Looking beyond buildings - Sustainability and the city

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1st MAR 2012. NEW DELHI

Urban Growth

If the current pattern of development and the trends in the growth of major metropolises of the country continue unabated, we are probably building an environmentally unsustainable future for our cities.

We seem to be caught in the vortex of a vicious cycle propelled by a complex interrelationship between five factors:

We seem to be caught in the vortex of a vicious cycle propelled by a complex interrelationship between five factors:

- **Growing dependence on personalized motor vehicles for mobility.**
- **Growing dependence on refrigerant based air-conditioning for thermal comfort.**
- **Growing demand for water for non-domestic uses.**
- **Growing gross densities of development of land.**
- **Growing dependence on the speculative value of land as an economic asset.**

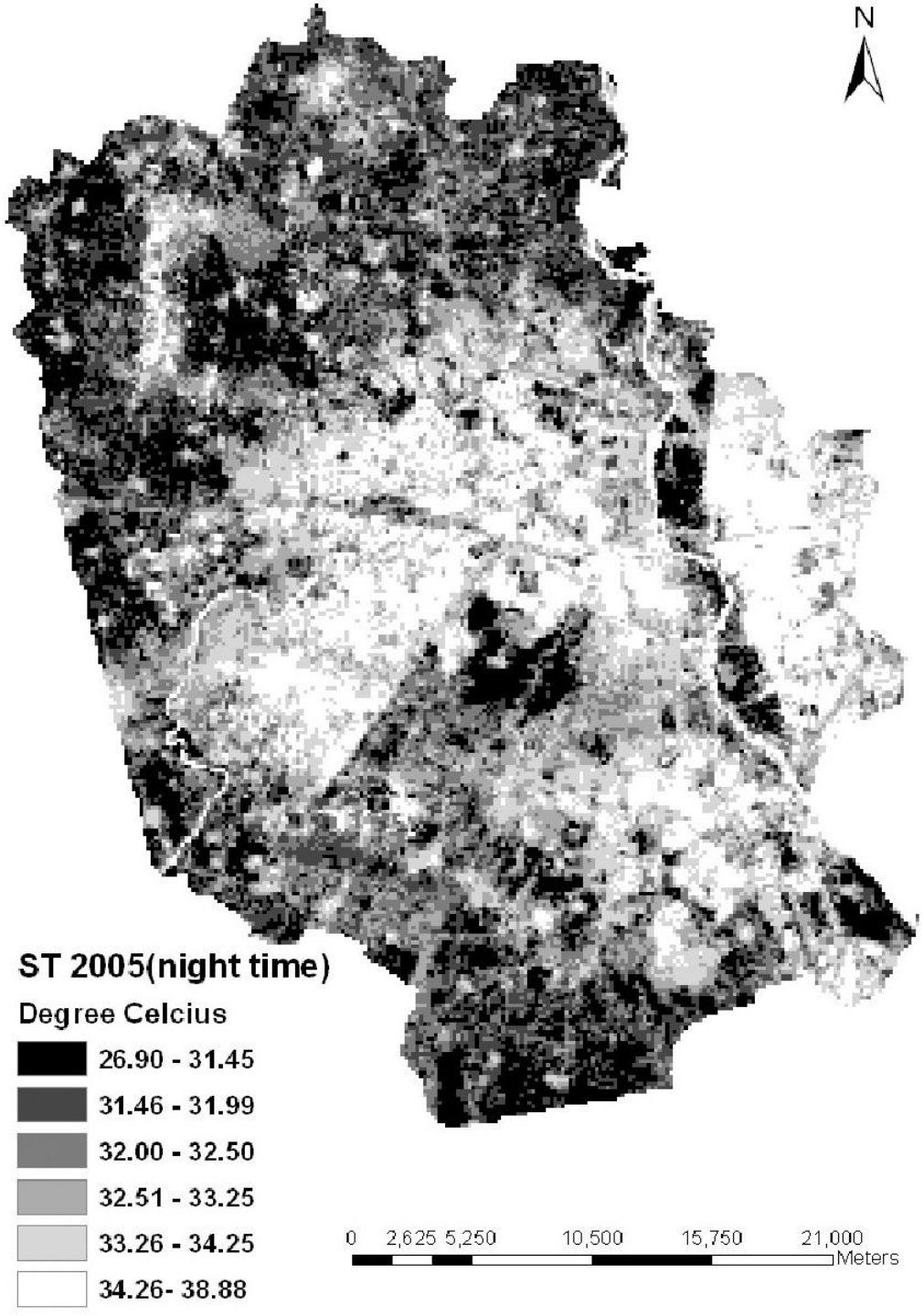
Low carbon imperative

The macro view of mitigating climate change requires a low carbon pattern of urban life.

This means minimizing energy intensity while constructing an improved quality of life.

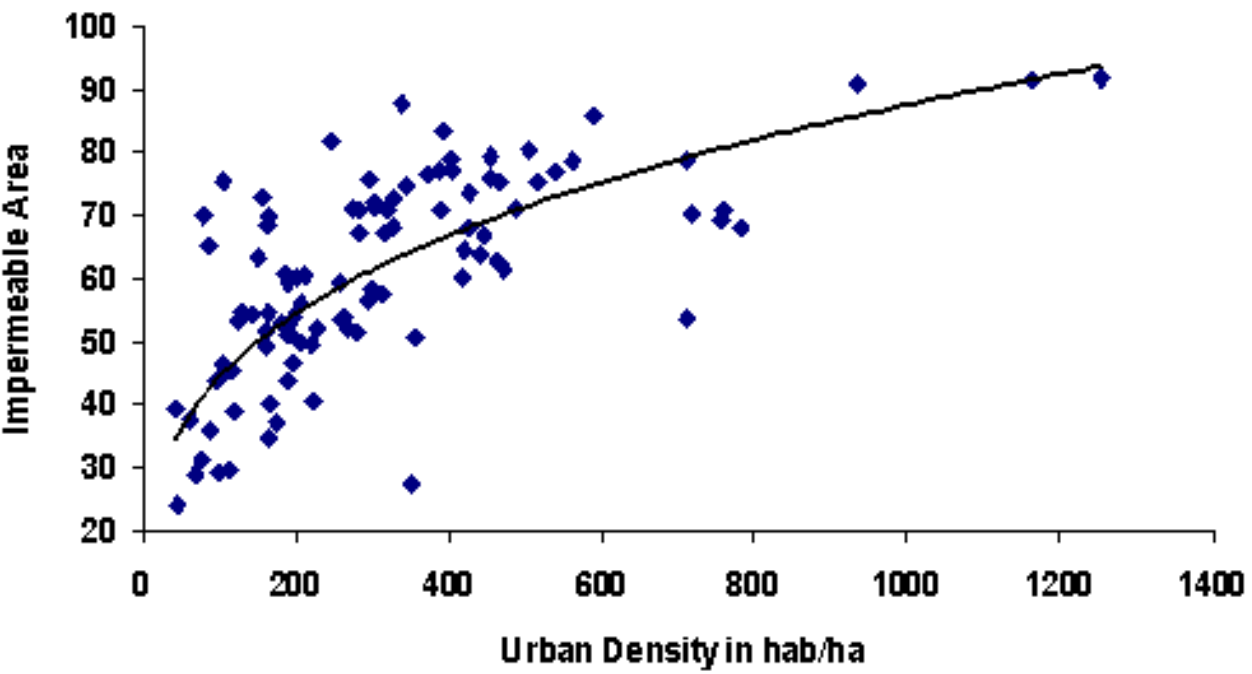
Mobility and thermal comfort increase energy intensity several fold, and these two factors are the primary engines of the vicious cycle.

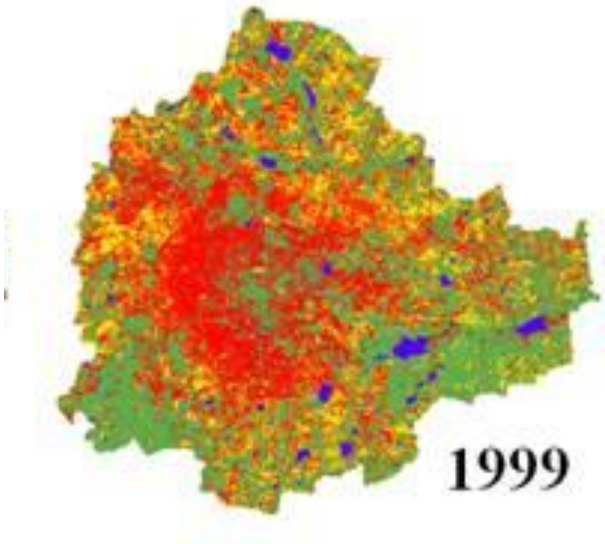
Primary engines of the vicious cycle



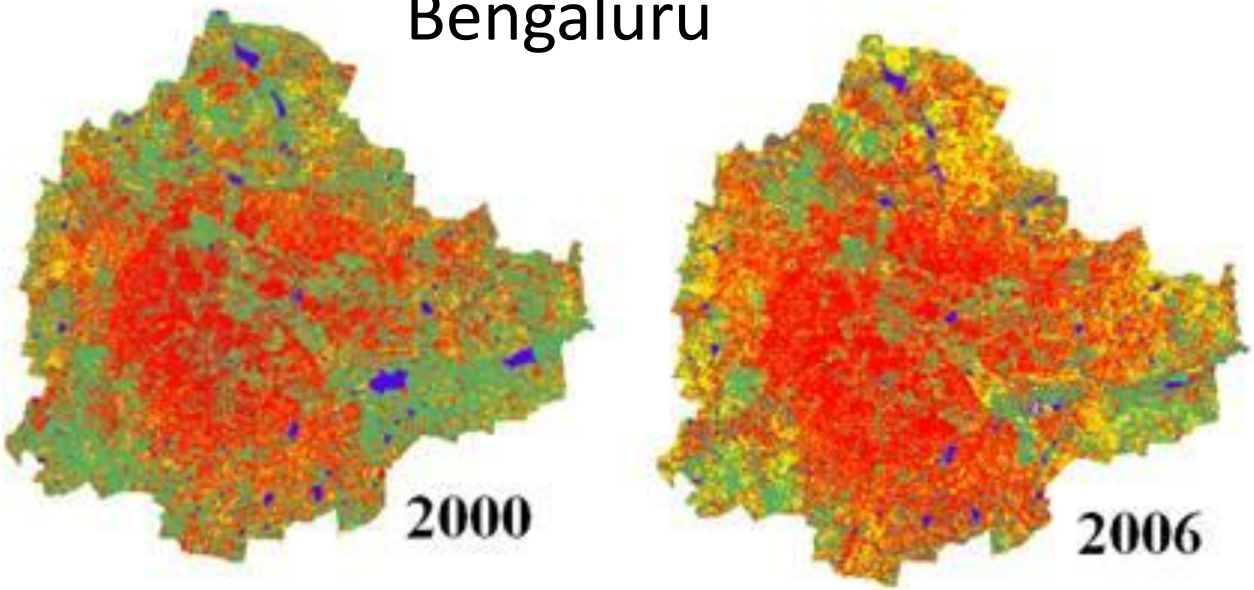
Night time land surface temperatures for Delhi, compiled from ASTER data for 2 October 2005 at 10:35pm, local time.

Source:
Urban remote sensing for a fast-growing megacity: Delhi, India
Netzband Maik and Atiqur Rahman

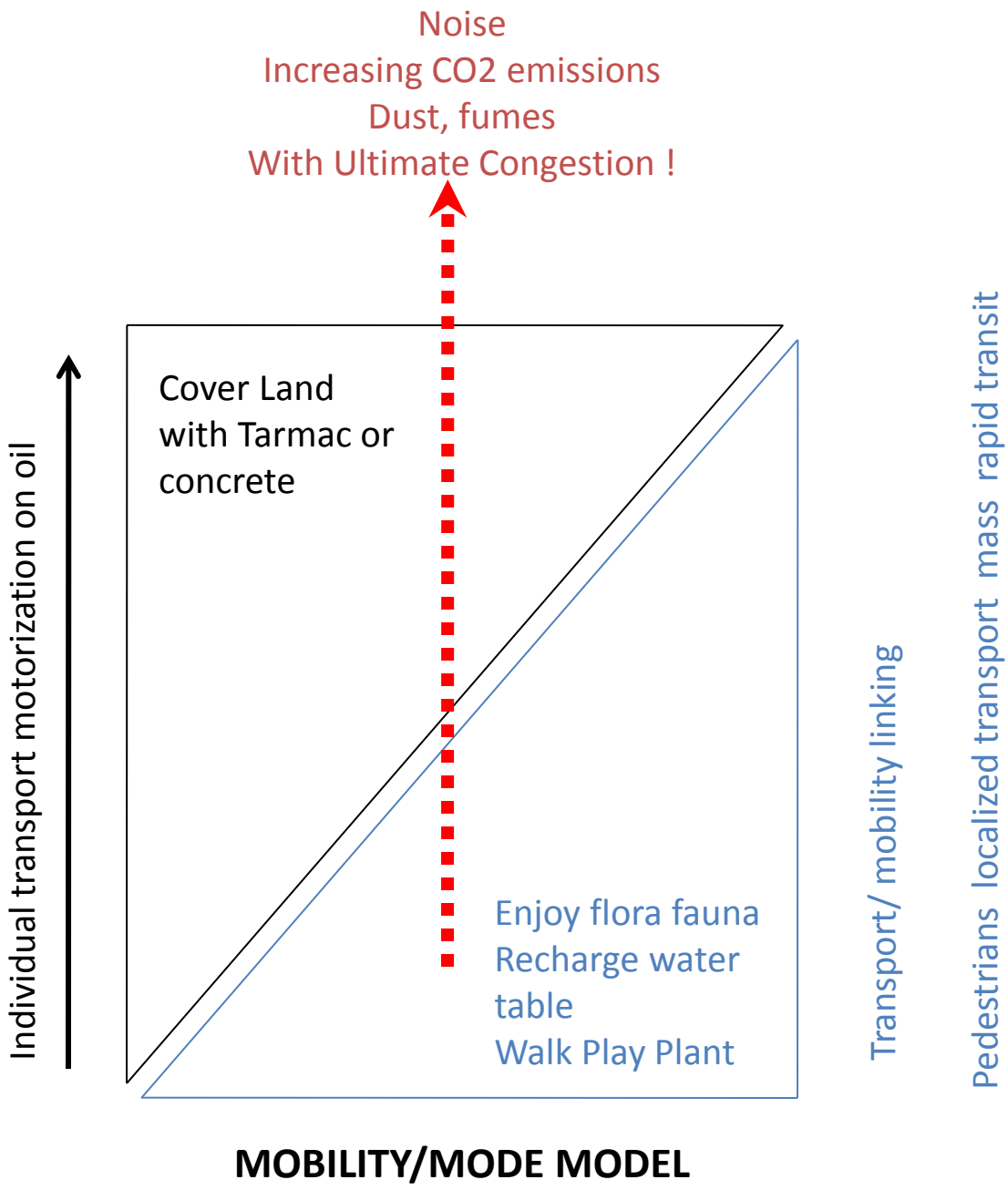




Bengaluru



Source: Landscape Modeling for Sustainable Urban Management
Energy and Wetlands Research Group


Noise
Increasing CO2 emissions
Dust, fumes
With Ultimate Congestion !
Cover Land with Tarmac or concrete
Individual transport motorization on oil
Enjoy flora fauna
Recharge water table
Walk Play Plant
Transport/ mobility linking
Pedestrians localized transport mass rapid transit
MOBILITY/MODE MODEL

Heat Island, Water Run off,
Water Pollution, Dust, Noise.

Rising CO2
Emissions

Rising temperatures,
(Water shortage)

Congestion
Road Rage

?

Land for
The citizen?

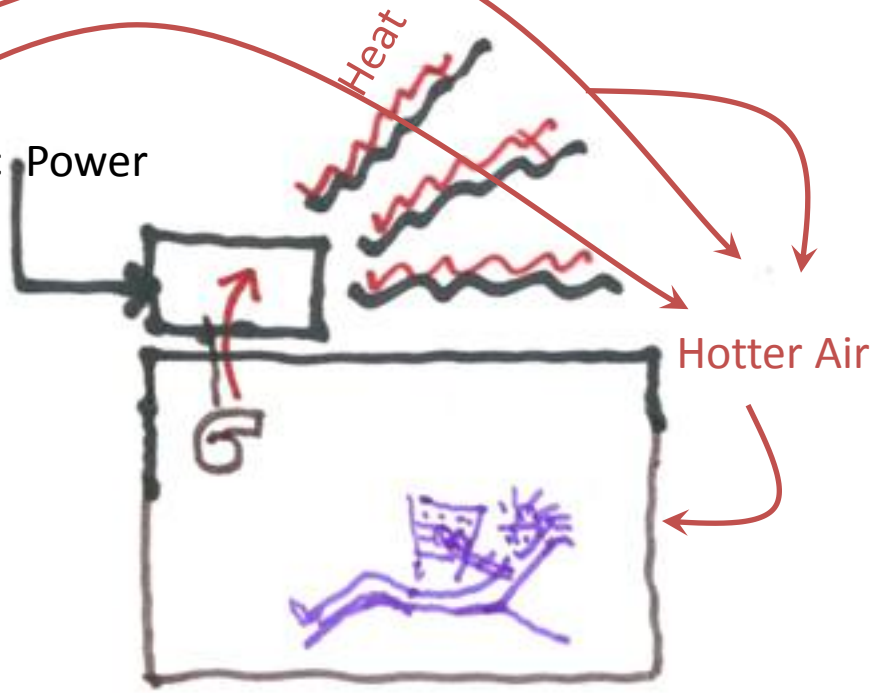
Even more cars
Super Highways roads

More cars
Highways roads & parking

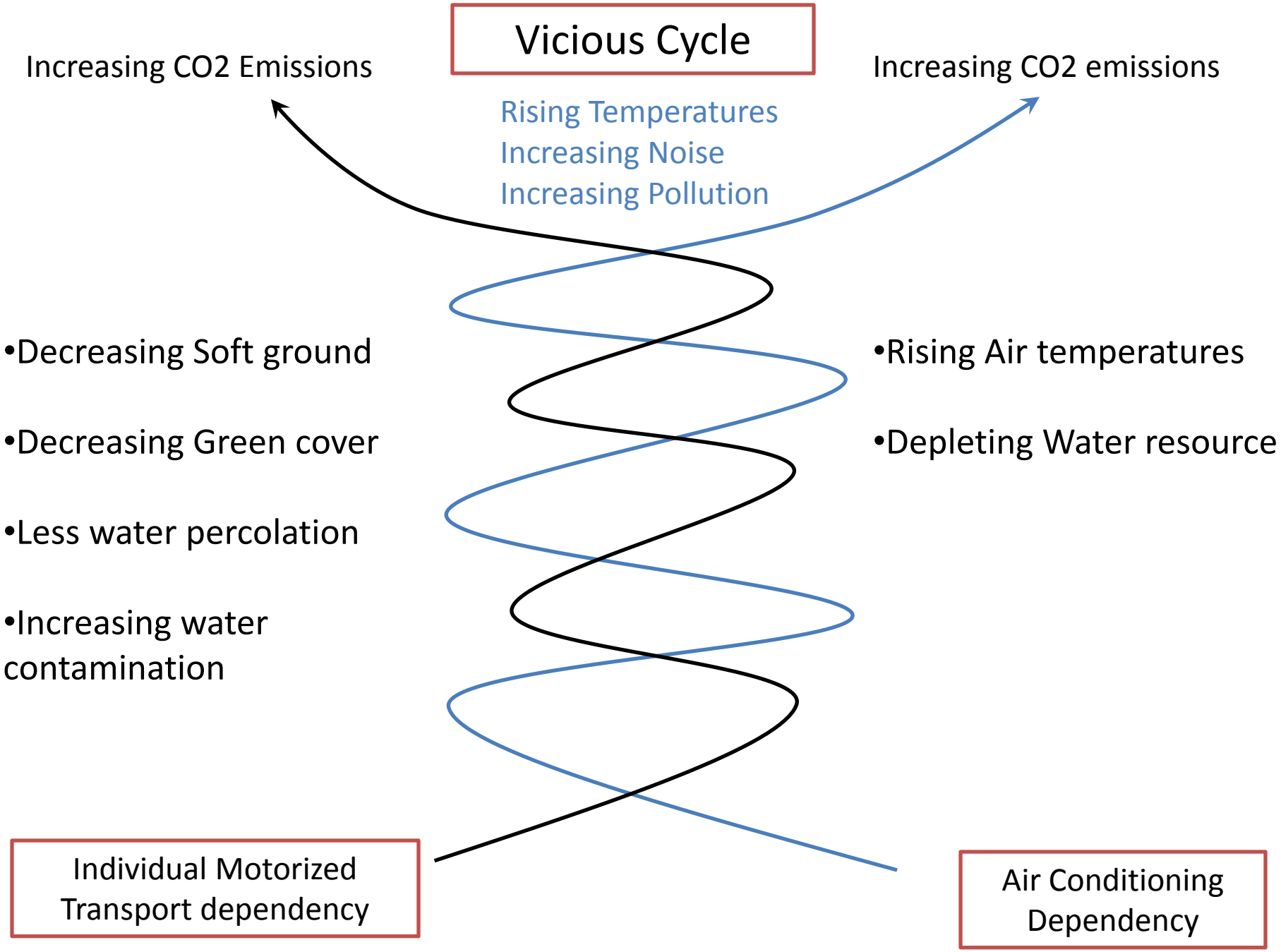
Cars
roads & parking

Individual motorized
transport

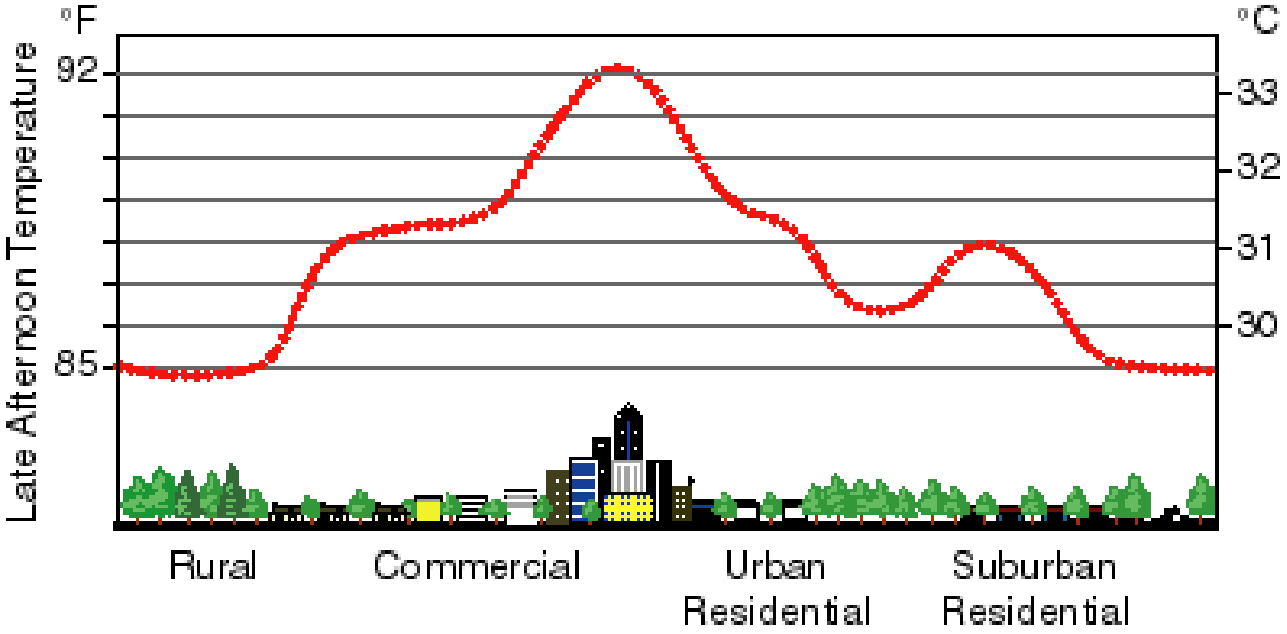
Electric Power

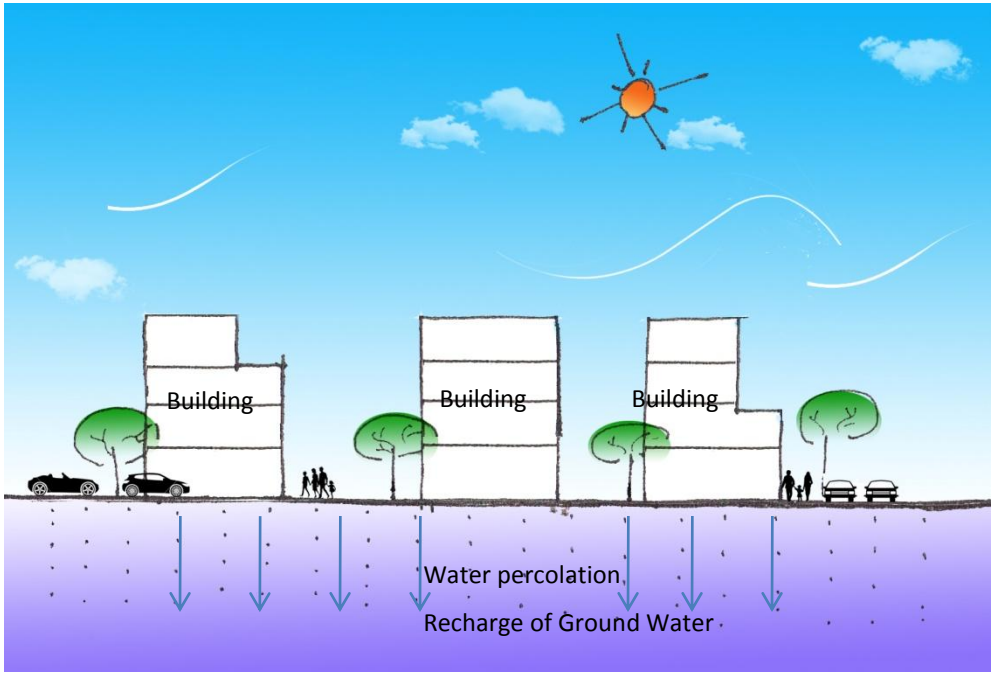


Air - Conditioning
Inefficient air cooled systems

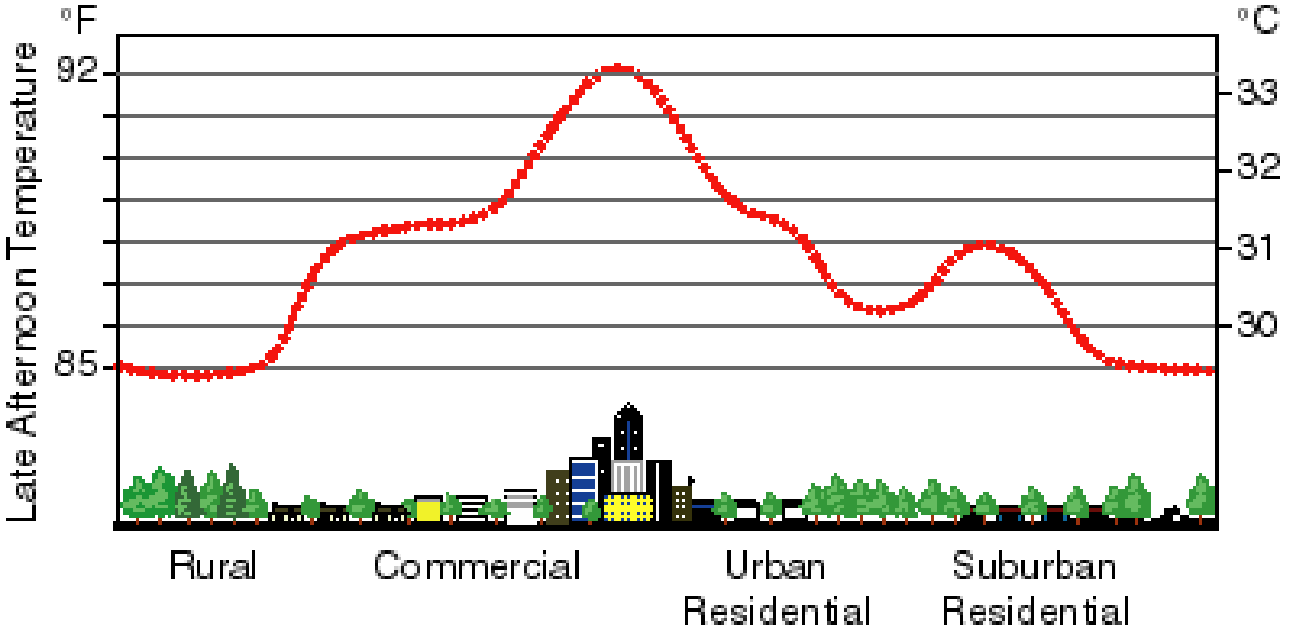

Vicious Cycle
Increasing CO2 Emissions
Increasing CO2 emissions
Rising Temperatures
Increasing Noise
Increasing Pollution
•Decreasing Soft ground
•Decreasing Green cover
•Less water percolation
•Increasing water contamination
•Rising Air temperatures
•Depleting Water resource
Individual Motorized Transport dependency
Air Conditioning Dependency

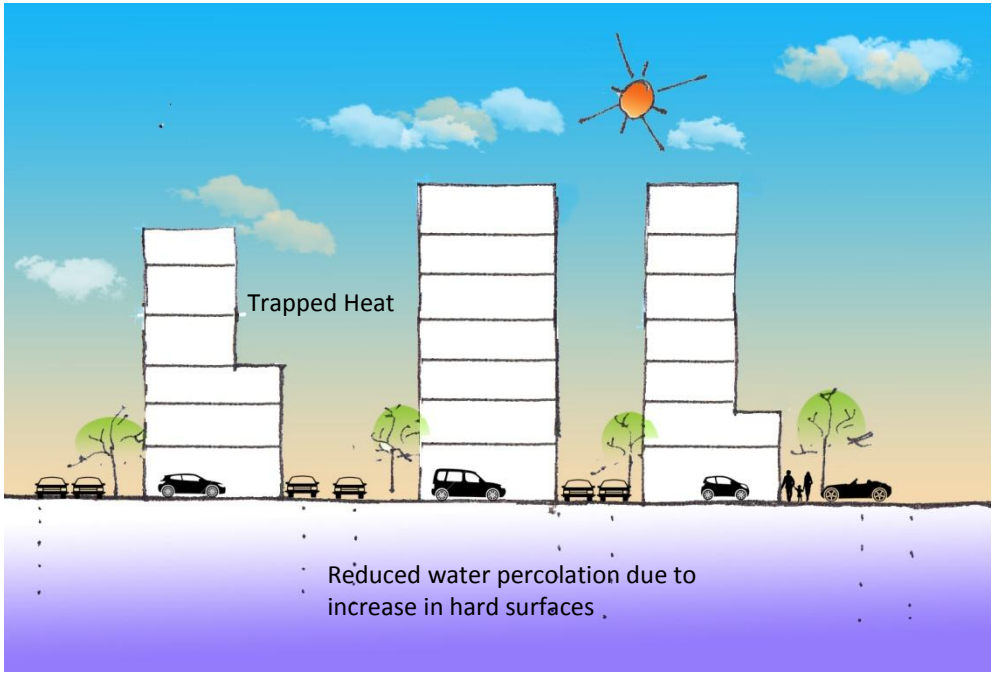
Sketch of an Urban Heat-Island Profile





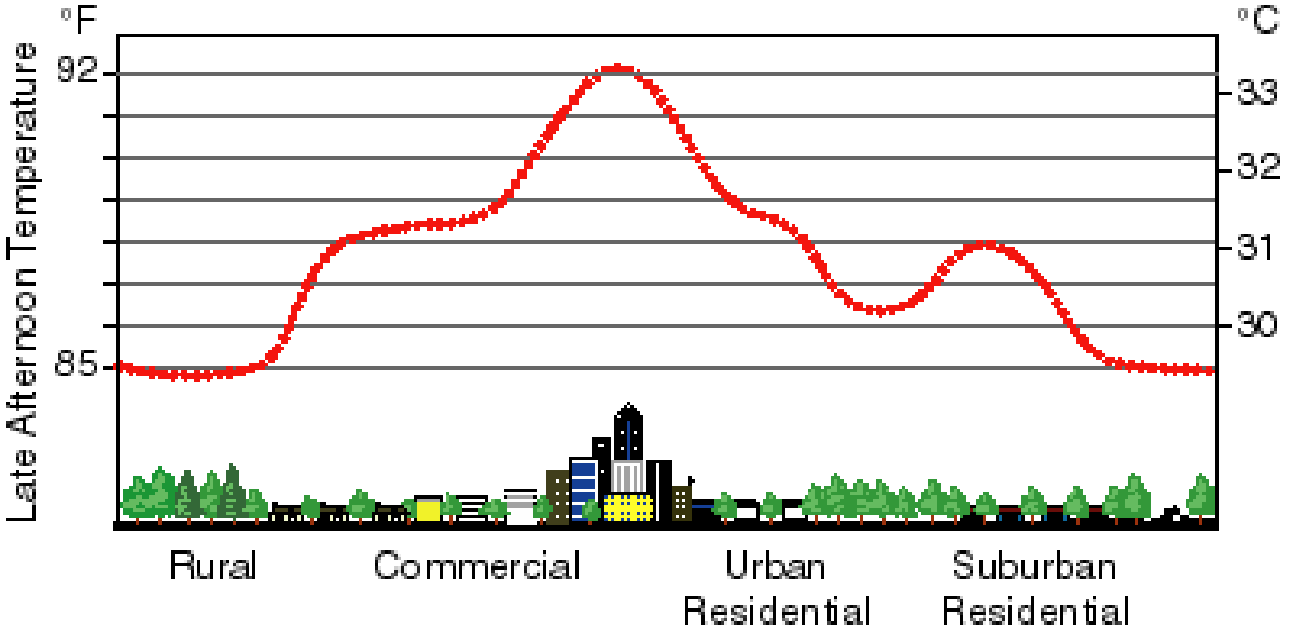
Sketch of an Urban Heat-Island Profile

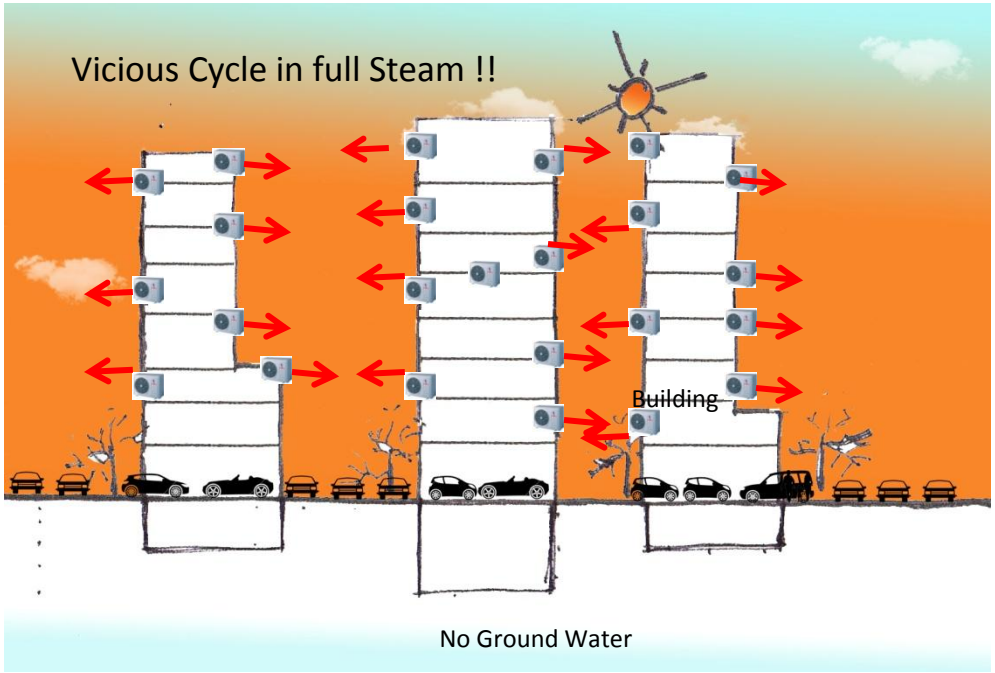




Increasing Density

Sketch of an Urban Heat-Island Profile



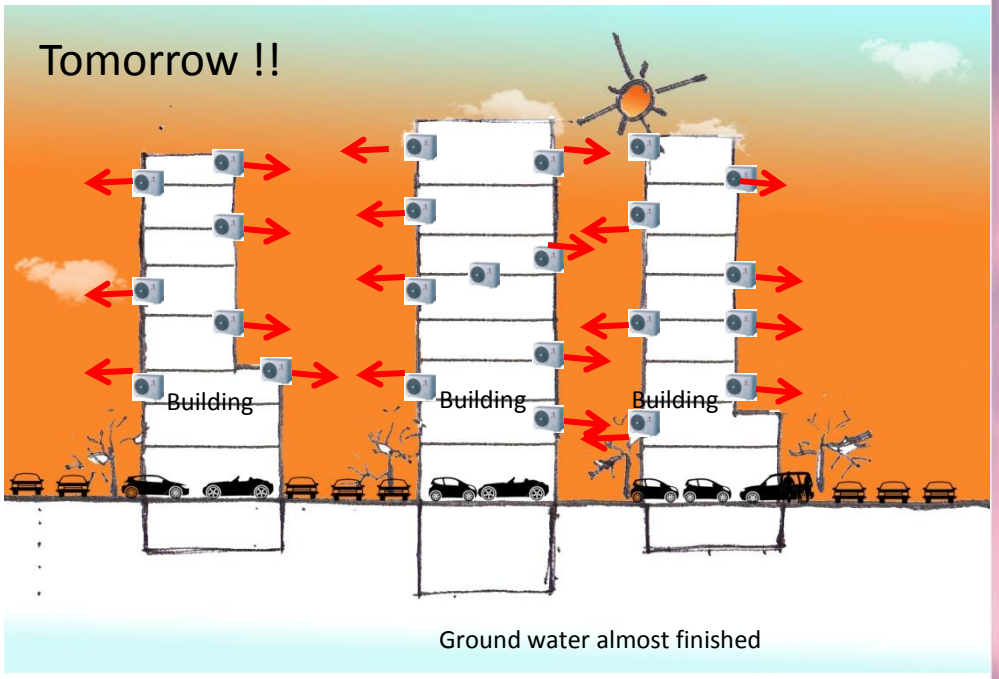


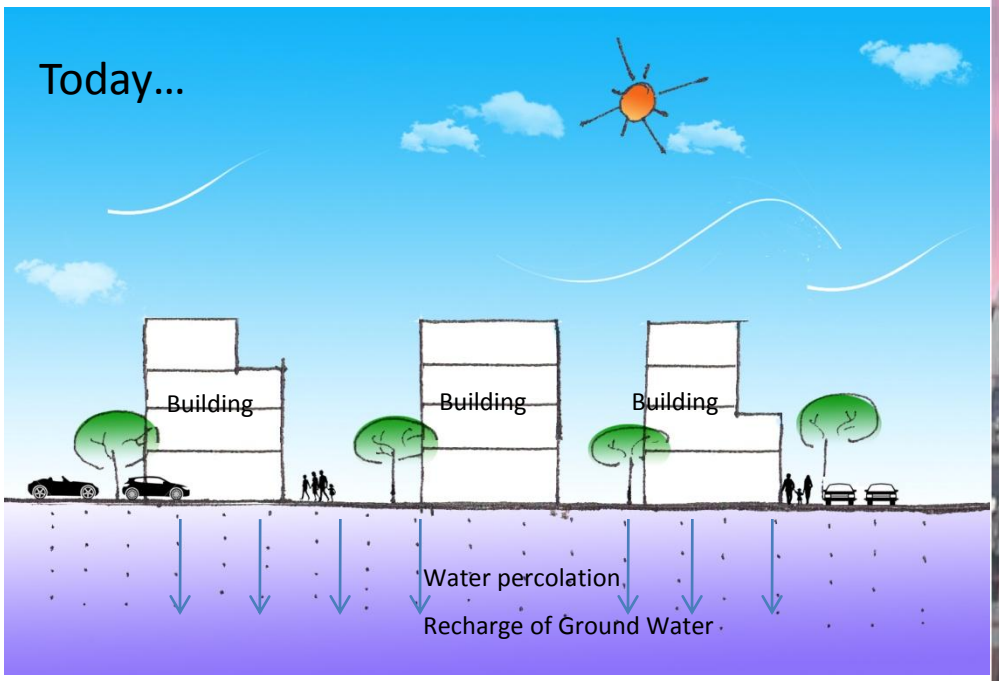
Fully Air Conditioned !

High Density

Two Cars per Household

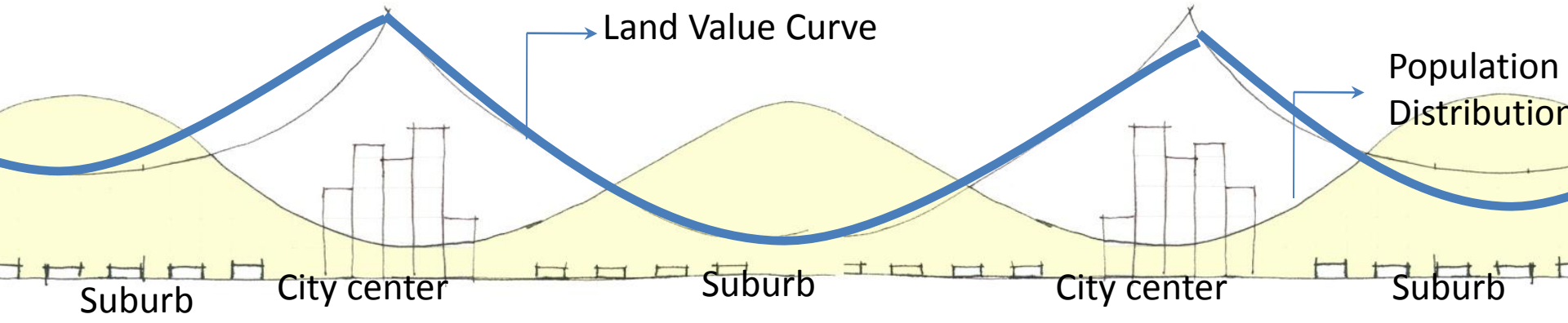
Water from Ganga !


Tomorrow !!
Building
Building
Building
Ground water almost finished


Today…
Building
Building
Building
Water percolation
Recharge of Ground Water

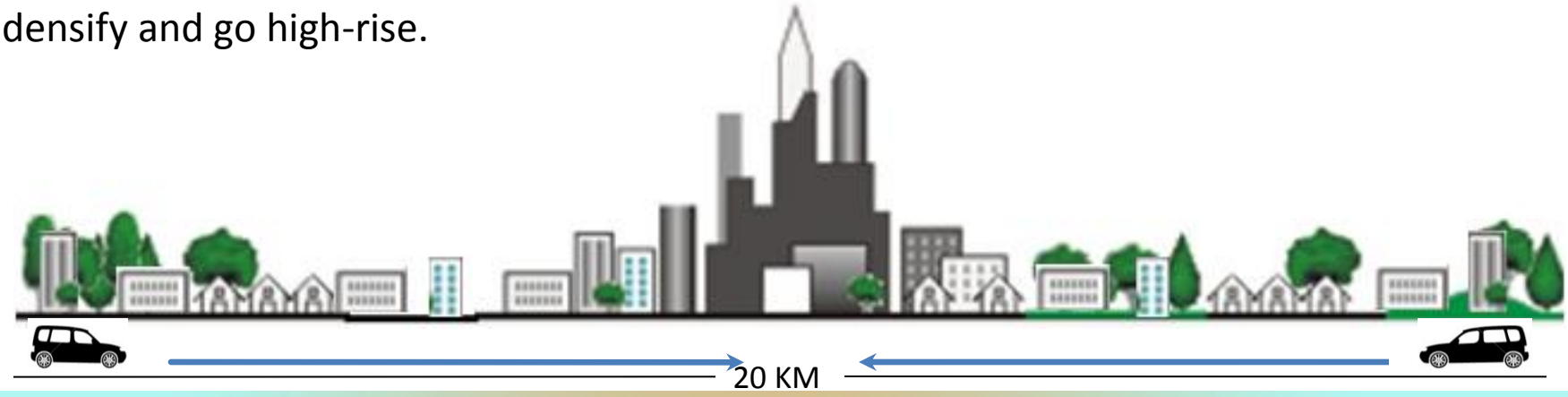

Watch out for the effect of split units hanging out of all the flats in hundreds of thousands of middle class homes!

The economics of land coupled with segregated land use creates a distribution of population in an inverse ratio to land value and this results, overall, in longer man-trips for work for more and more citizens.



Longer travel distances combined with private motorized transport inevitably leads to higher carbon intensity for mobility in the city.

Reflex reaction : in order to economize on carbon emissions in the operation of the city infrastructure – transportation, conveyance of water, electricity and waste – we must densify and go high-rise.



Paradoxically this results in exchanging shorter runs of horizontal movement with increased movement vertically –of people, goods, water – against gravity. Vertical conveyance, needless to say, is much more energy intensive than rolling along the ground.

Also, the height of structures calls for more carbon emissions per unit area of built space on account of the increased consumption of structural steel and cement to withstand earthquakes and high winds.

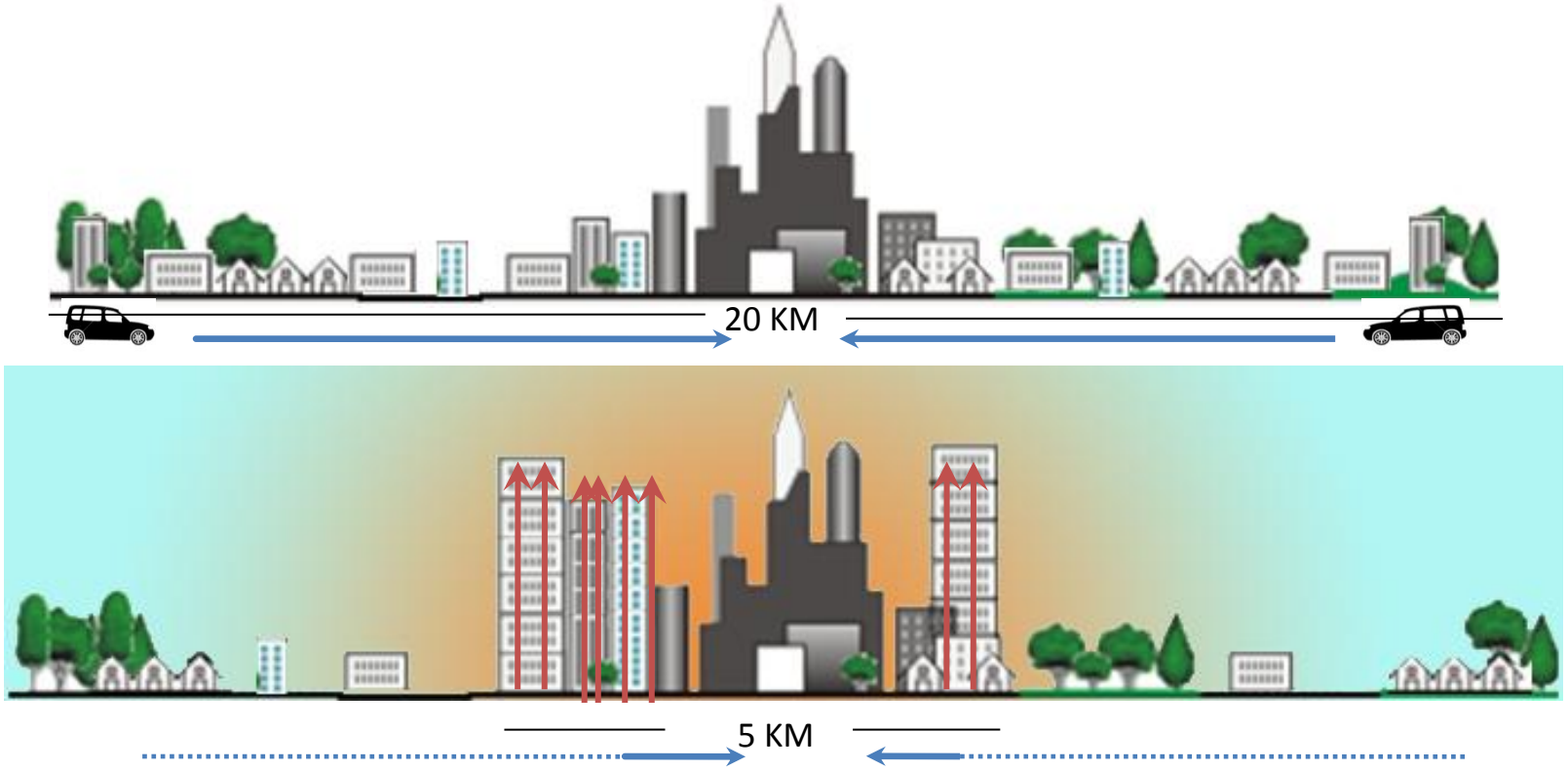
Prescription for low carbon urban system

1. Prioritize public transport plus pedestrian access over private motorized transport.
2. Maximize soft ground and vegetation.
3. Design buildings to minimize need for air conditioning.
4. Avoid high building densities to minimize heat island effect.
5. Yet manage all of the above in a compact urban form !

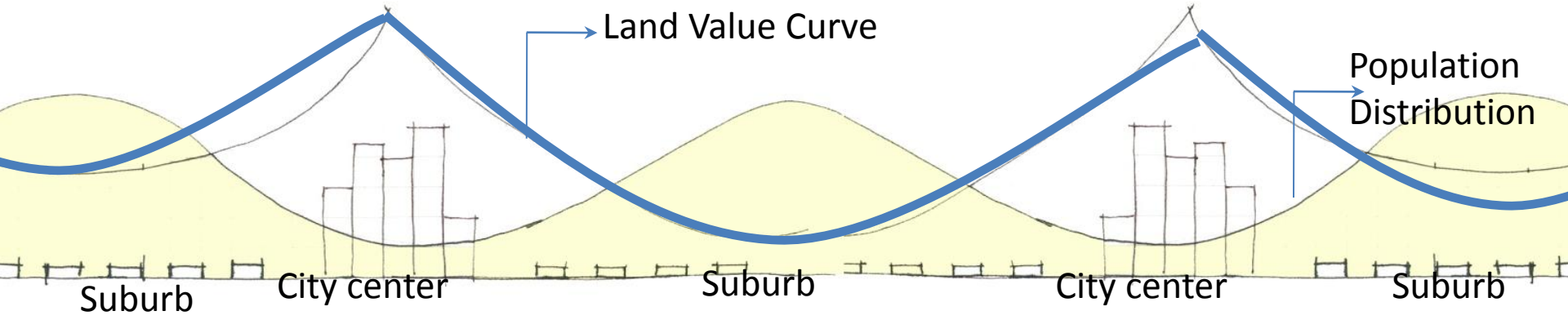
Three technical studies are recommended :

1. Carbon Emissions of total urban system as a function of density and height

The commonly held view that “going for high rise is a solution” needs careful technical evaluation from the low-carbon point of view (there are also the sociological and cultural implications of this pattern of development, though not in the scope of this presentation that needs serious study). What is needed, therefore, is a **total-energy-systems study to evaluate the relative carbon intensities of different patterns and densities in urban form.**



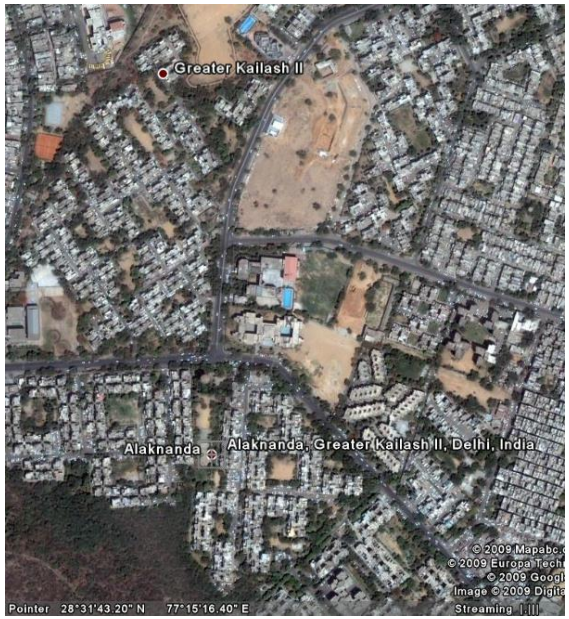
2. Carbon Emissions in transportation as a function of land value and land use patterns



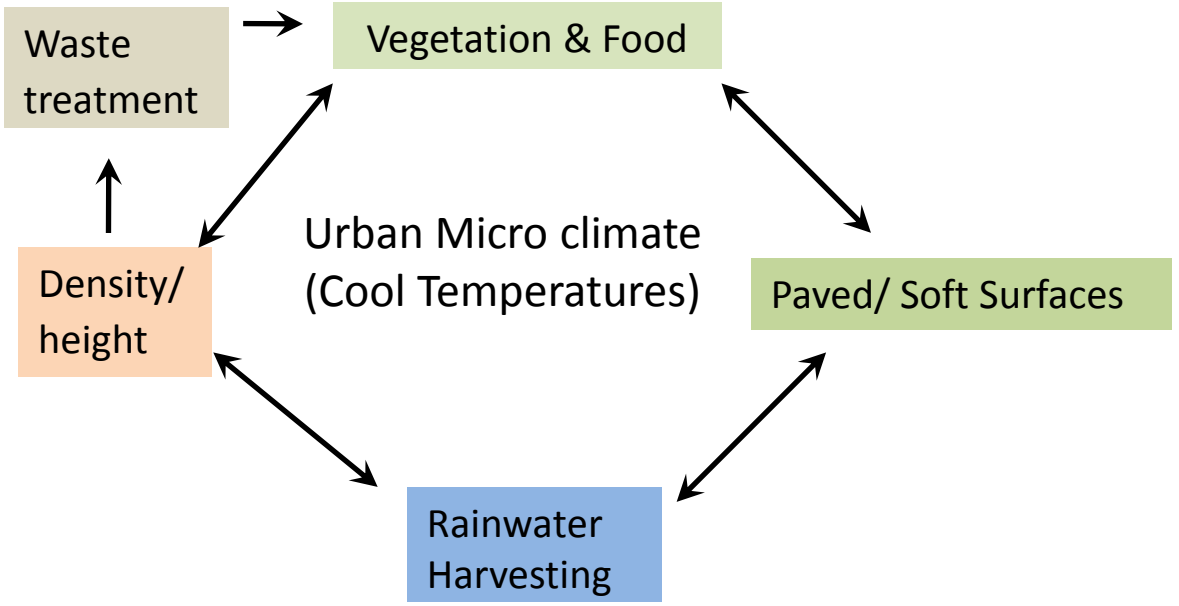
The policy relating to land - the intensity of development and land use, combined with the operation of speculation on land value, has a direct impact on the pattern of city growth. The land policy is, perhaps, the most critical instrument in influencing the carbon intensity of the urban system.

3. Balancing the urban ecology

Green Park, New Delhi



Alaknanda , New Delhi



Patpargunj , New Delhi

METRICS : DESIGN STAGE PARAMETERS

A. COMPACTNESS

- **Land Consumption: Land area / Capita**

- **Building Consumption: Built Area/ Capita (resident)**
  Built area / Capita (direct employee)

B. ROBUSTNESS

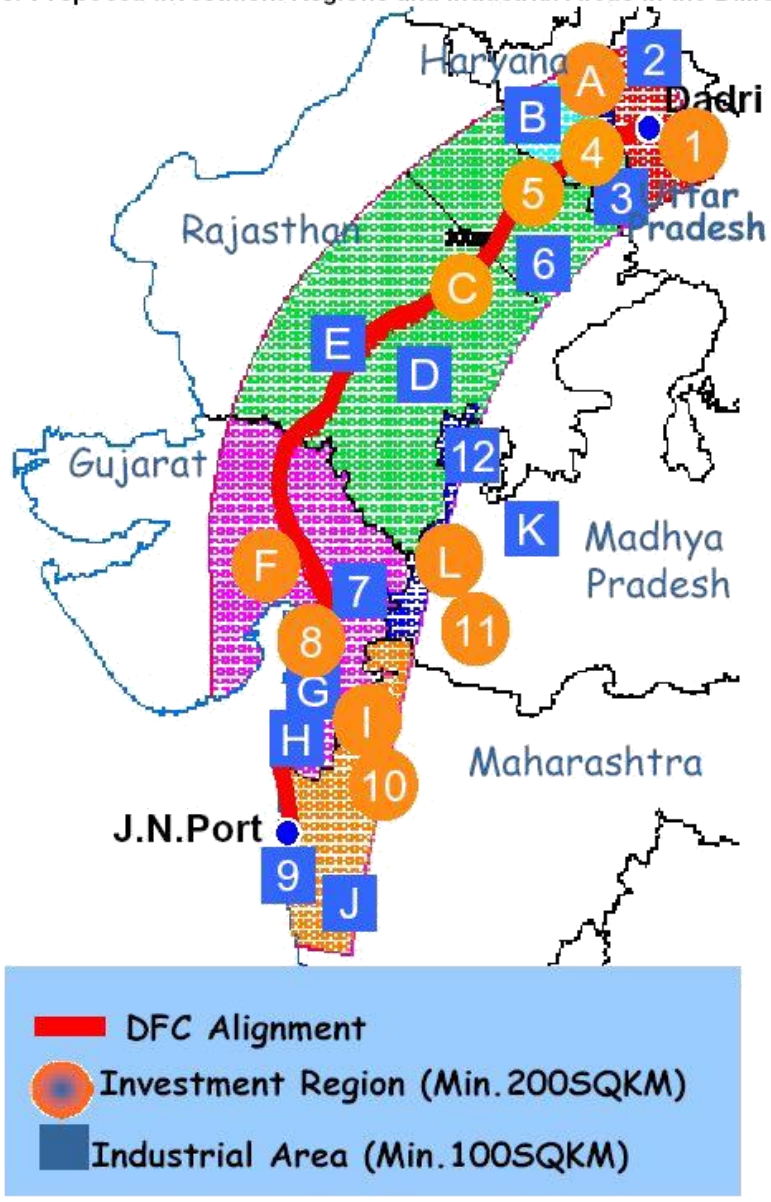
- **Energy resource dependency: Backup generation capacity/Capita**

- **External water resource dependency: Water demand as a factor of natural precipitation**

METRICS : OPERATION AND MONITORING

- **CO2 Emissions / capita (gross)**
- **CO2 Emissions for city infrastructure/ capita**
- **CO2 Emissions in local city level mobility and transportation/ capita**
- **CO2 Emissions from embodied energy in buildings/ capita (gross)**
- **CO2 Emissions from operational energy in buildings/ capita (gross)**

Map for Proposed Investment Regions and Industrial Areas in the DMIC Region

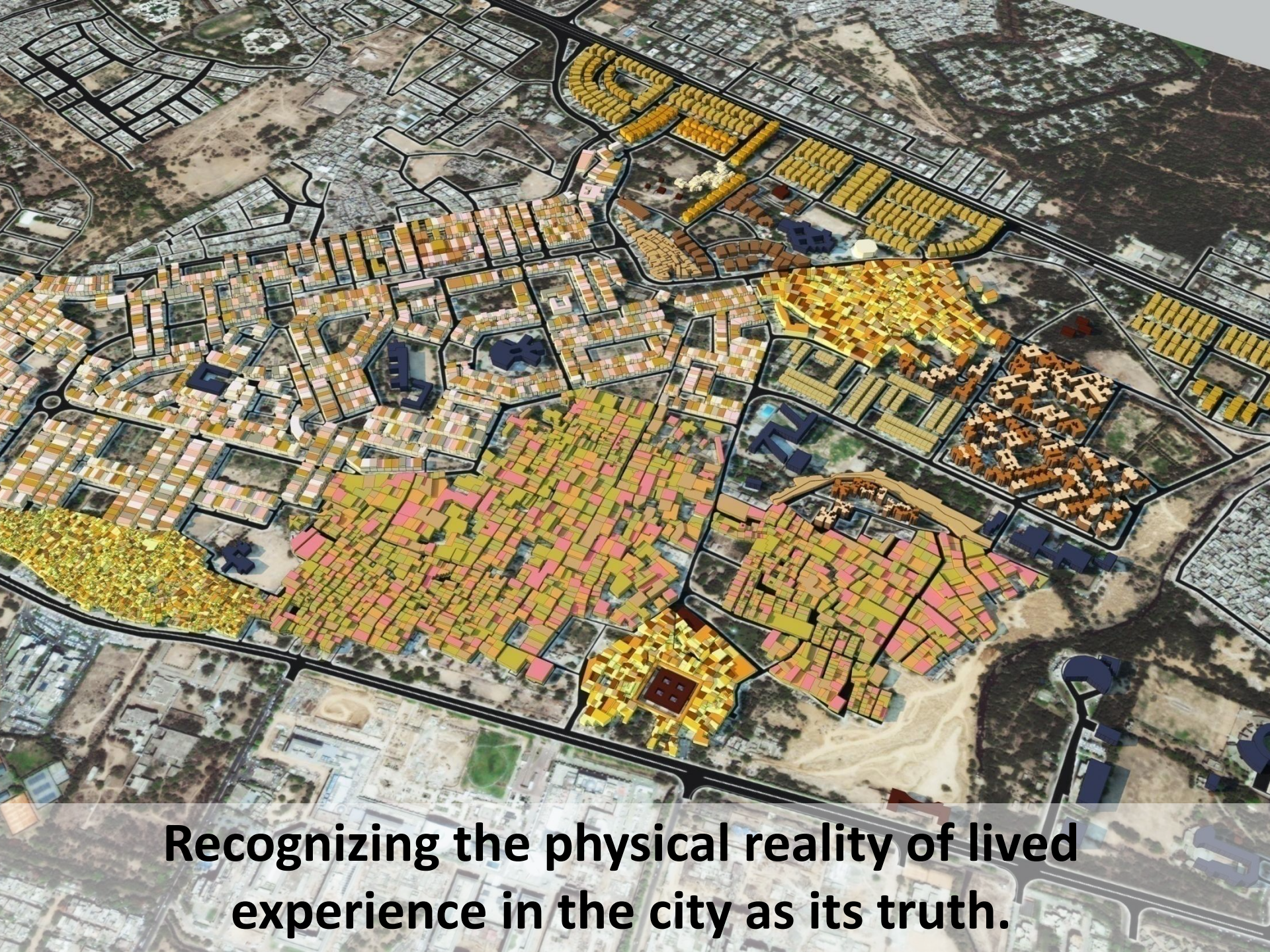


The establishment of new townships on greenfield sites with an ambition of setting 'world class' benchmarks requires :

- Innovation of city governments and management structures committed to environmental sustainability and energy efficiency

- Establishment of legislative framework to drive environmental objectives

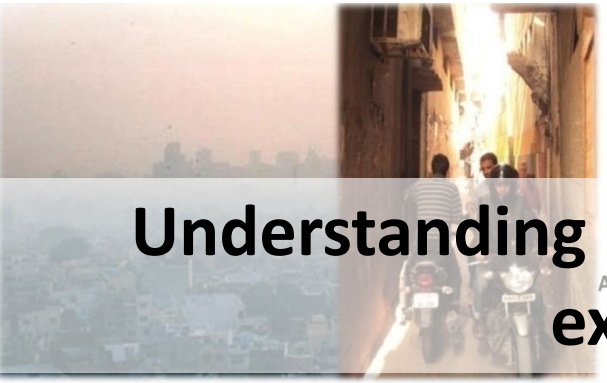
- Envisioning a quality of life for all citizens ensuring convenience comfort and security at minimal environmental costs



Recognizing the physical reality of lived experience in the city as its truth.

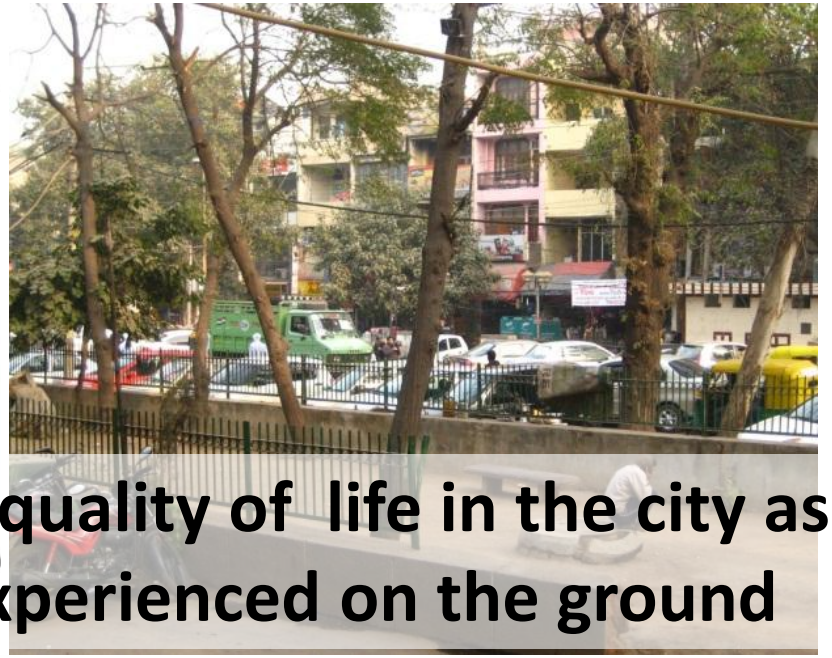
Water Borne Diseases

Mosquito Borne Diseases



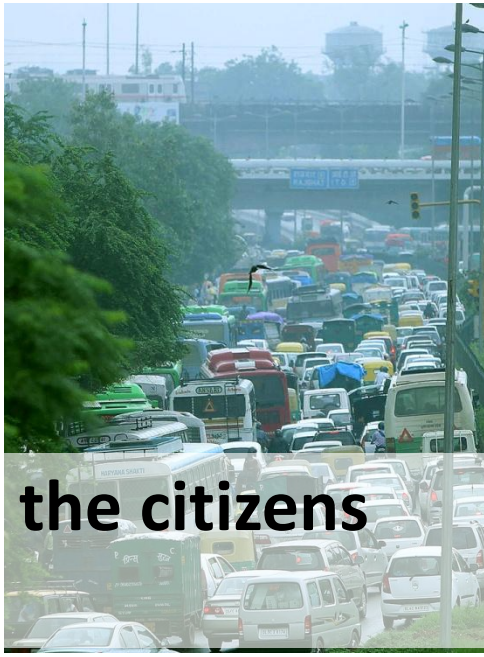
Respiratory Diseases

Unattended Pedestrian Space



Un-cared for Spaces in the City

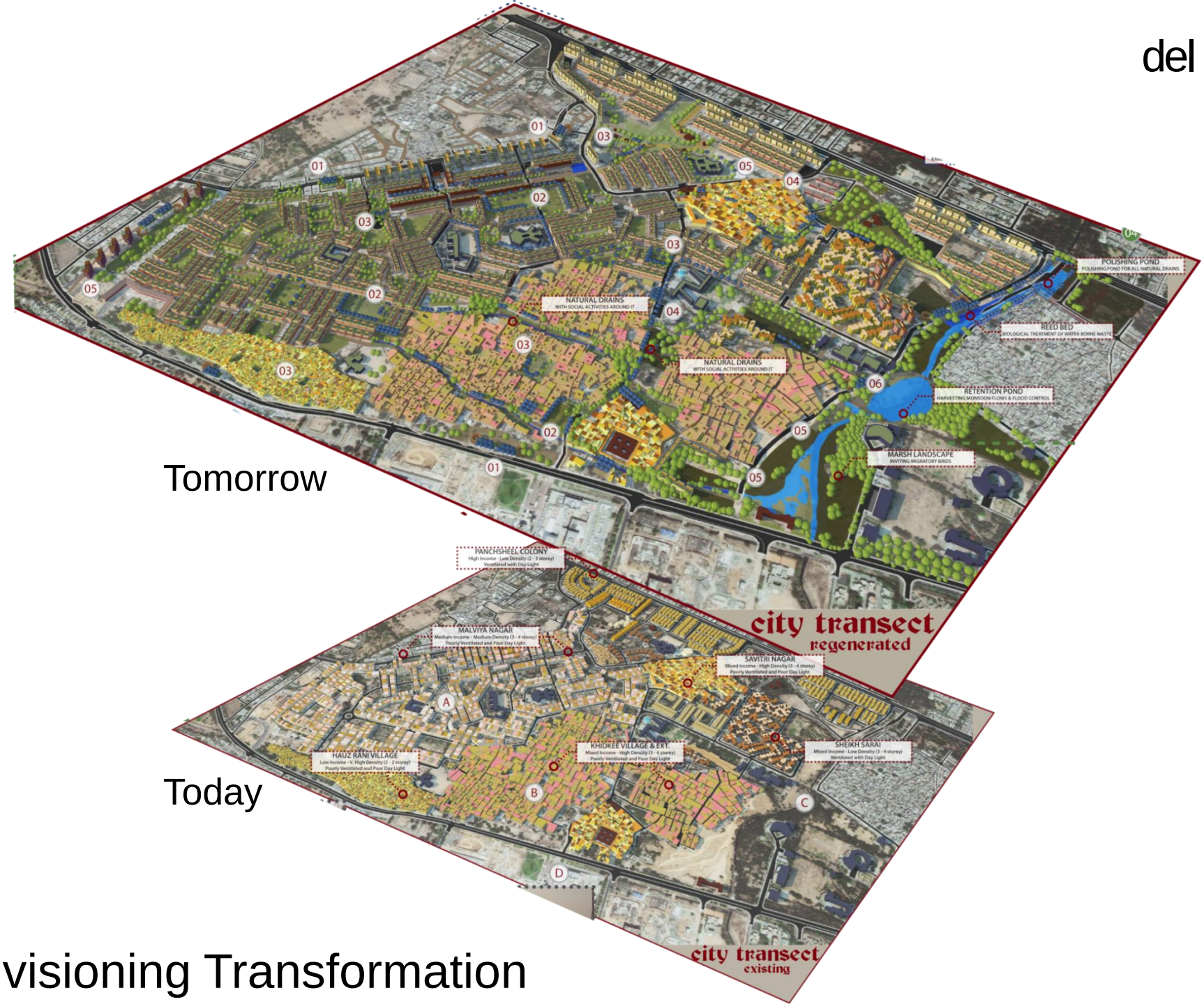
Space lying in neglect



Congestion

Understanding quality of life in the city as the citizens experienced on the ground

del hi



Envisioning Transformation

Restructuring Mobility

Public Transport – Bus & Rail

Local Slow Transport Connectivity

Pedestrianisation & Pedestrian Access

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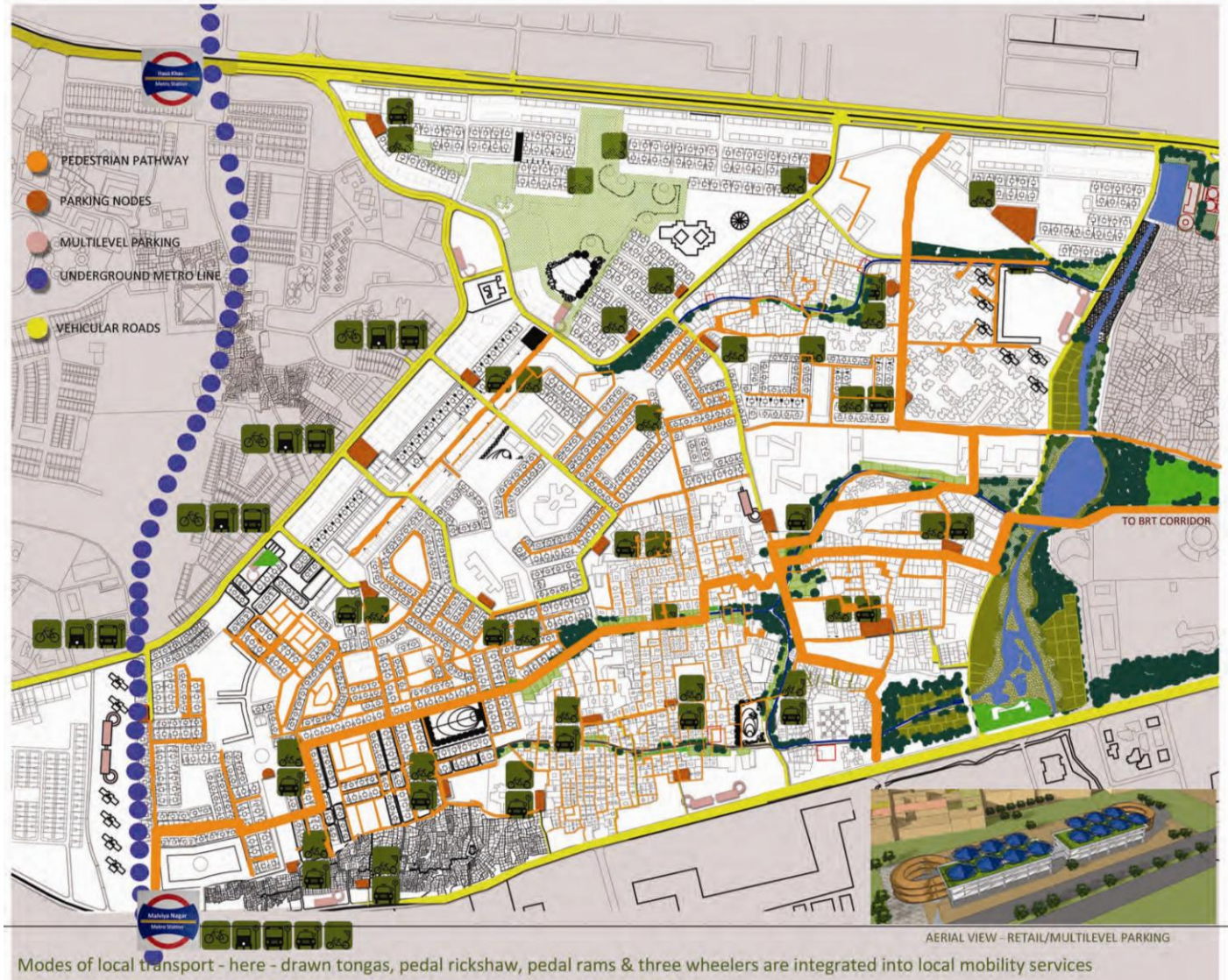
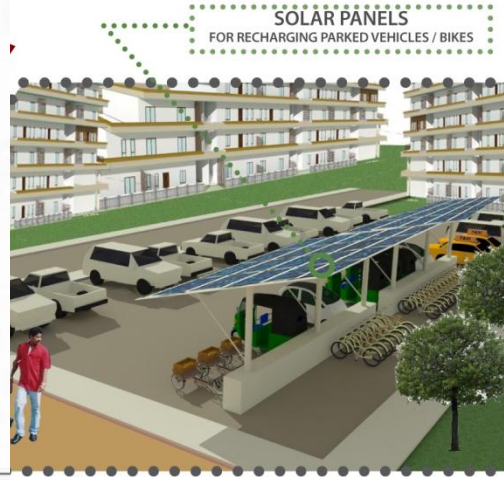


Modes of local transport - here - drawn tongas, pedal rickshaw, pedal rams & three wheelers are integrated into local mobility services

THE CITY TRANSITIONS TOWARD MOTOR FREE LIVING AND PUBLIC TRANSPORTATION

Transitional Parking



Parking CUL-DE-SAC

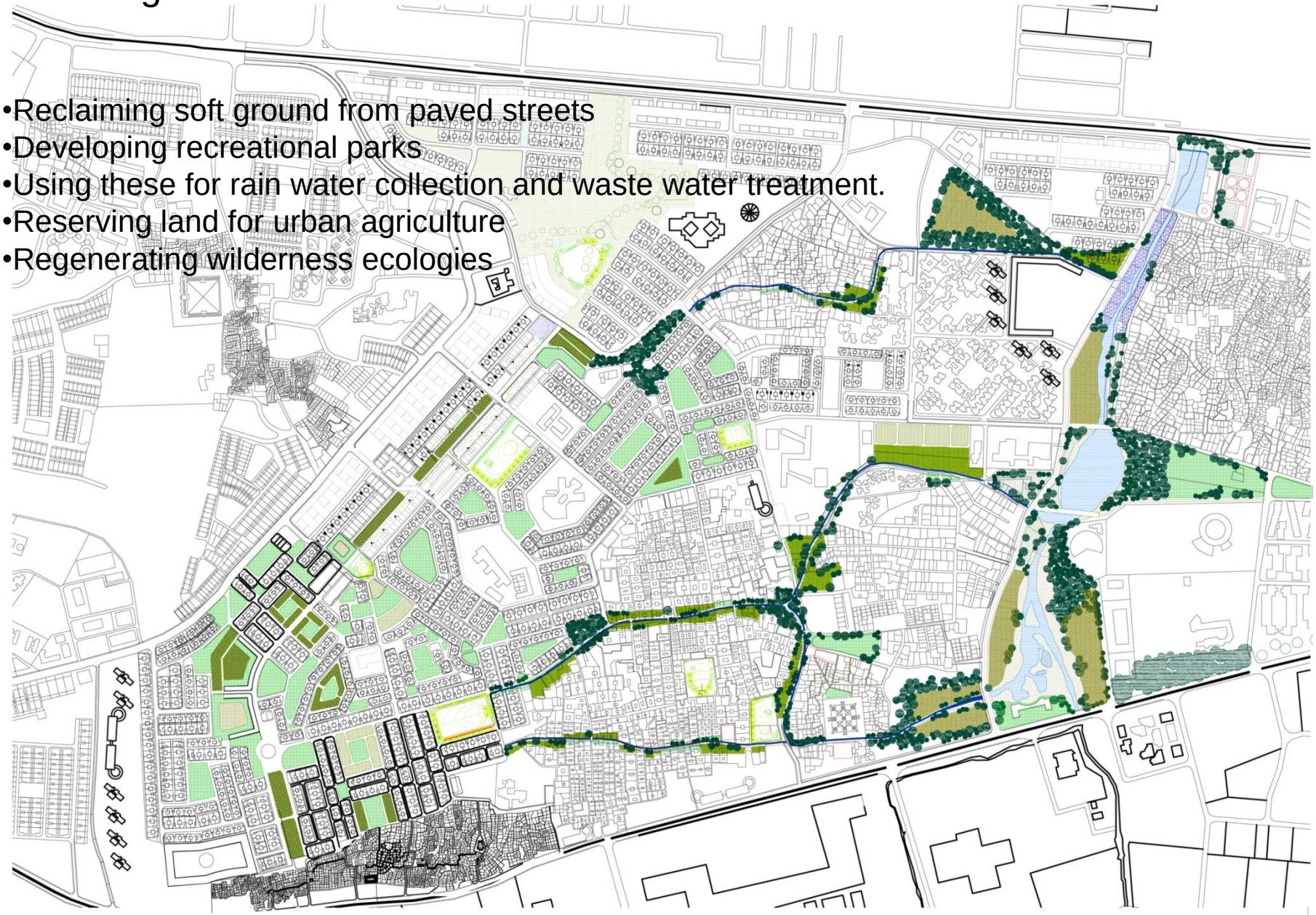
EMERGING POINT FOR SITE PATHWAYS


Pedestrian Street

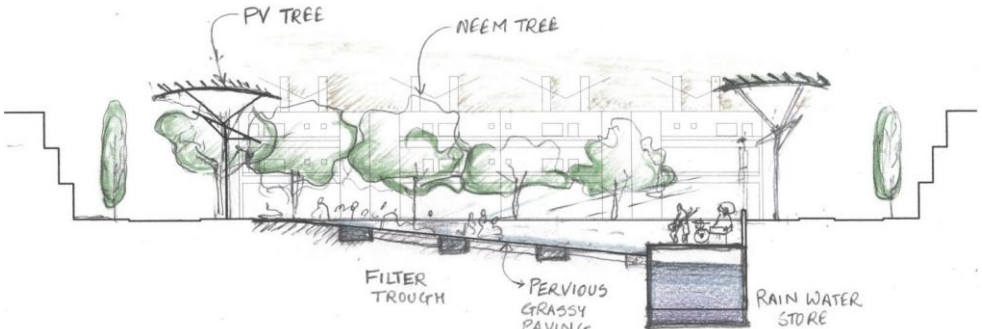

Gardens

Land Regeneration

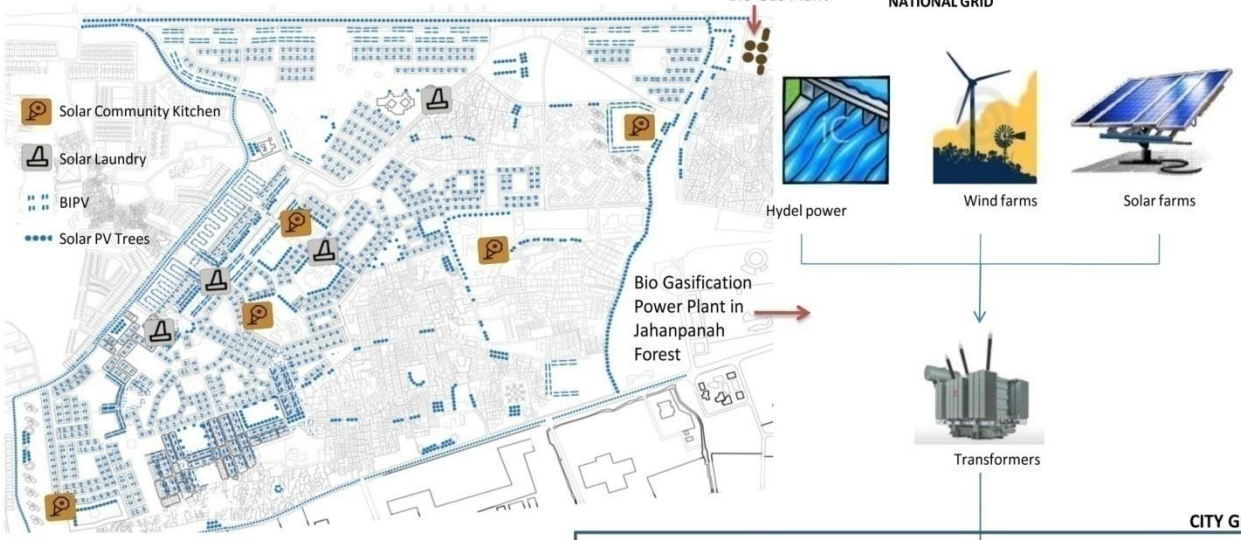
- Reclaiming soft ground from paved streets
- Developing recreational parks
- Using these for rain water collection and waste water treatment.
- Reserving land for urban agriculture
- Regenerating wilderness ecologies



Bowl Garden – Rainwater Harvesting Amphitheatre

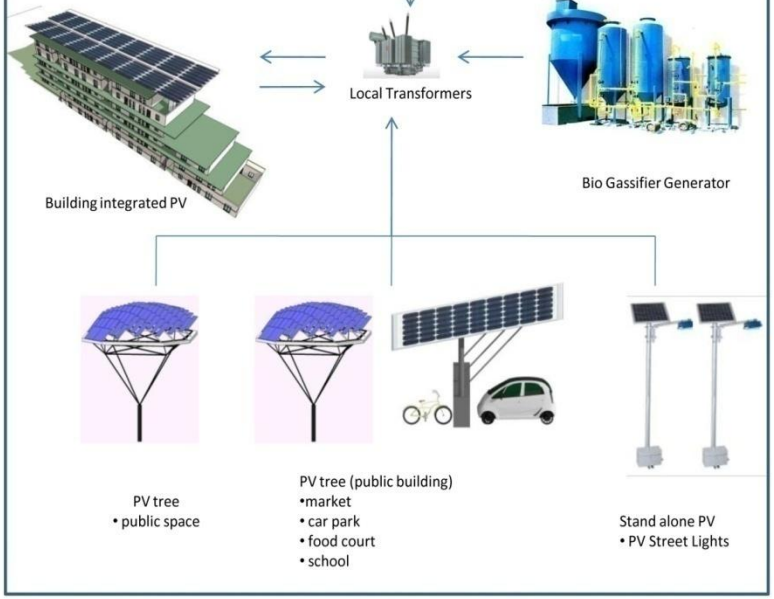


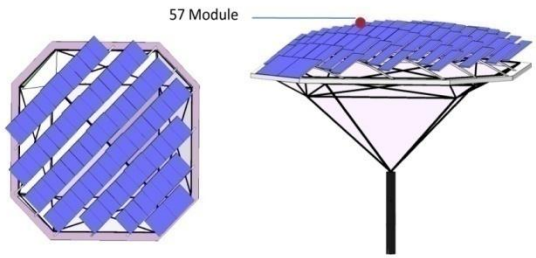
Trancept Plan showing Renewable Energy Systems



Transformers

CITY GRID





PHOTOVOLATAIC TREE

PHOTOVOLTAIC TREE

Capacity /tree	= 8580 Watts
Total number of trees	= 1157
Total electricity produced	= 9,928,942 Watts

BUILDING INTEGRATED PHOTOVOLTAIC (BIPV)

Total roof area = 1,619,830	
Area of roof covered with BIPV (7.6%)	= 124111sqm (l)
Electricity generation/sqm	= 120W/sqm (m)
Total electricity produced (l x m)	= 14,893,414 Watts

STRATEGY

The strategy for electricity is for the state to install PV trees on public and institutional lands and buildings, and along public rights of way. The PV trees clear the height of natural trees. They integrate seamlessly with the environment, as elements of public art, reducing urban heat island effect; they shave the peak demand by linking to the city's electricity grid. This allows rapid switch over to renewable energy at the city level. In turn BIPV is encouraged to follow suit.

DELHI ENERGY BALANCE

DEMAND

As per master plan for delhi 2011-2021

• Projected population	= 24,000,000
• Electricity demand	= 11000 MW
• Potential of demand reduction by energy efficiency	= 30% of 11000 MW
• Potential of offset by solar water heating, bio methanation, bio gassification	= 5% of 11000 MW
• Reduced demand	= 7150 MW
• Per capita demand at the city level	= 7150 X 10^6/24 X 10^6 watts = 298 Watts

SUPPLY

• Electricity supplied by building integrated PV	= 45%
• Electricity supplied by photovoltaic trees	= 30%
• Electricity supplied by national grid powered by renewable sources	= 25%

TRANSECT ENERGY BALANCE

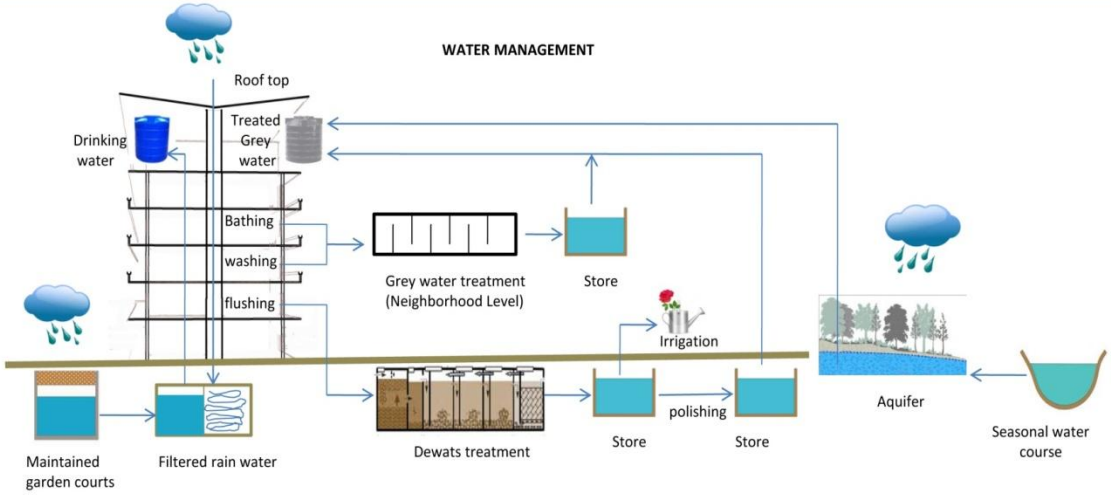
DEMAND

Per capita demand	= 298 Watts
Transect projected population	= 1,11,062 (a)
Transect demand = a X b	= 33,096,476 Watts (b)

SUPPLY

Solar trees on site	= 9,928,942 Watts (30%)
Building integrated PV on site	= 14,893,414 Watts (45%)
Supplied by national grid	= 8274119 Watts (25%)

OTHER RENEWABLE ENERGY

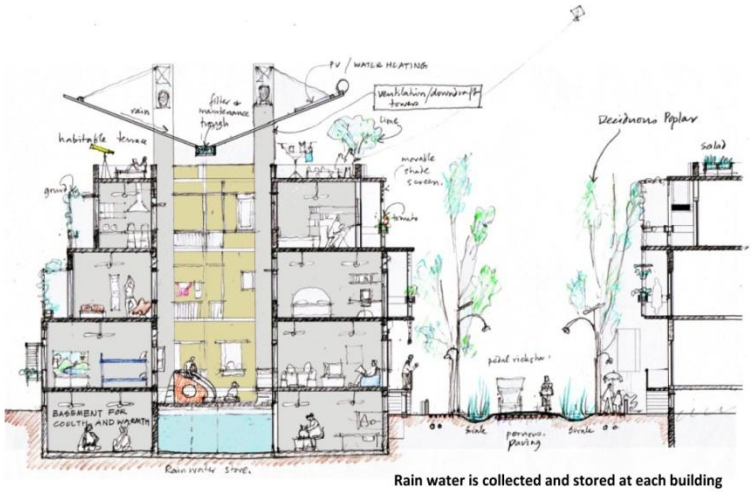


Today majority of households in Delhi are meeting their needs for drinking, cooking, bathing, washing and cleaning with 80 lpcd.
With recycling potential the demand for fresh water can be reduced to 35 lpcd.

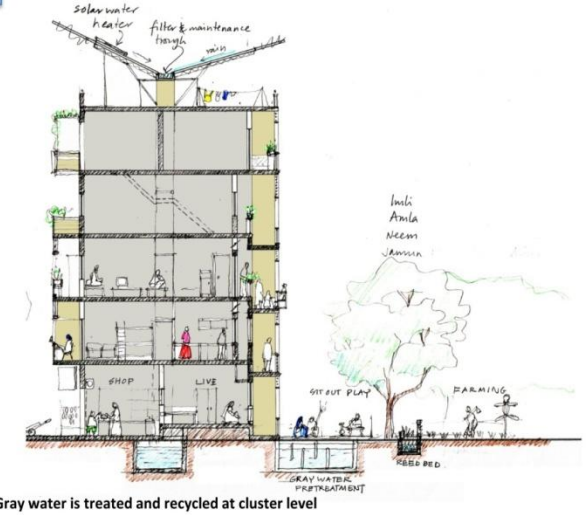
per capita demand	recycling potential	net per capita demand
80 lpd	45 lpd	35 lpd

WATER IS SCARCE. ANNUAL RAINFALL IS 620 MOST OF WHICH FALLS DURING THE SUMMER MONSOON.

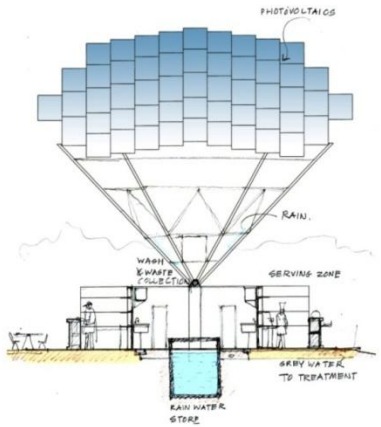
- **<u>First claim</u> on water is the universal right to safe drinking water**
- **Each building and building cluster directly stores rainwater for drinking and cooking. Remainder is directed to recharge aquifer.**
- **Capture water of seasonal watercourse for aquifer recharge.**
- **The rest is under strict rationing recycling is resorted for all domestic uses.**
- **Urban agriculture is designed to utilize and be <u>limited to</u> recycling of treated black water – MORE ORCHARDS, LESS VEGETABELS !**



Rain water is collected and stored at each building

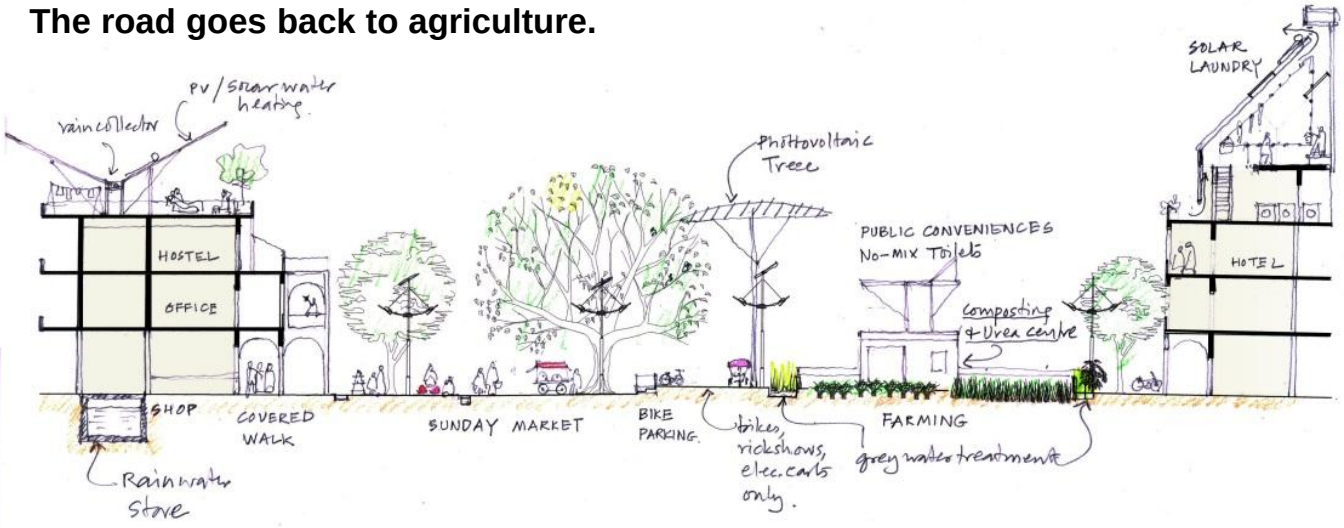


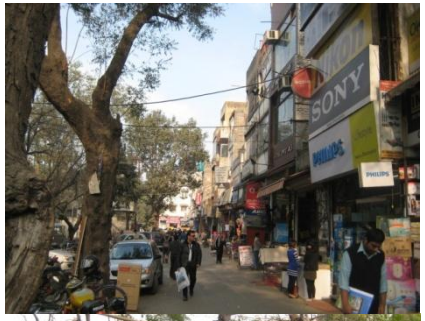
Gray water is treated and recycled at cluster level



Market Street; Malviya Nagar ...Rejuvenating the open market

Take away cars and you have a market. shade of the trees shelters open stalls and street vendors.
The road goes back to agriculture.





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