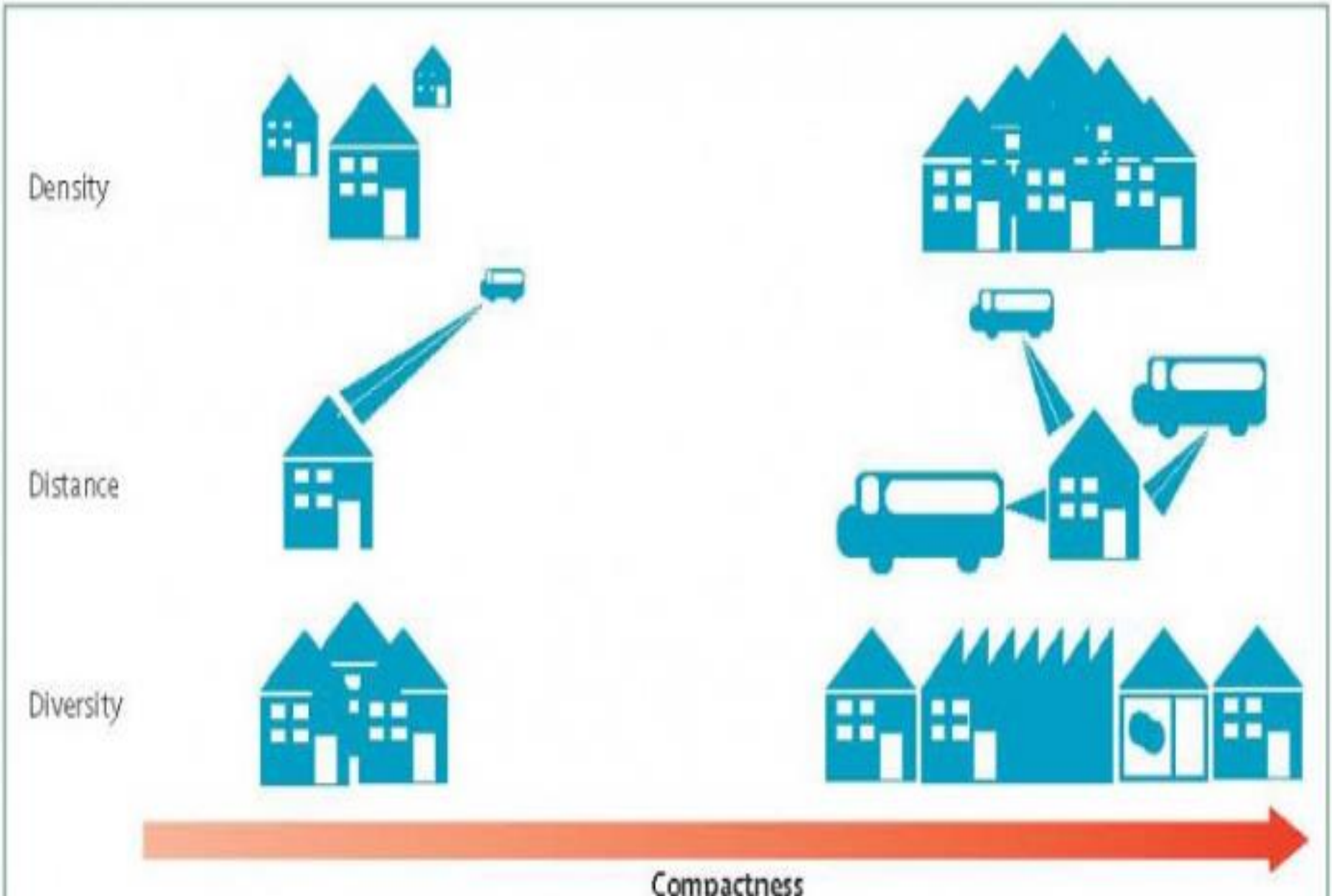
--- Building mix not pure

---Building dense not shallow

----- optimizing current infrastructure.

.

COMPACT CITY



COMPACT CITY- Jaisalmer - Rajasthan

Valuing Orientation

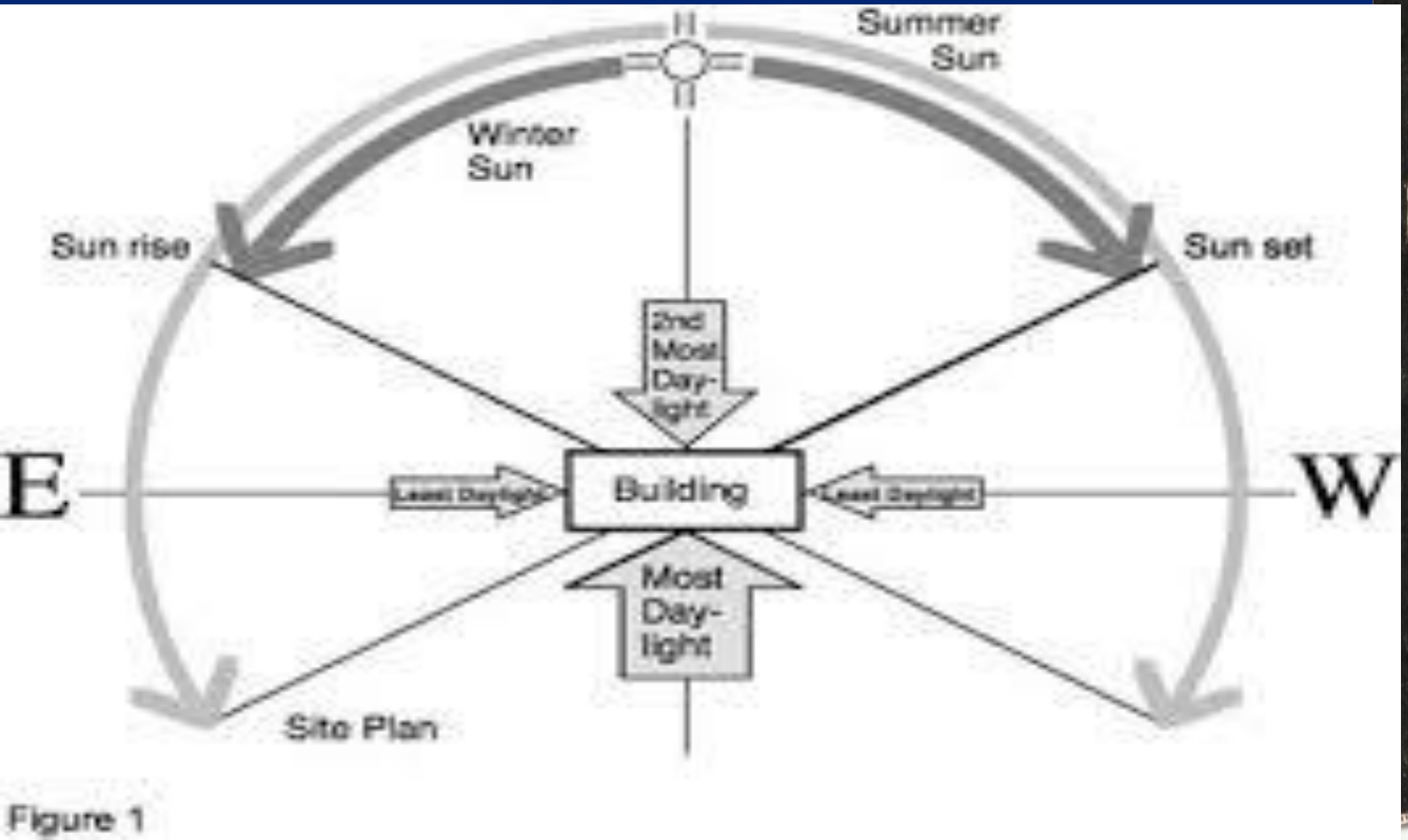
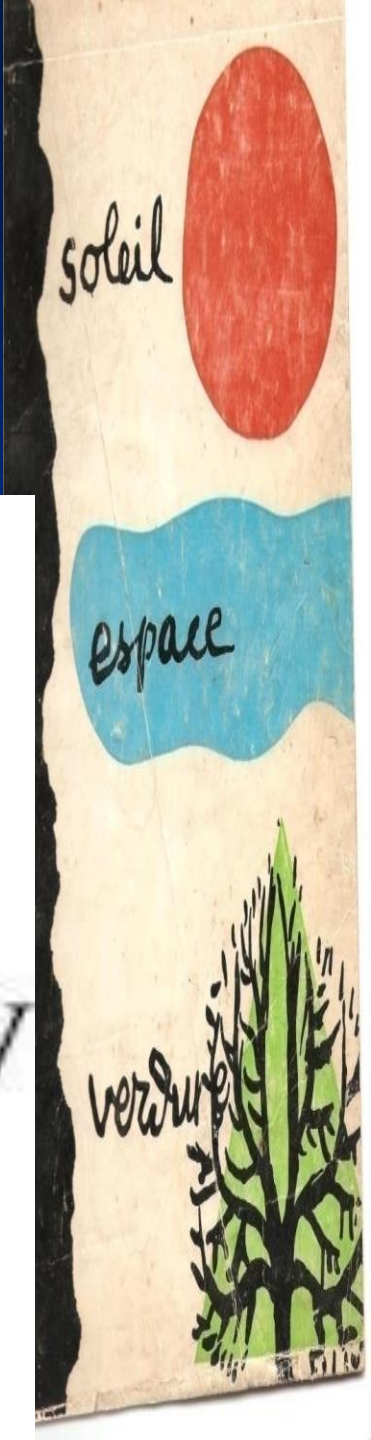


Figure 1



Valuing Orientation

- Role/importance of orientation - not fully understood / appreciated in Planning/making cities
- Orientation - positioning plots/buildings -considering four cardinal directions; NSEW - four other subsidiaries directions;
- Each direction unique/distinct- strength and weaknesses, - in terms of solar radiation /heating/cooling of cities/buildings
- If North has no Sun; -- South has highest Solar Intensity - Sun low/horizontal - – West side hottest-- Avoid West direction for minimizing heat gain.
- Making cities cool require –
- - maximum plots - best advantage of orientation.
- -- SE /NW could be best option
- - With Plots having best orientation,
- - much easier for architects to plan climate responsive buildings
- Place Longer axis of building facing north-south direction,
- -- with shorter sides facing East-West remains best option for minimizing adverse impact of buildings in heating the cities.

Leveraging Wind For Cooling Cities

Leveraging Wind For Cooling Cities

- Leveraging Potential of wind -in cooling cities / reducing temperature by;
- - mapping prevailing direction of wind-flow
- - integrating wind flow in planning process of city/NHs.
- - Orienting urban roads /streets/houses to face wind direction.

- for washing away excessive heat trapped in streets/buildings

--making cities cool- specially in coastal areas

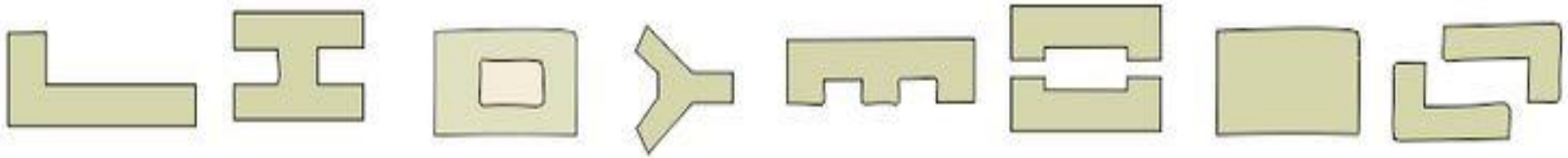
-settlements located close to water bodies;

- have high degree of humidity, throughout year.

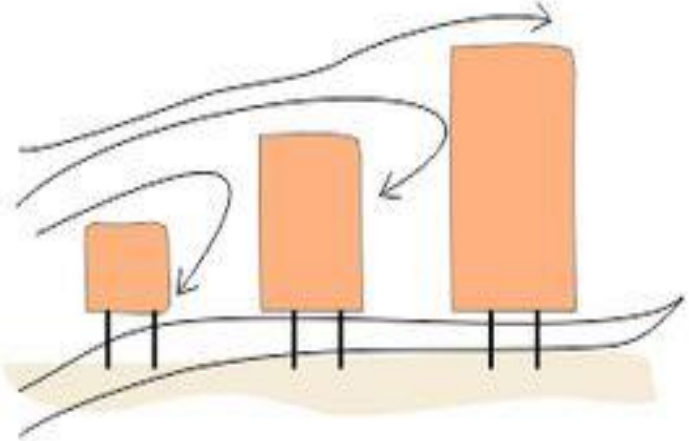
- Stagger high density/rise buildings

- for reducing urban heat island effect

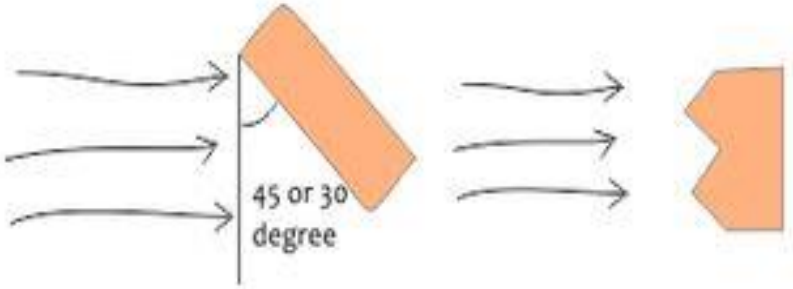
- -- by taking away heat trapped within high rise buildings.
- --Accordingly, existing air flow pattern – essential/ integral component
- --- while planning of cities;-
- - undertaking sub-division of land and
- -- positioning of buildings



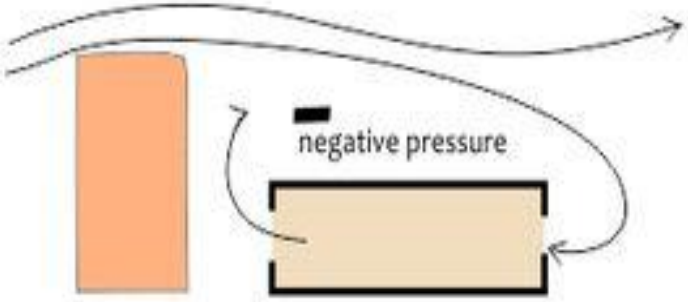
Orient longer facades along the north. This will provide glare free light in summer from north without shading and winter sun penetration from the south.



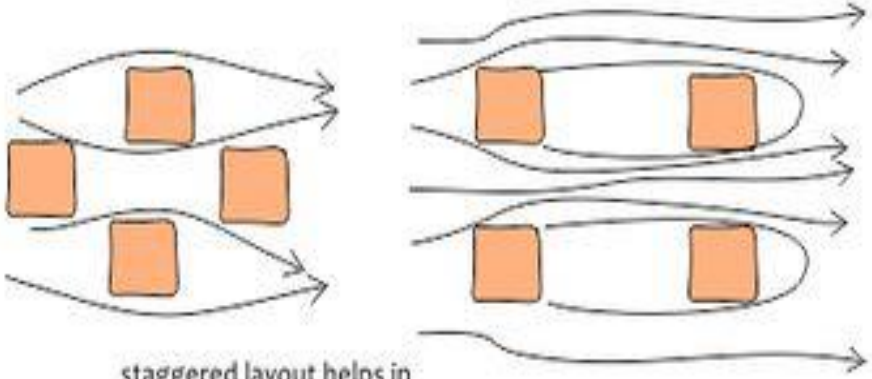
if a site has multiple buildings, they should be arranged in ascending order of their heights and be built on stilts to allow ventilation



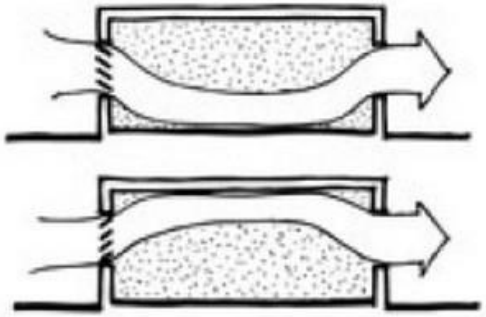
Place buildings at a 30 or 45 degree angle to the direction of wind for enhanced ventilation. Form can be staggered in the wind facing direction also to achieve the same result.



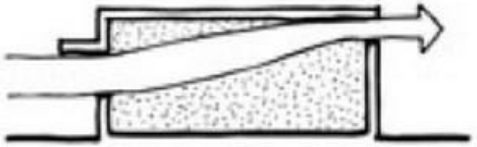
Taller forms in the wind direction of prevailing wind can alter the wind movement pattern for low lying buildings behind them



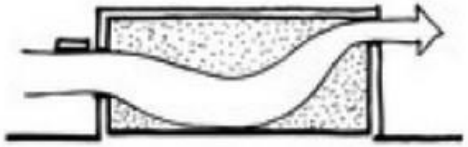
staggered layout helps in accentuating wind movement



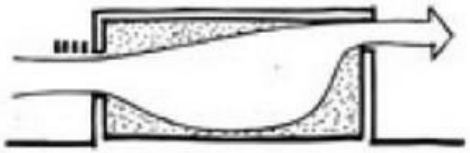
Louvres can direct airflow upward or downward.



A canopy over a window tends to direct air upward.



A gap between canopy and wall ensures a downward pressure.



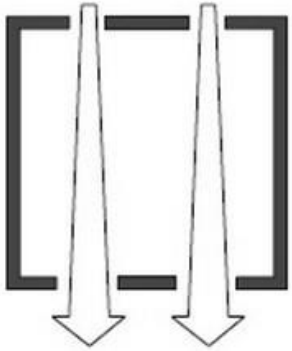
Downward pressure is improved further in the case of a louvered sunshade.

Steve Szokolay

_cross-ventilation

_higher up windows to allow hot air to escape

_smaller inlet windows facing prevailing winds and larger outlet windows on opposite side



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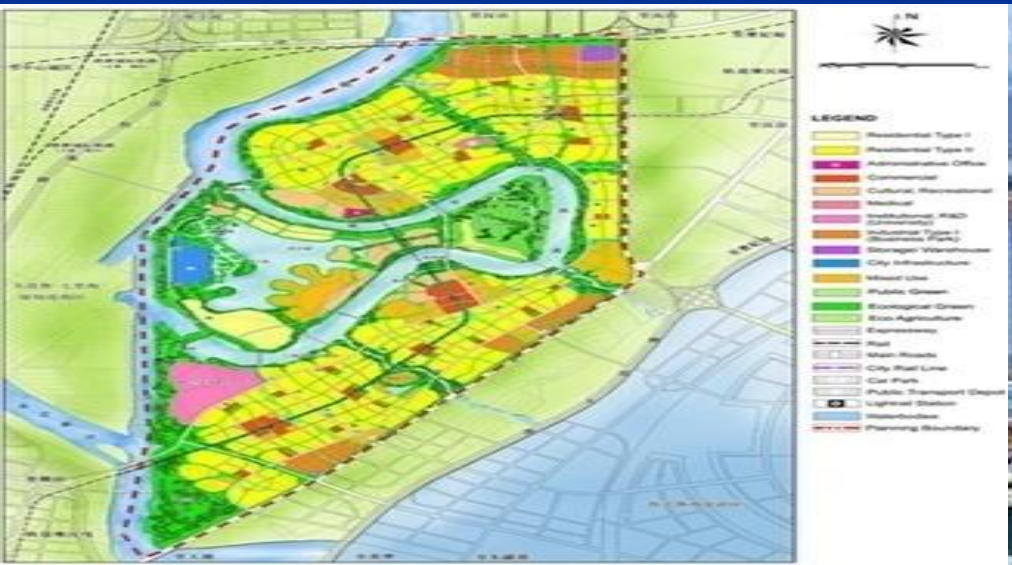
TIANJIN- Master Plan

1. **Land-use Planning – compact City — mix land uses – TOD**

2. Transport Planning -Green transport .—public transport ; bicycles and walking

3. Green & Blue Network ---extensive green (vegetation) and blue (water) networks – for quality living /working environment.

4. **Water bodies --**linked for circulation – enhancing ecology , environment , recreational activities.
5. A **wastewater pond -**rehabilitated /transformed into a clean/beautiful lake.



Green City of World –Musdar – Abu Dhabi-UAE

- **A city of 50,000population**
- **City of "no cars", no waste**
- Planned to make use of cool sea winds
- Using solar energy on rooftop
- Narrow streets shading houses
- Total recycling of waste/water
- **working/ living area--** not farther than200 mts from transportation nodes.
- Electric powered light rail on elevated track to permit easy transport between Musdar and Abu Dhabi.

•for Intra-city travel people use personal rapid transit pods (PRT) run on magnetic tracks using electric power.

•**Aim is to create:**

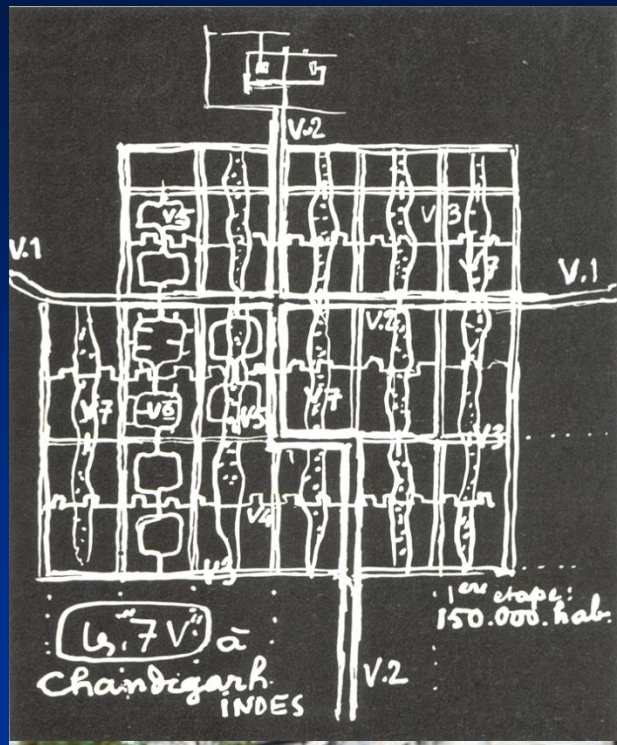
- Zero Carbon
- Zero Waste
- Zero Car city

GREEN TRANSPORTATION

TRANSPORTATION SCENARIO IN INDIA

ISSUES:--Heterogeneous Traffic

- increasing individual vehicle ownership;
- low road capacity; poor road geometry;
- large obsolete vehicular population;
- inefficient/ inadequate public transportation;
- high degree of environmental pollution;
- low priority for traffic planning; ;
- Low priority to bicycles/pedestrians
- poor traffic management;
- mismatch between vehicle density/ road capacity;
- multiplicity of agencies involved
- absence of unified traffic regulatory authority;
- acute problems of parking;
- high rates of accidents etc.



CONFLICT BETWEEN MAN& MACHINE

Transportation- Options

- Minimize travel- Making cities compact-
- Planning for mixed land-use/ TOD
- Changing priority for travel-
- Planning for People-- not for vehicles
- Promoting Accessibility-- Not Mobility
- Promoting Walking/Cycling- not Cars
- Promoting Mass Transportation
- Pricing Roads
- Making Equitable allocation of road space

Green Transportation pyramid

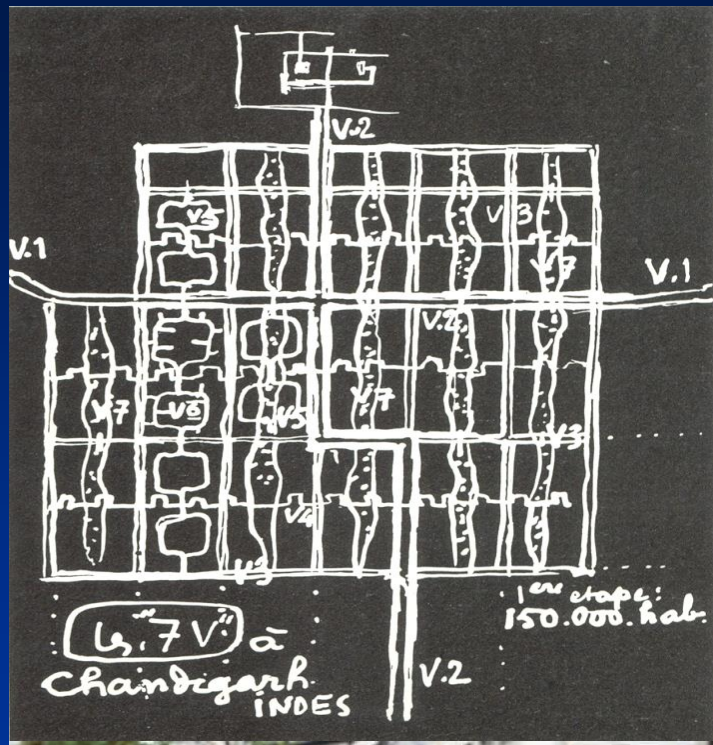
Transport systems are major emitters of greenhouse gases, responsible for 23% of world energy-related GHG emissions in 2004, with about three quarters coming from road vehicles.

Currently 95% of transport energy comes from petroleum. Energy is consumed in the manufacture as well as the use of vehicles, and is embodied in transport infrastructure.

Source: Wikipedia.org

SMART TRANSPORTATION- CYCLING

- Promoting use of Bicycle as preferred mode of travel for majority of intra- city travel being :
  - Most inexpensive
  - Most flexible
  - Environmental friendly
  - Zero pollution
  - Zero Energy Vehicle
  - Occupying minimum road space
  - Requiring minimum Parking Space
  - Promoting National Economy
  - Promoting Human Health
  - Reducing depletion of Non-renewable resources
  - Best option for travelling over short distance.



JANMARG AHMEDABAD

SINGAPORE MODEL OF ROAD PRICING

Cool Roads

- Roads, major cause of heating cities.
- Occupying > 10 % area with black asphalt-absorbing about 95% of sun's energy – creating heat island
- Painting roads -- with white-coloured sealant ----with high reflectivity
- ----reduction of 10- 23F cooler after painting.
- Opt for lighter clay tiles
- —reflect sunlight quite well.
- .

Cooling Roads

Green Rotaries

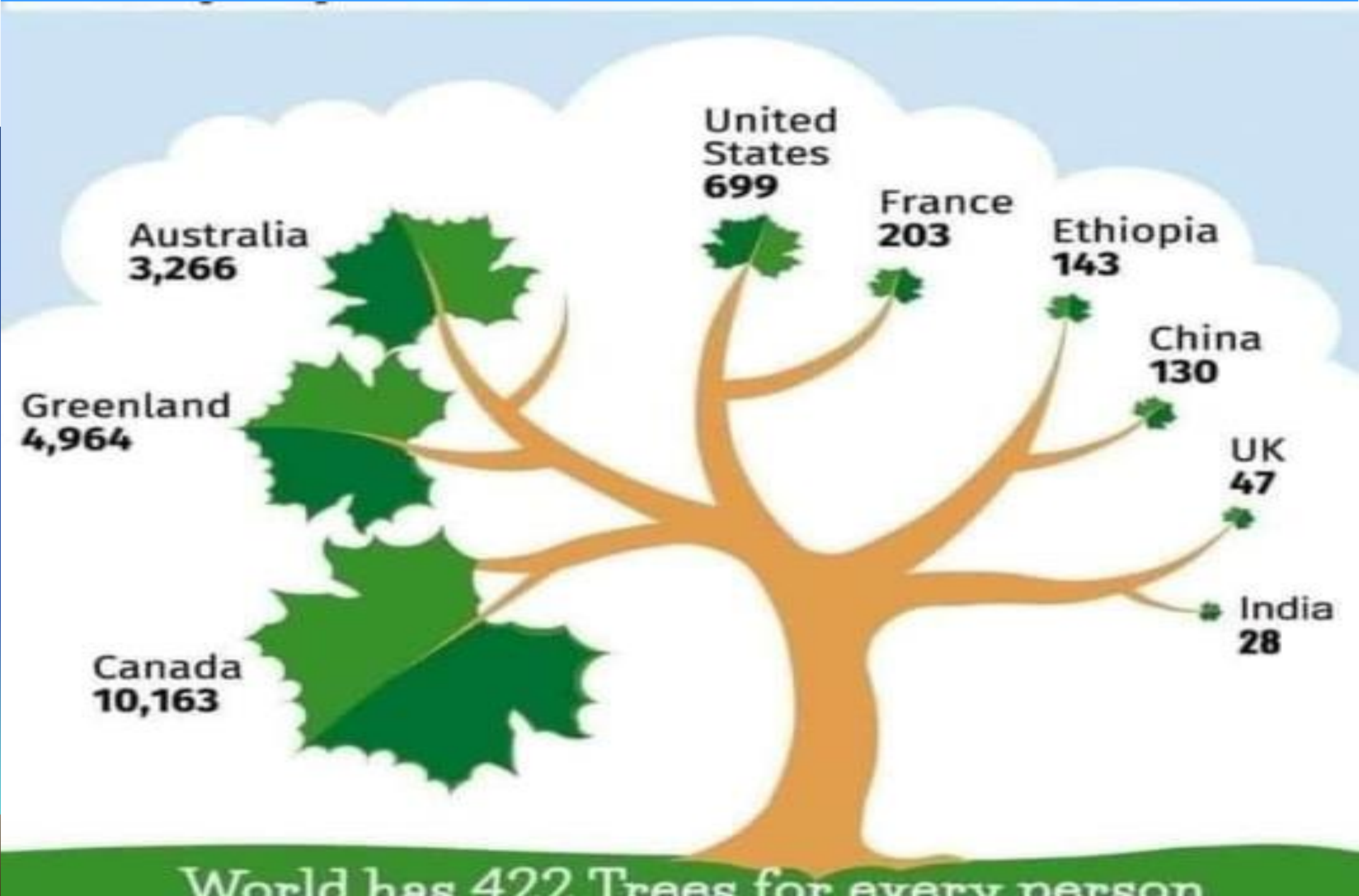
Green Rotaries- Chandigarh

GREENING CITIES

Green Spaces- Cooling Cities

- Green spaces - known for distinct advantage in urban setting;;
- *lowering urban temperature*
- *Making Cities Cool*
- *reducing demand for air- conditioning*
- *- reducing & absorbing - heat*
- *Acting as sponge- for absorbing floodwaters/minimize flooding*
- *making neighborhood qualitative / beautiful,*
- *providing shade -during a heat wave,*
- *promoting good mental health.*
- *Creating jobs - planning, developing/ maintaining green spaces.*
- ,

Global- Tree Count



Trees- Man Ratio

A human breathes about 9.5 tonnes of air /year

-- oxygen only makes up about 23 % of air by mass

-- One third of oxygen from each breath-- 740kg of oxygen / year.-

- -- roughly, seven / eight trees' worth.

Cities gasping for breath

WHO recommends 9 square metre of open space per person

Mumbai
0.99
square metre per person

Bangalore
2
square metre per person

Tokyo
4
square metre per person

London
32
square metre per person

socialcops

SOURCE: Municipal Corporation of Greater Mumbai, 2012 & TOI

THE VALUE OF TREE

A Tree that lives 50 years.

Generates Rs. 5.3 lakhs worth of Oxygen.

Recycles Rs. 6.4 lakhs worth of Soil Fertilizer.

Facilities Rs. 6.4 lakh worth of Soil Erosion Control.

Creators Rs. 10.5 lakh worth of Air Pollution .

Control and provide 5.3 lacs of shelter for Birds & Animal.

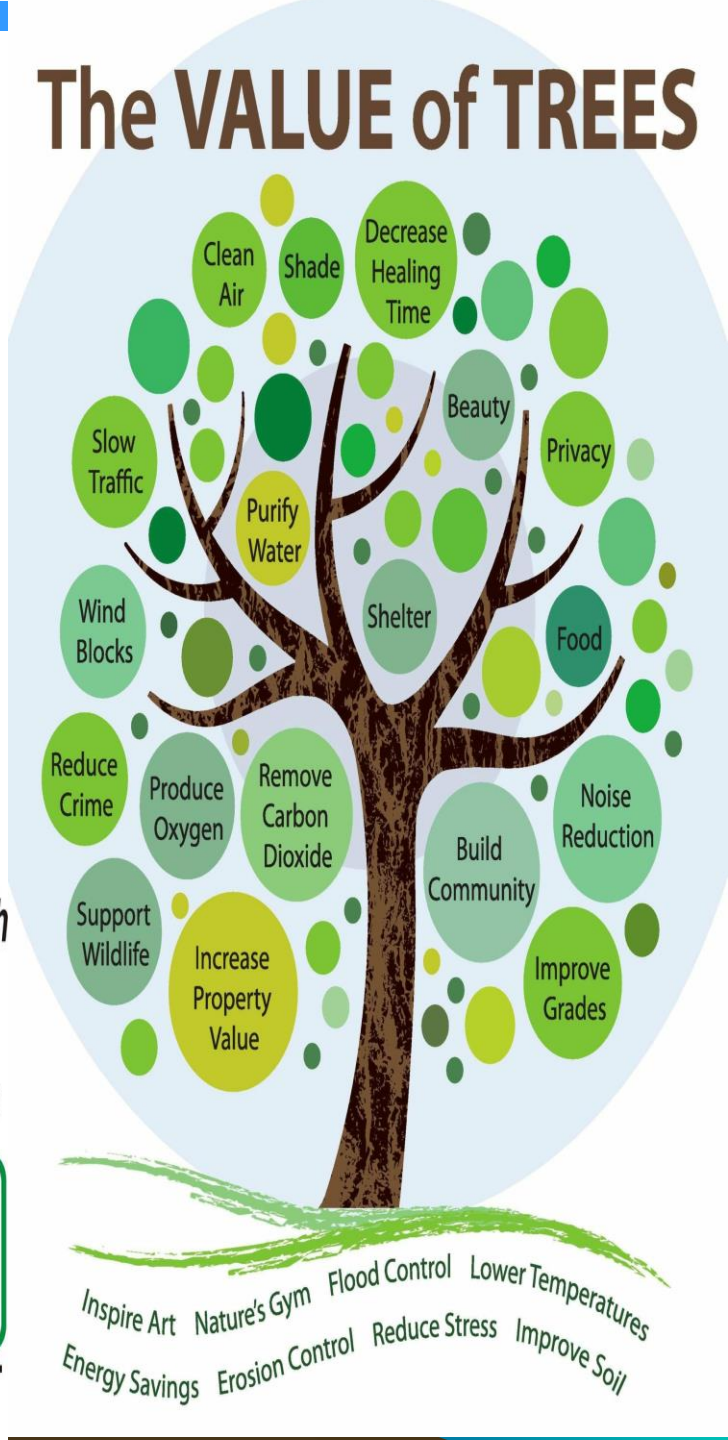
Besides, if provides flowers and fruits .

So, when one tree fall or is felled the city's net loss in worth more than Rs. 33 lakh.

THINK BEFORE YOU CUT A TREE .....!

PLANT YOUR OXYGEN TODAY !!

SCF TRUST



Urban Forest

Central Park New York- 700 Acs *Vaux and Olmsted'*

Planning Gardens for making value addition/ Recreation of people-Moghul Garden PINJORE

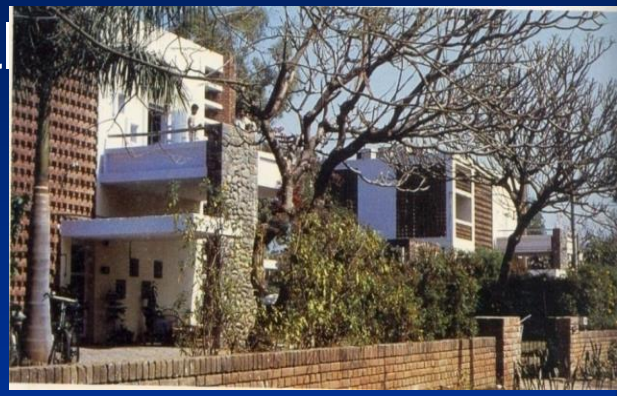
Chandigarh Master Plan- Le Corbusier

Today Curitiba boasts > 50 sq metres of green space per person. Buenos Aires's two sq meters / person

Making Buildings Green

BUILDINGS AS CONSUMERS OF RESOURCES

- Built environment impact environment / consumption of resources:
  - 16% of world's fresh water withdrawal
  - 25% of wood harvested.
  - 30% of consumption of raw material.
  - 50% of global energy consumption.
  - 35% of world's
  - CO_2 emission
  - 40% of Municipal solid waste.
  - 50% of Ozone depleting CFC's still in use.
  - 30% of the residents having sick building syndrome



(Roodman and Lenssen, 1995)

- 70% global warming--outcome of buildings / transportation

- Buildings planned, designed and operated with utmost care for considerations--- energy/ sustainability/resources

Buildings and Climate

- Buildings responsible for-- global warming, climate change/ increasing carbon footprints. buildings - warming planet earth/ raising
- Essential for making buildings supportive of cooling cities /moderating temperature
- buildings designed/operated with nature-- sun, space and greenery, -- Evolving Passive design of buildings,
- minimizing building-led heating- critical role of building envelop.
- -- Major heat gain/ loss through building envelop.
- Within buildings envelop- building façade/ roof gain/lose heat
- - greatest challenges posed by-fully-glazed facades.
- - building trap lot of unwanted heat in summer.
- - Facades need shading to minimize solar radiation.
- --shielding glass from adverse impact of direct/reflected solar radiation.
- -Mechanical systems used to move with local weather/ sun,

for allowing filtered light / views =while protecting inhabitants from sun

- buildings made of wood /natural resources -- reduces heat absorption

When compared to buildings- using steel conc/rete

Defining- Green Buildings

DEFINITION:

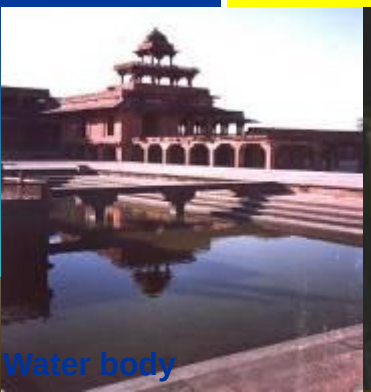
- "A green building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

- ***Buildings can achieve zero carbon by; Adopting Integrated approach to design-Planning with nature, natural elements, Climate, Evolving passive building design,- eliminating using fossil fuel --for heating, cooling /air conditioning; using on-site/off-site renewable energy,Retrofitting Buildings***
- ***reducing use of high global warming potential refrigerants using low-carbon, reused/re-cycled construction materials***

Indian Way of approaching design

- **Rediscovery of the Indian ethos**
  - **We worship 5 elements of Nature (Panchabhutas)**

Prithvi (Earth)	**Sustainable Sites**
Jal (Water)	**Water Efficiency**
Agni (Energy)	**Energy Efficiency**
Vayu (Air)	**Indoor Environmental Quality**
Akash (Sky)	**Daylight**

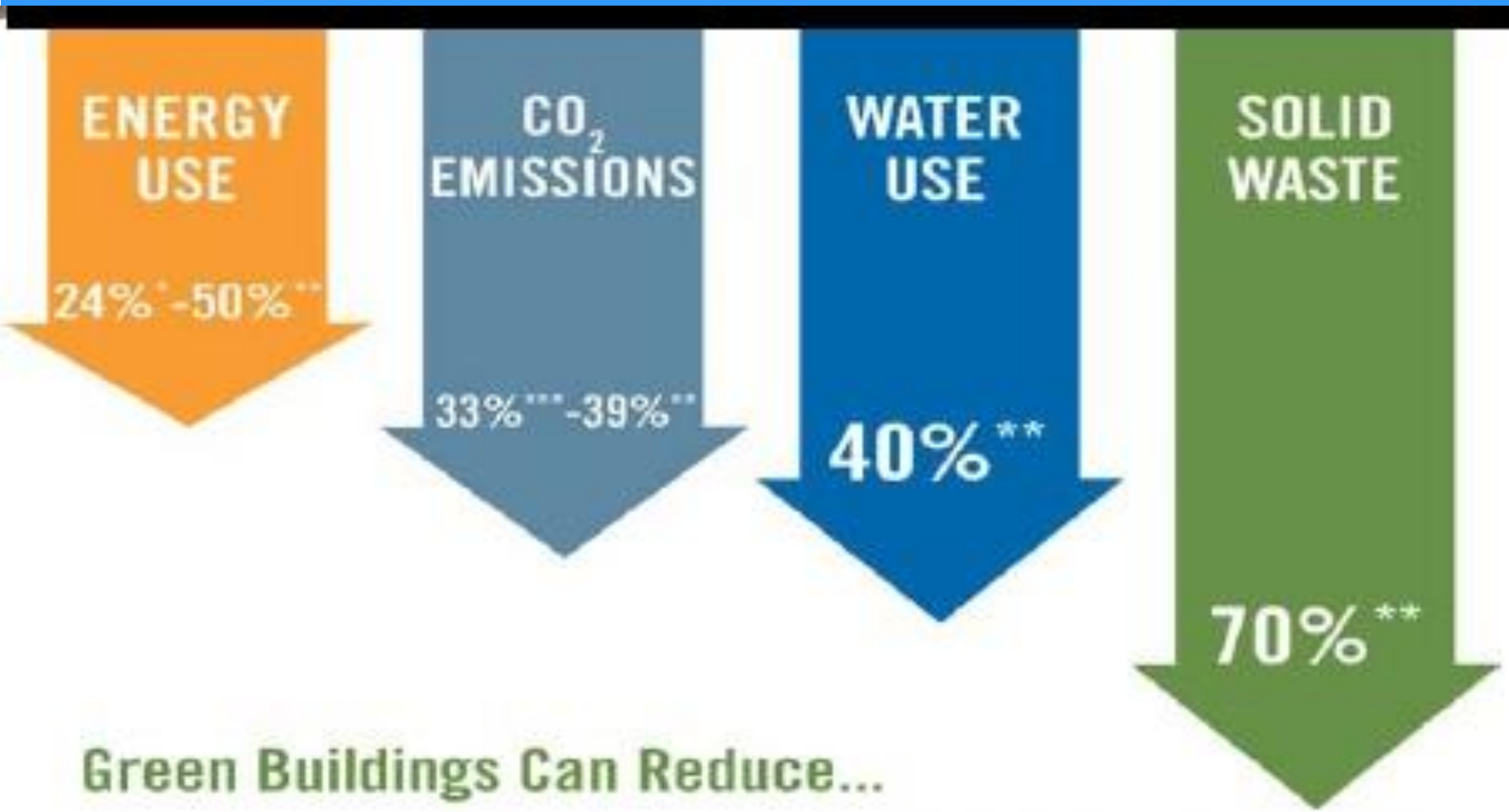

Water body


Local materials


Views

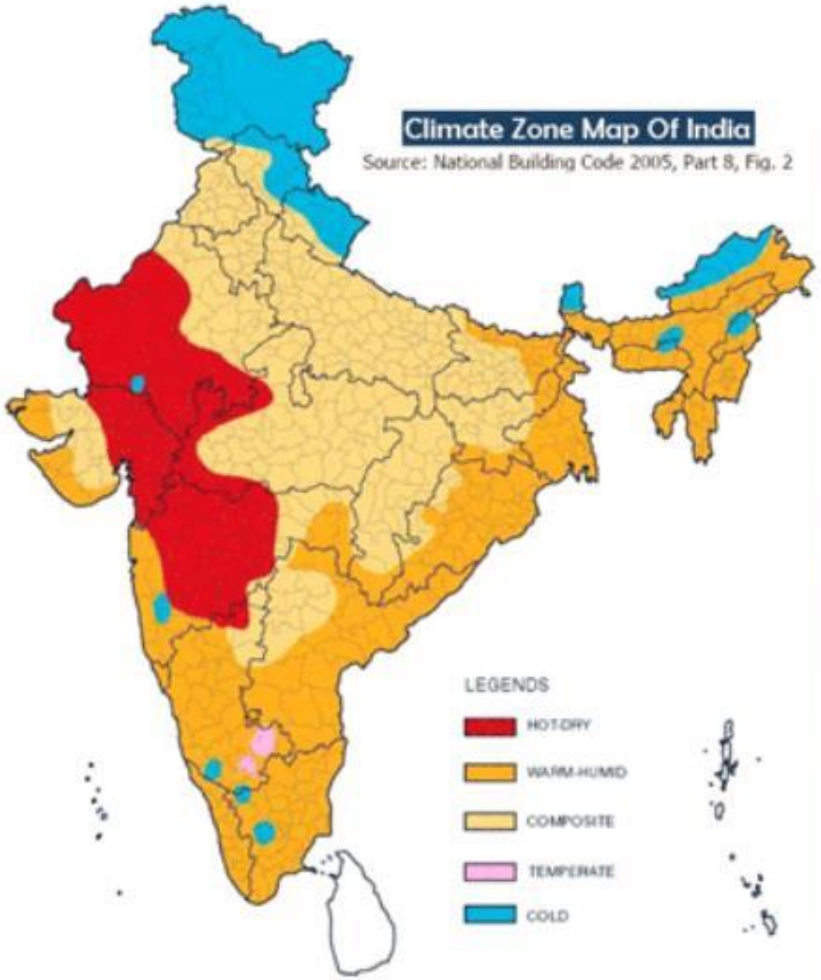

Daylighting

Advantages of Green Buildings



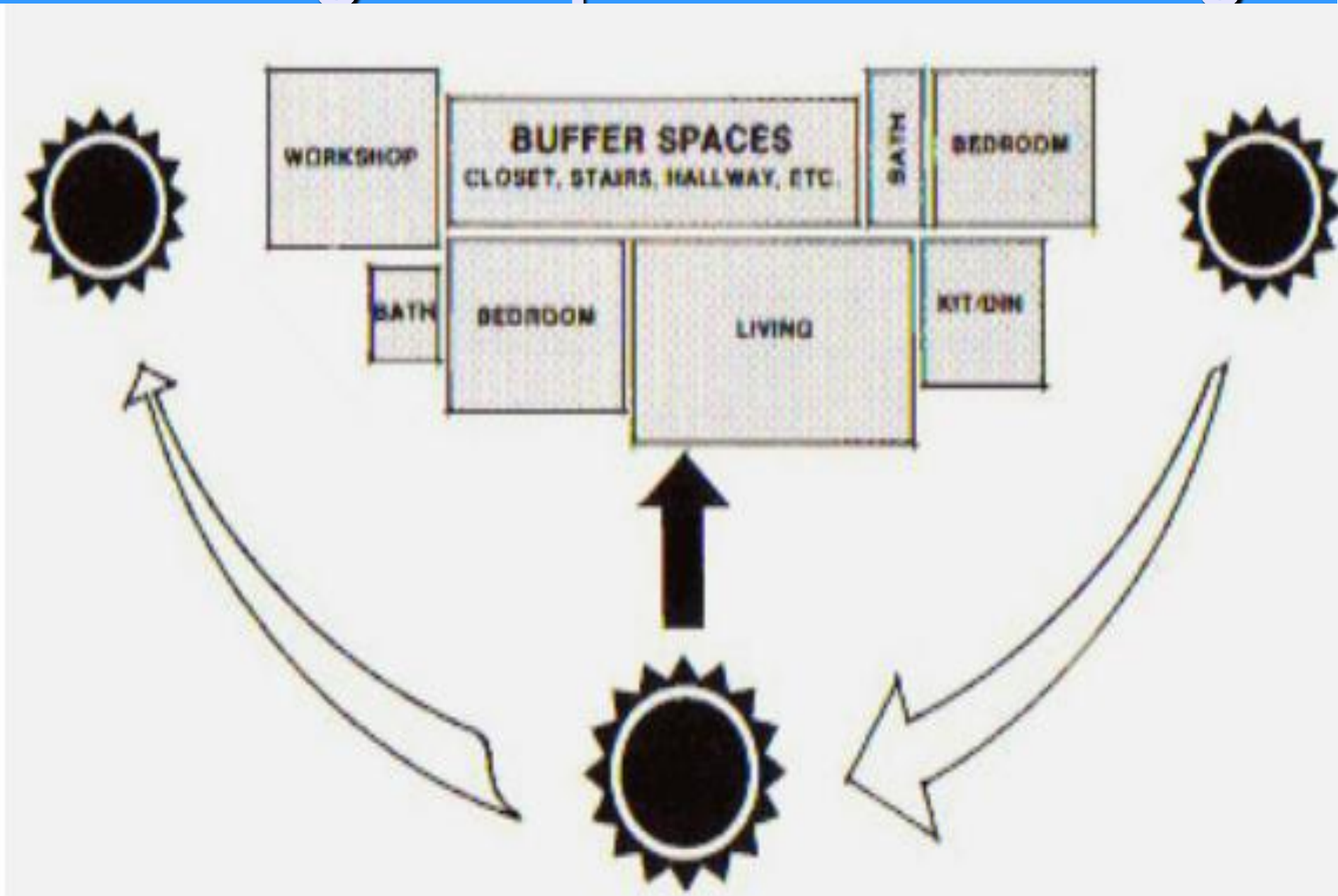
* Turner, C. & Frankel, M. (2008). Energy performance of LEED for New Construction buildings. Final report.
** Kats, G. (2003). The Costs and Financial Benefits of Green Building: A Report to California's Sustainable Building Task Force.
*** GSA Public Buildings Service (2008). Assessing green building performance: A post occupancy evaluation of 12 GSA buildings.

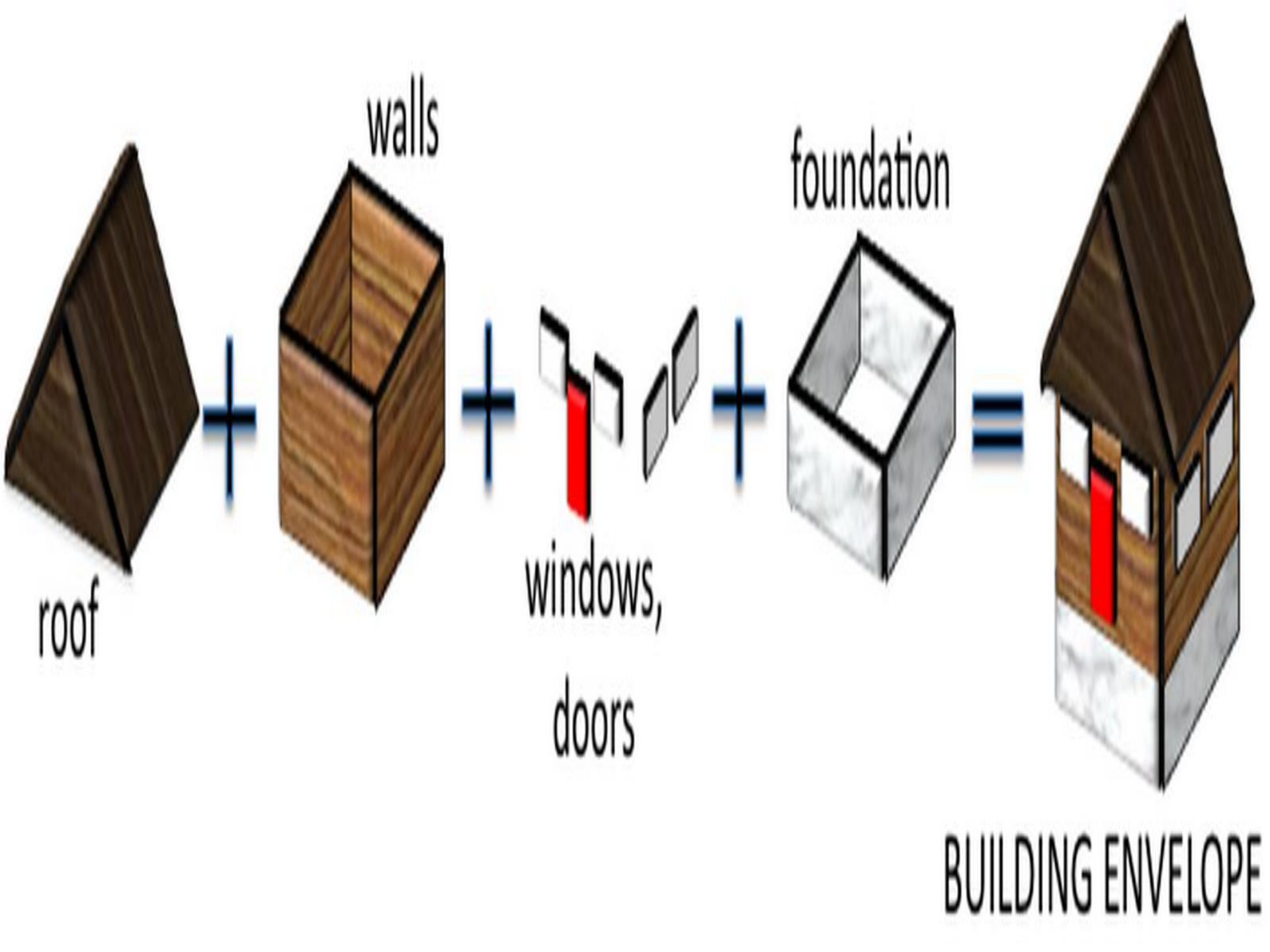
Climatic zones of India



- Hot & Dry
- Warm & Humid
- Composite
- Temperate
- Cold

Planning for spaces in buildings




walls
foundation
roof
windows,
doors
BUILDING ENVELOPE

Cool Roof- Advantages

- Reducing temperature within/outside buildings
- Decreasing energy use / cost
- Improving air & water quality within/outside neighborhood
- Sequestering carbon,
- Providing habitat for wildlife –
- -Meeting deficiency of green spaces in walled cities/congested areas
- Avoiding flooding cities
- - Reducing amount/ intensity/ duration of storm water release
- Creating space for socialization - for families & communities
- Increasing life of roof-- by protecting them from adverse impact of climate
- New York Cool Roofs initiative - more than 500,000m² of roof space covered in white reflective coating,- saving an estimated 2,282 tonnes of CO_2 per year
- NASA concluded - white roof could be-- 23C (42F) cooler than a typical black roof --on hottest day of New York summer

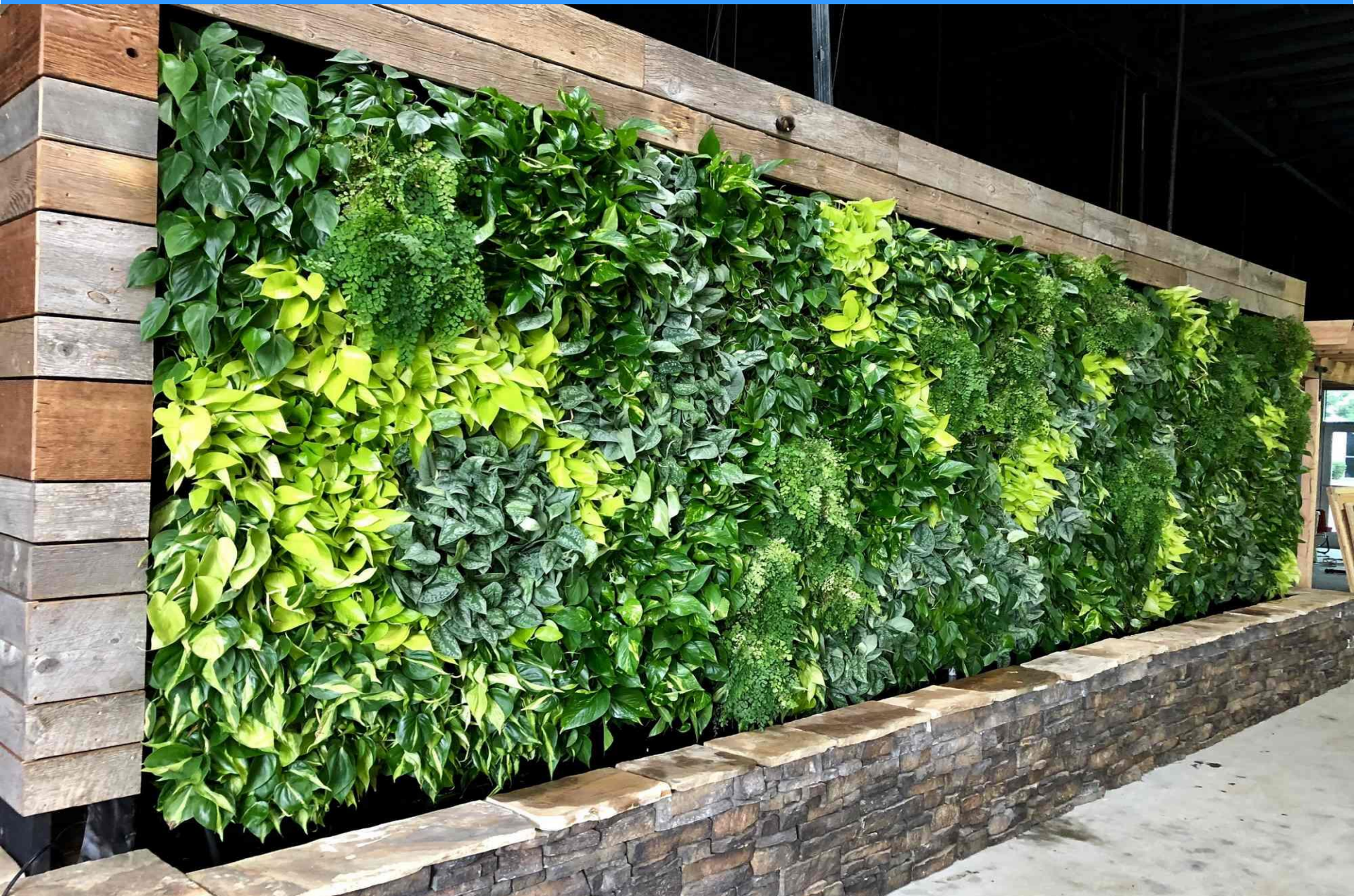
Making Roof White

Making Roof Garden

Public housing --Singapore, seven 50-story towers connected by 1,600-foot-recreational "sky garden." -- high-density development accommodating growth in compact city-state.

Singapore-- Super trees in 250-acre Gardens by Bay.
-- High-tech structures range from 80 to 160 feet
-- collect solar energy to power a nightly light show.
-- trunks are vertical gardens, laced with more than 150,000 living plants.

Making Walls Green



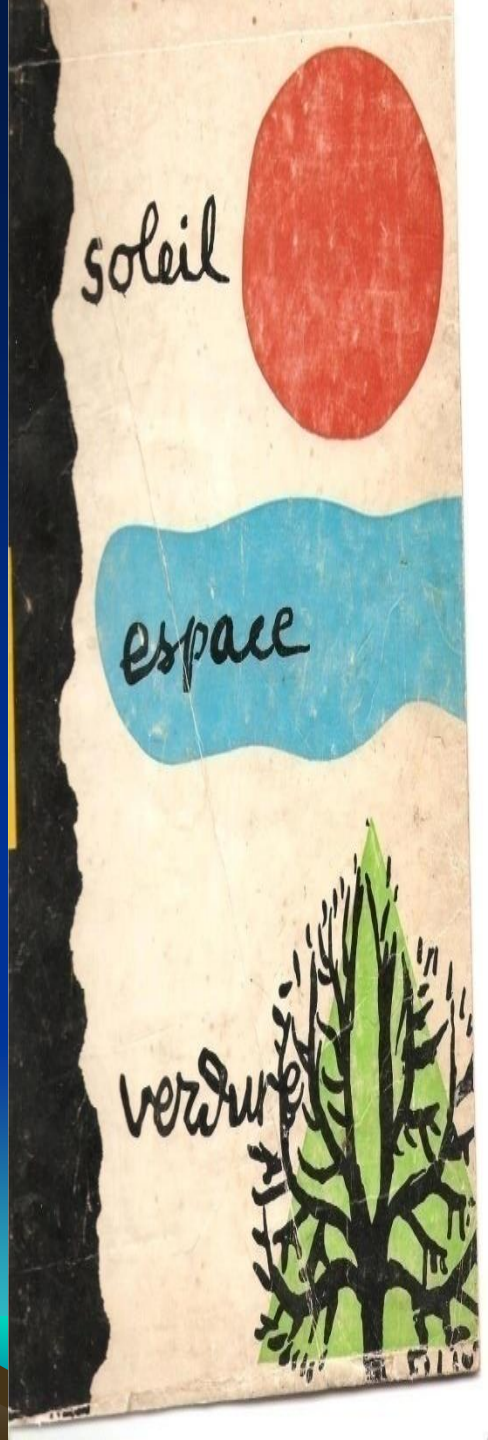
Cooling Cities with water

Cooling Cities with Water

- **Principle- Evaporation causes cooling**
- **Already used in old buildings - leveraged water in promoting cooling /lowering temperature**
- **- Making cities spongy/ planting trees -retain water in soil**
- **-- lowers temperature --by releasing moistures**
- **- helps in - trees/vegetation grow**
- **- Temperatures - near water features –lower up to 10 C lower**
- **- Leveraging existing water bodies, pools, fountains, sprinklers /misting system**
- **-Creating new water bodies**
- **- Chandigarh modulated city temperature -- creating inartificial Sukhna lake**
- **- Chongqing /China ,-- known for heat -- provided cooling by using water misters – created cooling by 5-7 C,**

Sukhna Lake- Chandigarh

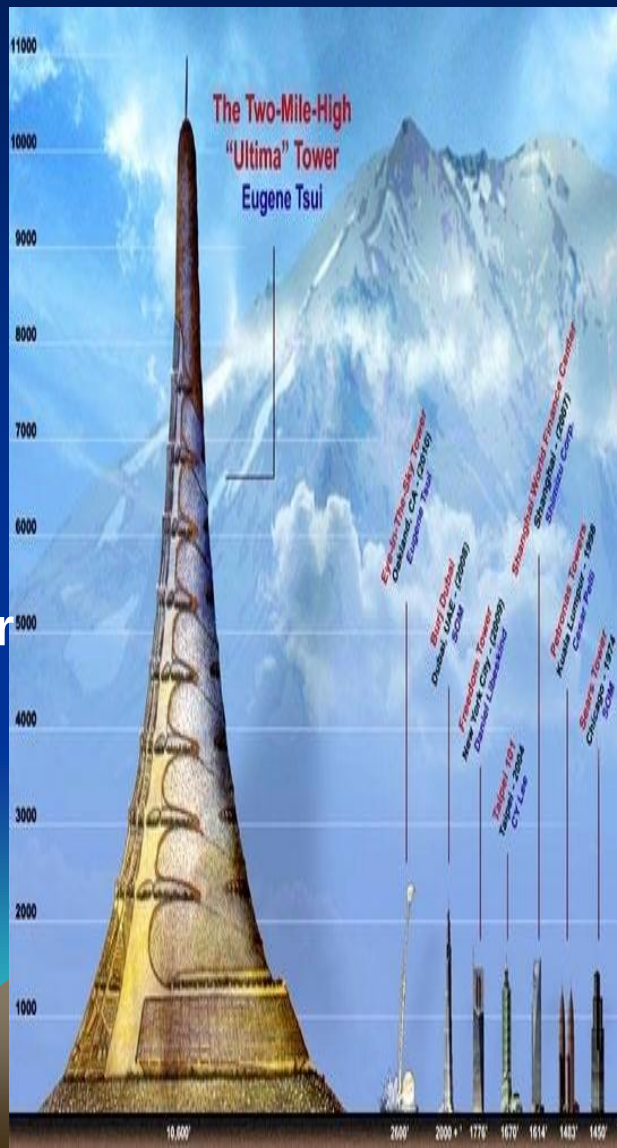
- FUTURE CITIES



Future Cities-Conceptual

Ultima Tower- 2Mile High Sky City

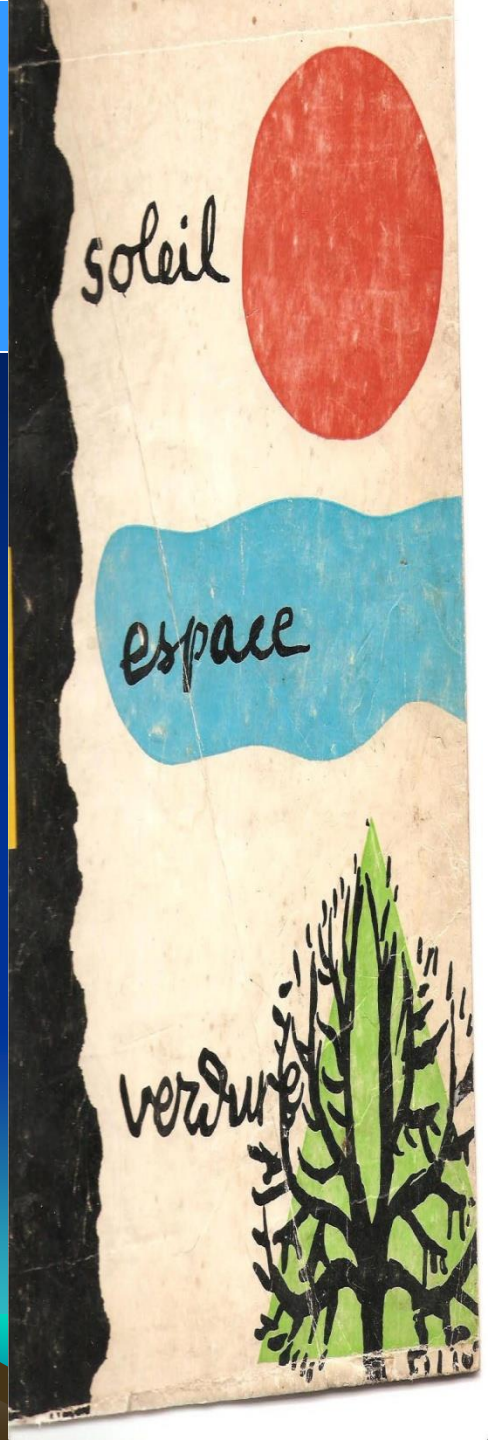
- Location: Any densely populated urban environment
- Date: 1991
- Cost: $150,000,000,000
- Population: 1,000,000 people
- Exterior surface area of building: 150,000,000 sft.
- Enclosed volume: 53,000,000,000 cubic feet
- Total enclosed acreage: 39,000 acres-156 sectors
- Elevator speed: 20 feet per second (13 miles per hour) 9 minutes and 40 seconds to reach top floor from ground floor.
- Dimensions: Height--10,560 feet;
- Diameter at the base--6000 feet;
- Number of stories--500;
- Total Square Feet: Approximately 5,000,000 sft



Using Smart Technologies-

Implementing IOT- Traffic, Transportation, Urban Planning, managing infrastructures/services, solid waste management, parking, pollutions, payments etc

- digital --bus stops- bus schedule,
--sensor based garbage bins
- Promoting accessibility
-Managing Traffic/parking – Managing services
Minimizing travel --Tackling noise- Planning cities-
Preparing Master Plans/ Development Plans
- Making amendment in MP/DP
- Monitoring Delivery of services- water supply
--Tackling air pollution
--creating platform for efficiency--breaking silos
-- lodging complaints/ --making payments on line
--rendering services on line



CREATING Smart/Sustainable CITIES POSES GREATEST CHALLENGE TO PLANNERS/ PROFESSIONALS