# TOWARDS A PLANNING FOR EARTHQUAKE RESILIENT AND CLIMATE FRIENDLY DEVELOPMENT IN KATHMANDU

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# Objective of Presentation

- Discuss earthquake and climate implications in planning
- Explore and propose some planning and zoning guidelines and regulations to make development in Kathmandu more earthquake and climate friendly
- Presentation addresses only planning level approaches, not building codes
- Several structural Guidelines and Building Codes exist in Nepal to ensure earthquake resilience in building design and construction
- Climate friendly urban planning is new in Nepal

# City Zoning and Land Use regulations of Kathmandu

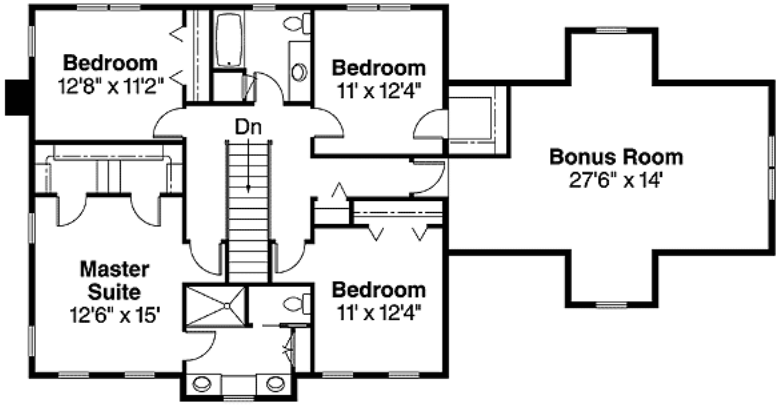
- Kathmandu Metropolitan City Development Code (KMCDC) 2007 (2064) is in effect
- The KMCDC Guidelines and Regulations are quite comprehensive from classic municipal planning perspective
- However, they are not well crafted for making development Earthquake and Climate friendly
- The regulations are primarily motivated more from preservation and aesthetics perspectives, and a little from the angle of pressure on infrastructure on the ground
- Disaster mitigation guidelines which are not mandatory specifically address earthquake issues

# Earthquake Friendly Planning Guidelines

Presentation by Ambika P. Adhikari, Dr. Des, AICP

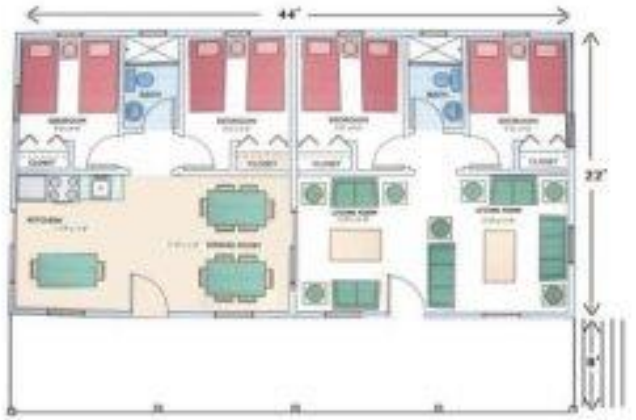
# Suggested Building Configuration- EQ

- Generally symmetrical plans and elevations
- Square or similarly proportioned floor plans
- Minimal amount of cantilevered floors, slabs and projects from the walls
- Low overall height, whenever functionally feasible
- Lowered center of gravity (larger and weightier base and smaller tops)
- Equal floor heights, and short room spans
- Compliant with the National Building Code



# Planning Guidelines

- Adeqaute separation between buildings
- Identify the most hazardous quake prone aeras, and restrict development in those locations. L/U maps are available
- Locate open spaces in a regular patterns within 2-3 minutes walk (600') for every residential pocket residential areas
- Ensure that the utility lines are safely constructed – earthquake guidelines
- Limit location areas for high-rise buidlings and provide adequate surrounding open spaces
- Create building codes that address the safety priority required for occupancy types, and by site locations which are more vulnerable, or less vulnerable
- Symmetry in plan and elevations are desirable



Earthquake resistant building lay-out Haiti

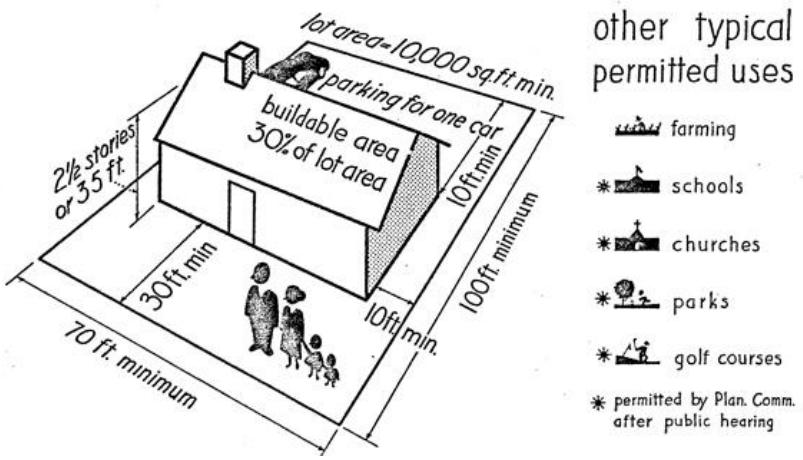
Earth-quake resilient design Philippines

# Open Spaces - Community

- To be provided abundantly and ubiquitously ( min. 2 acres/1,000 residents)
- US cities: 4-10 acres/1,000 residents (average 300 sft/person).
- Bangladesh and India 0.5-2 acres/1,000 persons; India 1-2.5 acres/1000 persons
- Provide open spaces every 600 feet (within 2 minutes walk), for gathering for safety
- Can be contributed by developers as a condition for approval
- Retrofit in old developments
- GoN Home Ministry has identified some 84 significant open spaces in the valley cities for emergency gathering
- Protect the existing open spaces

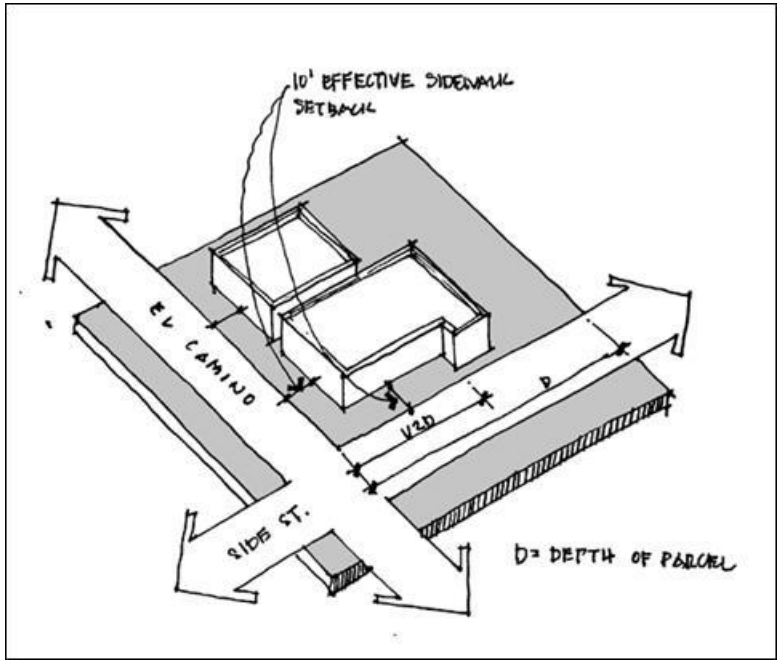
# Ground Coverage - Development

- Land value at premium in Kathmandu, but must still address safety concerns
- Many US cities, single family residential lots – state 40-60% maximum site coverage
- High density, multi-family dwelling units – ground coverage is low – 20%
- Kathmandu Metropolitan City Zoning and Land Use Regulations: 40-80% maximum ground coverage/ Appears reasonable



# Building Set-backs

- The KMCDC BLDG setback requirements appear adequate for earthquake safety (typically 10' (3m) setback for residential buildings)
- For mid-rise and high rise buildings significant setbacks are required, which should depend on the building height and the road width. These setbacks should be typically a minimum of 50 feet – ideally the setback should be in proportion to the bldg height and be landscaped. Max 50% ground coverage
- Adequate setbacks are important to create safe streets in case of a high intensity earthquake

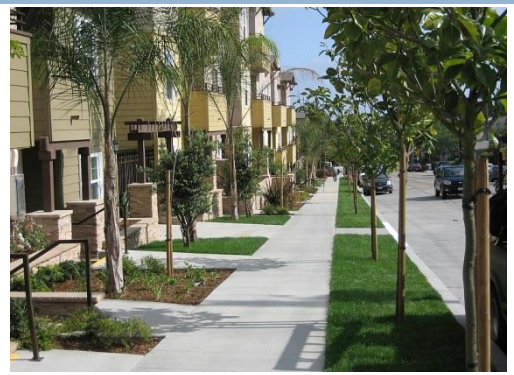


# Right-of-Way (ROW)

- Current ROWs inadequate for seismic and other emergencies
- The recent widening of major arterial roads has greatly helped the situation
- Provision of Minimum RoW critical in Kathmandu for emergency access. Hierarchy of roads/streets: highways, major and minor: arterial, collector, local)
- Minimum RoW, suggested
  - Local Roads – 35 feet (2 car lanes, 2 x 5.5 ft. wide sidewalks)
  - Collector Road – 55 feet
  - Arterial Roads – 65 feet
  - Major arterial roads – 110 feet


# Pedestrian-Friendly Streets

- Wide and detached (separated by landscaping) sidewalks
- Sight (vision) triangle at intersections (min 33’ x 33’)
- Traffic calming devices- speed humps, roundabouts, medians
- Parallel parking on streets
- Low vehicle speed in heavy pedestrian areas
- Dedicated pedestrian streets in high density interior roads



# Building Height

- The building heights allowed under the KMCDC 2007 look generally appropriate from earthquake safety standards too.
- It is suggested that the building heights should be confined within an angel of 45 degrees to the horizontal line as drawn from the opposite side of the adjoining street. The KMCDC regulations allow the height to fit within a 63.5 degree angle.

# Floor Area Ratio (FAR)

- FAR (typically 0.2 – 5.0) are an alternative way to control the total bundling square footage on a site or in an area, to ensure the adequacy of the infrastructure serving the area
- The 2007 Code allows generous FAR (up to 3.5), perhaps to do justice to the very high land prices in Kathmandu area, and also to generally allow a higher density, which has been the norm n the valley.
- If setbacks, building height and ground coverage all are controlled, FAR becomes irrelevant.

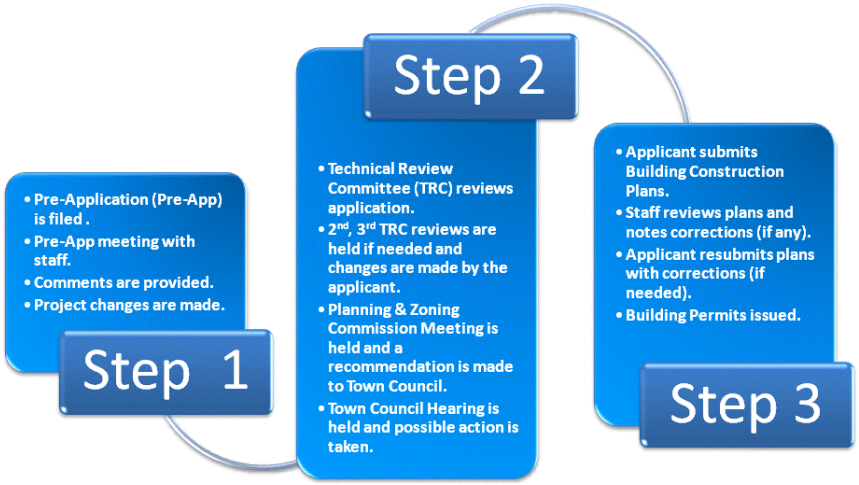
# Types of Buildings

- It is important to address earth-quake safety design for all types of buildings
- However some buildings need even more stringent design standards to mitigate the impacts of potential earth-quakes: schools. Hospitals, assembly halls, designated disaster shelters, high density apartment complexes.



# Approval process

- Use stipulations to obtain concessions from the developers as a condition of approval
- Adopt modern design guidelines and standards
- Train the municipal planners in design and plan review



# Basic Climate Considerations in Planning

Presentation by Ambika P. Adhikari, Dr. Des, AICP

# IPCC: PROVIDING THE SCIENTIC FOUNDATION

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

# Some Findings of IPCC 2011

- Warming of the atmosphere and ocean system is *unequivocal*. Many of the associated impacts such as sea level change (among other metrics) have occurred since 1950 at rates unprecedented in the historical record.
- It is *extremely likely* that human influence has been the dominant cause of observed warming since 1950, with the level of confidence having increased since the fourth report.
- The longer we wait to reduce our emissions, the more expensive it will become.
- If we carry on as we are it will result in 3.7 to 4.8 degrees of warming by the end of the century
- Renewable energy is ready to boom and comes with benefits including less air pollution, more security and fewer severe accidents than conventional energy generation

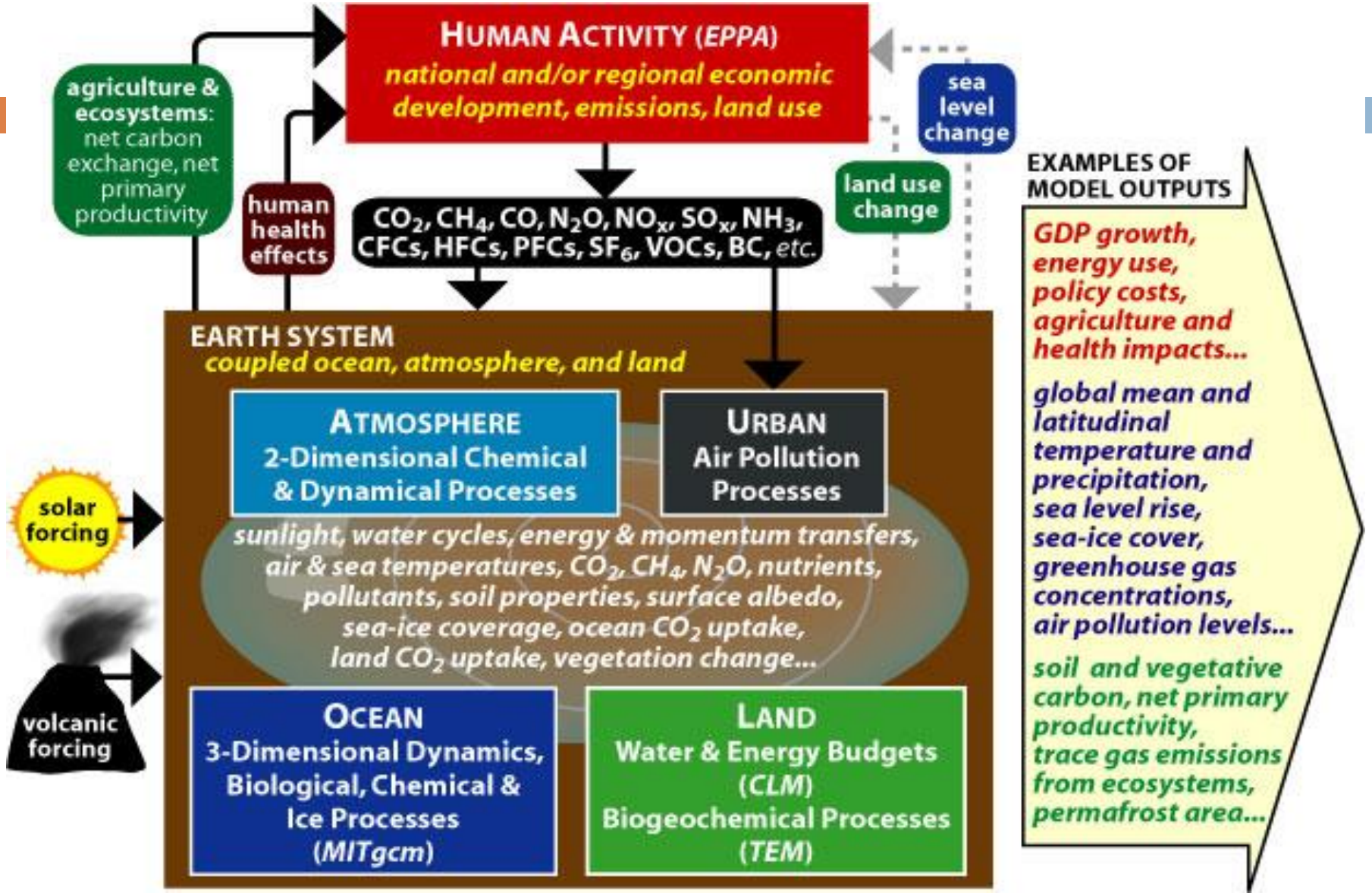
# Causes for GHG increase

- Population growth (global average emission 1.2 ton/yr/person of Carbon about 5 Tons of $CO_2$)
- Increase in per capita energy consumption
- Increased transportation activities (due to higher income)
- Increase in aviation activities
- Changing land use patterns – especially, deforestation
- Increased urban coverage eliminating sinks
- Decrease in global sinks
- Dams and reservoirs (methane)
- Landfills and waste transfers and transportation
- Positive feedback loops

# Some Concepts Related to Greenhouse Gases

- Carbon footprint of individuals and activities
- Carbon imbeddedness in products
- Transferring emission responsibilities in export and import
- Trade and movement of carbon emission assignments
- Export and import, and carbon responsibility of societies
- Carbon offsets for activities
- Carbon neutral activities and technologies – e.g., Ethanol, wind power
- Carbon sequestration
- Carbon Accounting and Carbon Budget

# MIT Climate Model




Source: MIT Website

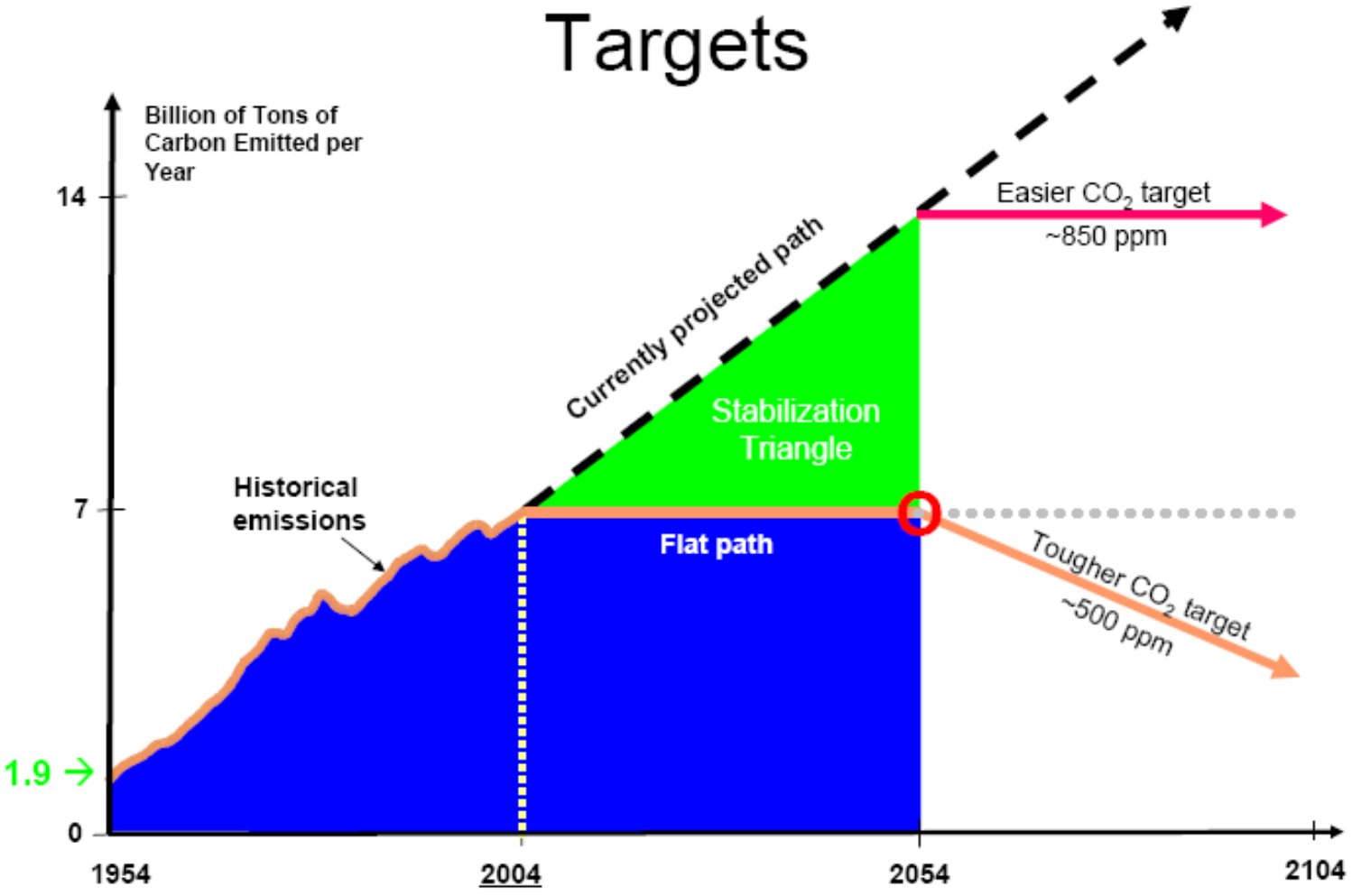
# Carbon Foot Print

- A carbon footprint is a representation of your personal impact on global warming.
- It is measured by the greenhouse gas emissions that result from the choices you make and activities that you participate in.
- For instance, when you choose to drive instead of walking or riding the bus you are choosing to emit more greenhouse gases and increasing your footprint on the climate.
- There are many activities that produce greenhouse gases, but none that you have such a direct impact on as your energy use choices. Being aware of your footprint will bring to attention what you can do about climate change.

Source www.uni.edu

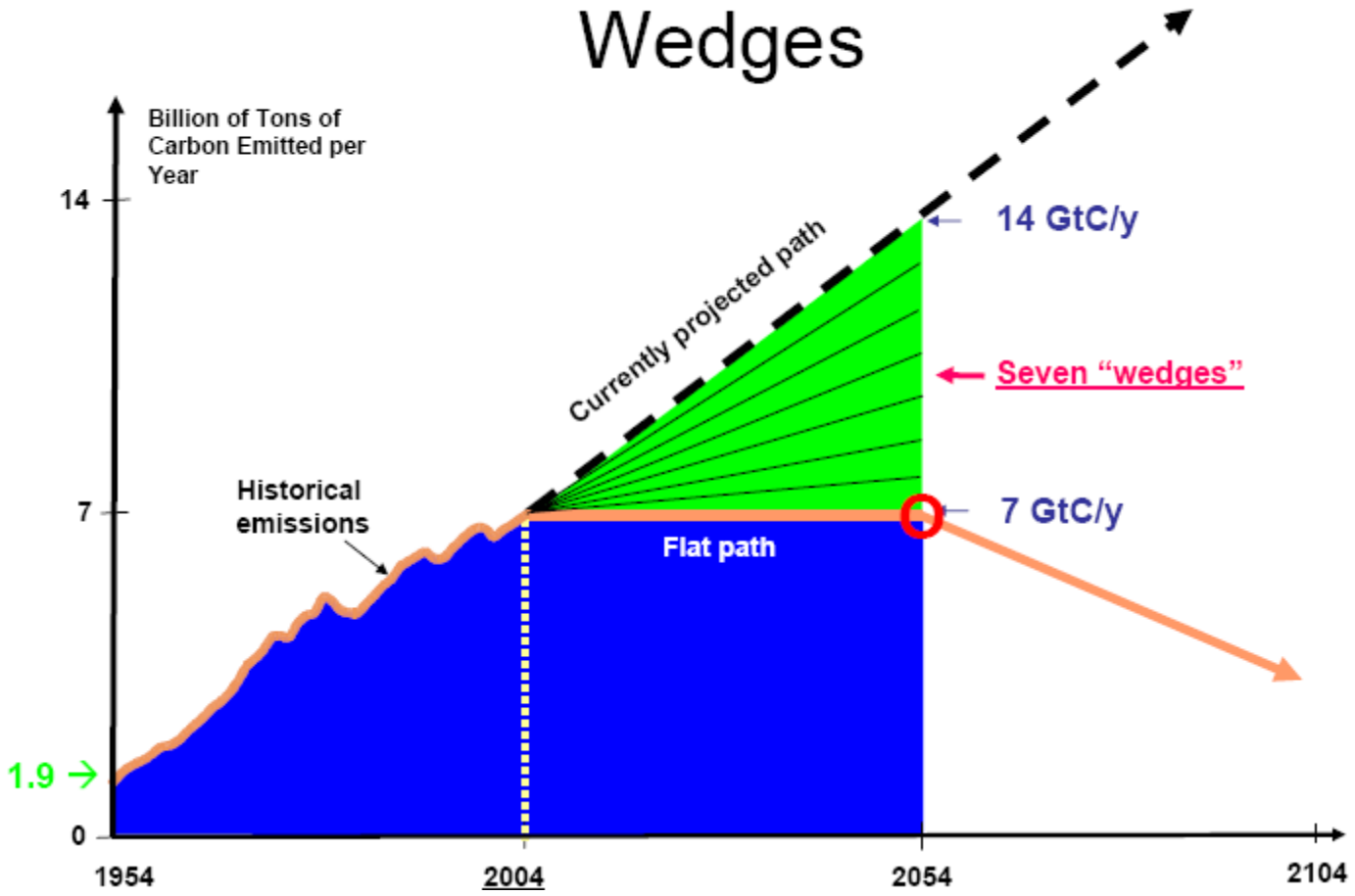
# CLIMATE CHANGE MITIGATION

Some Examples




Socolow Carbon Wedges:

Source: Robert Socolow, Princeton University

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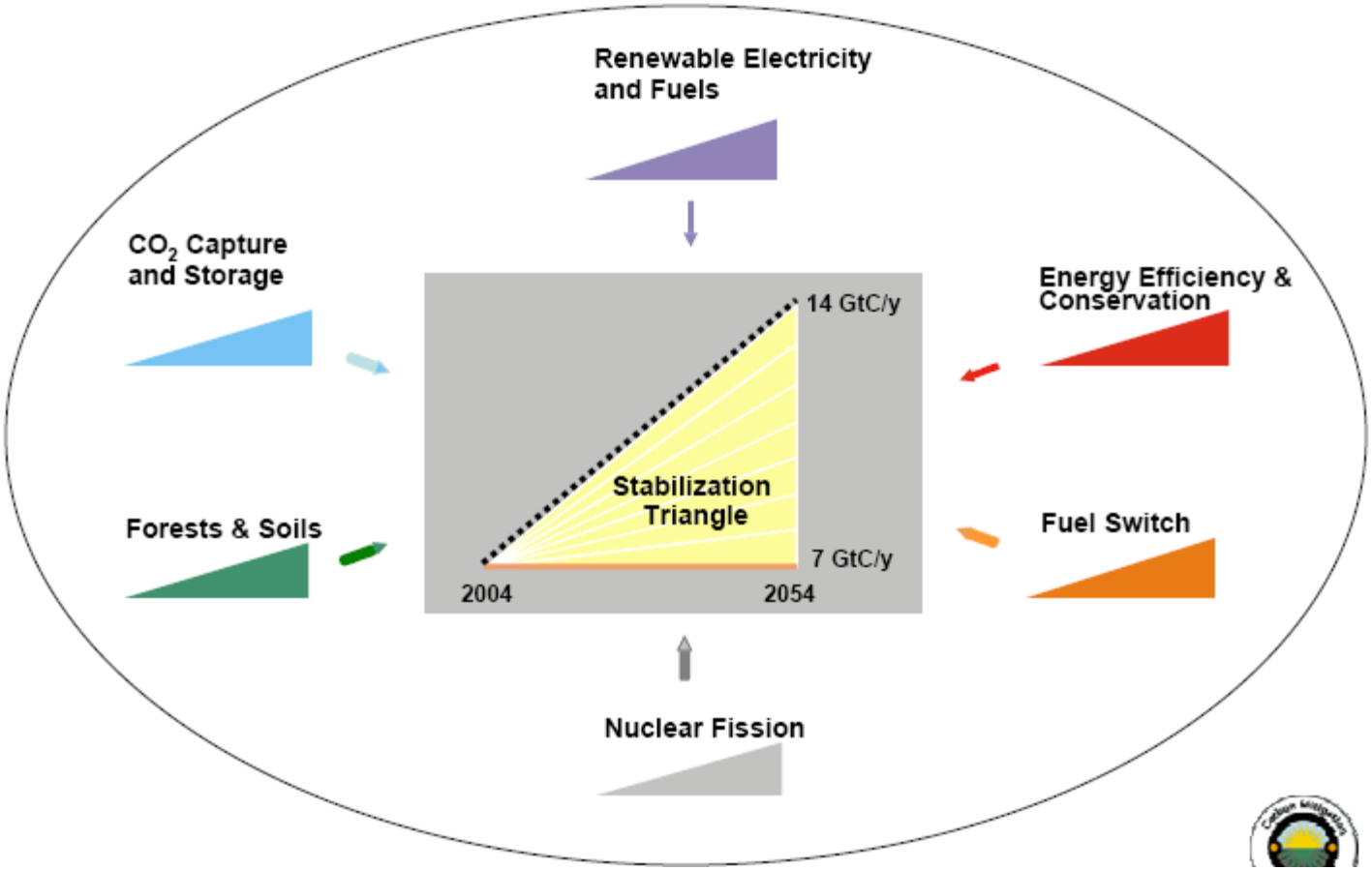



Socolow Carbon Wedges:

Source: Robert Socolow, Princeton University

# *Wind Electricity*

**Effort needed by 2054 for 1 wedge:**

Two million 1 MW windmills.

Today: 40,000 (2%)

*Prototype of 80 m tall Nordex 2,5 MW wind turbine located in Grevenbroich, Germany (Danish Wind Industry Association)*

Socolow Carbon Wedges:

Source: Robert Socolow, Princeton University

# Major Alternative Energy Source - Solar Energy

- "Scientists have confirmed that enough solar energy falls on the surface of the earth every 40 minutes to meet 100 percent of the entire world's energy needs for a full year."
- – Al Gore
- (It is perhaps, an underestimate)

- "The report notes that a 100-mile-by-100-mile solar thermal installation in the American Southwest could meet the entire country's energy needs."
- – Florida Environment Report

- A minute's worth of sunshine provides enough energy to power the earth's needs for a year
- – Green Nature
- Solar panels all over Nepal will produce sufficient energy for the global consumption - Estimate

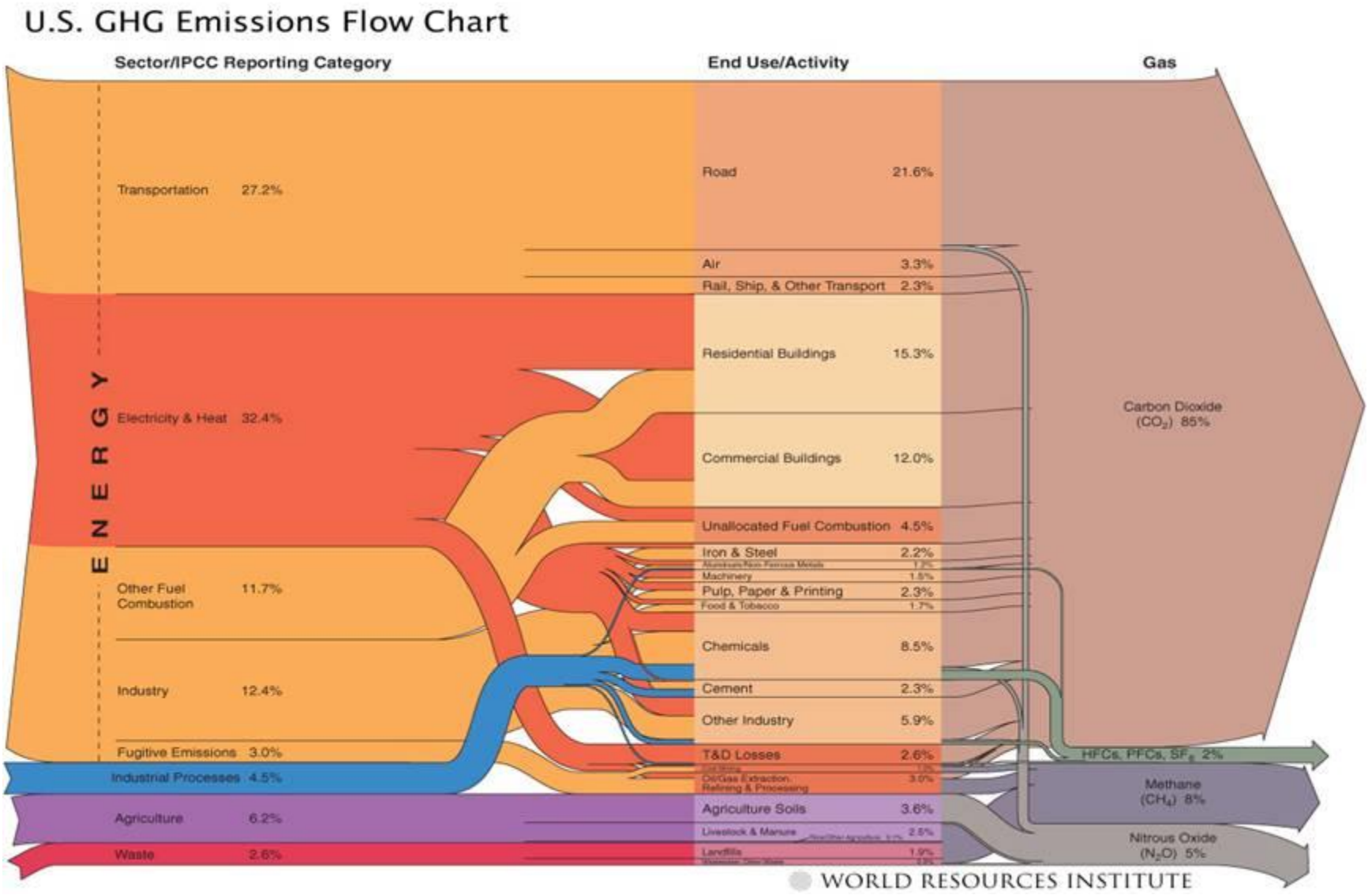
# CLIMATE POLICIES IN THE US

# Local Action on Climate Change

- **Mayor of Charlotte, N.C.:** "We are the ones building roads, designing mass transit, buying the police cars and dump trucks and earth-movers. We're the ones lighting up the earth when you look at those maps from space. Together we have huge purchasing power and if we invest wisely, that can have huge implications for the environment."

  - Foreign Policy Association 2007

# US GHG Emission Flow Chart




Source: World Resource Institute

# Some Urban Planning Tools to Combat Climate Change

- Smart Growth Bundle Option to Reduce GHG
  - Infill, increased density and Brownfield development
  - Transit Oriented Development
  - Smart Growth
  - Targeted open space preservation
  - Walkability
  - Public transit

# Municipal Climate Action Plan

- Building Design and Planning
  - Enhance building codes
  - Adopt International Energy Conservation Code (IECC) 2004
  - Regular code updates – each three years
  - Increased promotion of LEED buildings
  - Water conservation programs
  - Recycling waste, waste water and household items

# PLANNING IMPLICATIONS AND APPROACHES

Mitigation and Adaptation

"Urban planning has a direct impact on climate. Urban areas are major producers of greenhouse gas (GHG) emissions and therefore have a significant impact on climate change. UN-HABITAT deals with climate change and urban development, a key element of which is urban planning, as part of its mandate. This is expressed in the Habitat Agenda under the Global Plan of Action: Strategies for Implementation"

- Mrs. Anna Tibaijuka, UN-Habitat former Executive Director

# Climate Friendly Planning

- Basic areas:
  - Reducing emissions
  - Adapting to climate change impacts

Stats

  - Global emissions: CO2e-37 (billion tons) GT/yr:
  - Carbon: 10 GT/yr
  - 398-400 ppmv- increasing by 2 points/yr

- Nepal 4 Million Tons/yr (0.01% of global)
- Per capita 0.15 T/yr: US = 20T/yr: 160 times more
- KTM city 80 persons/acre – very high density (1 m/20 sq miles)
- US suburbs 5-10/acre

# Major areas of intervention

- Regional Planning
- Land use Planning
- Urban Design
- Building Design
- Energy and resource conservation
- Appliances
- Operation and Maintenance

Masdar City UAE,
ASU solar 27 MW

# Example: Climate Change Impacts

- Annually approximately 10 billion tons of carbon is emitted to the atmosphere –transportation contributes 25%

- The projected 3" to 3 feet (23' if all Greenland ice melts) rise in sea levels will submerge many coastal cities in the mid century. Low elevation coastal zones (LECZ) are vulnerable – Suriname has almost 95% urban population on LECZ

# Urban Sprawl – Anywhere USA

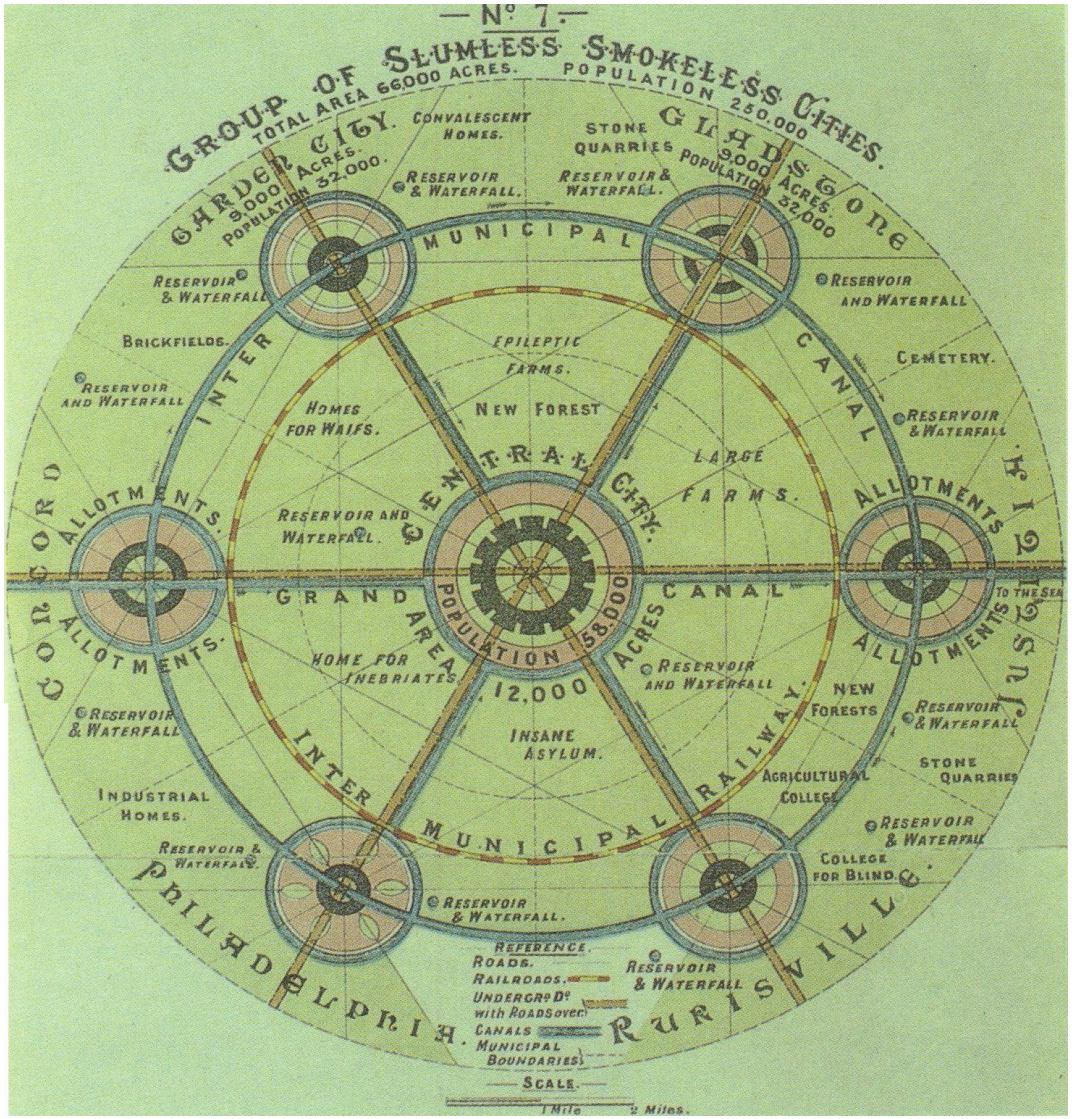
## Anonymity and Environmental Cost – Large Carbon Footprint/person

# Suburban Vocabulary vs Traditions

China

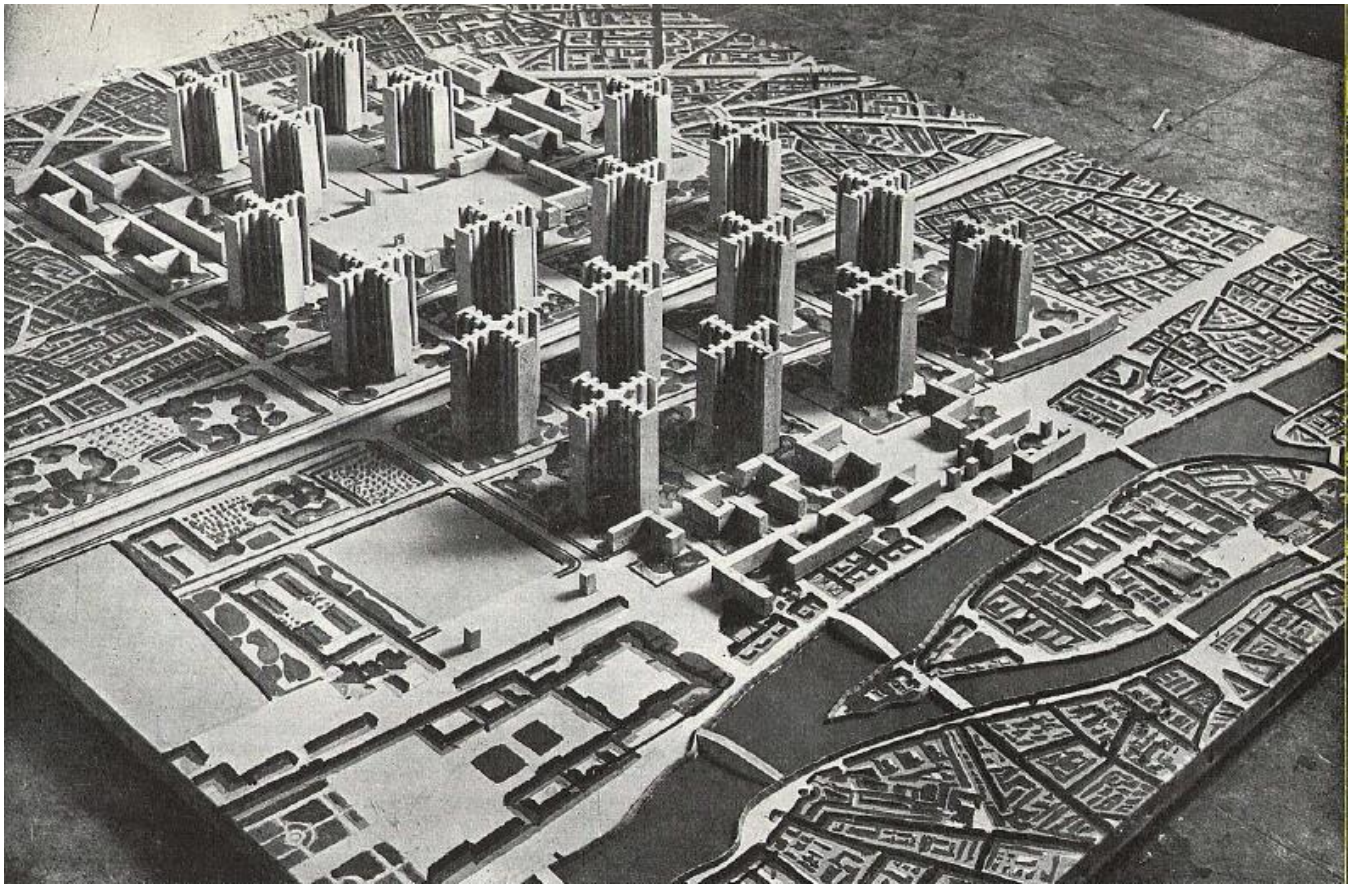
India

Nepal




Howard's Garden City – Carbon Friendly?

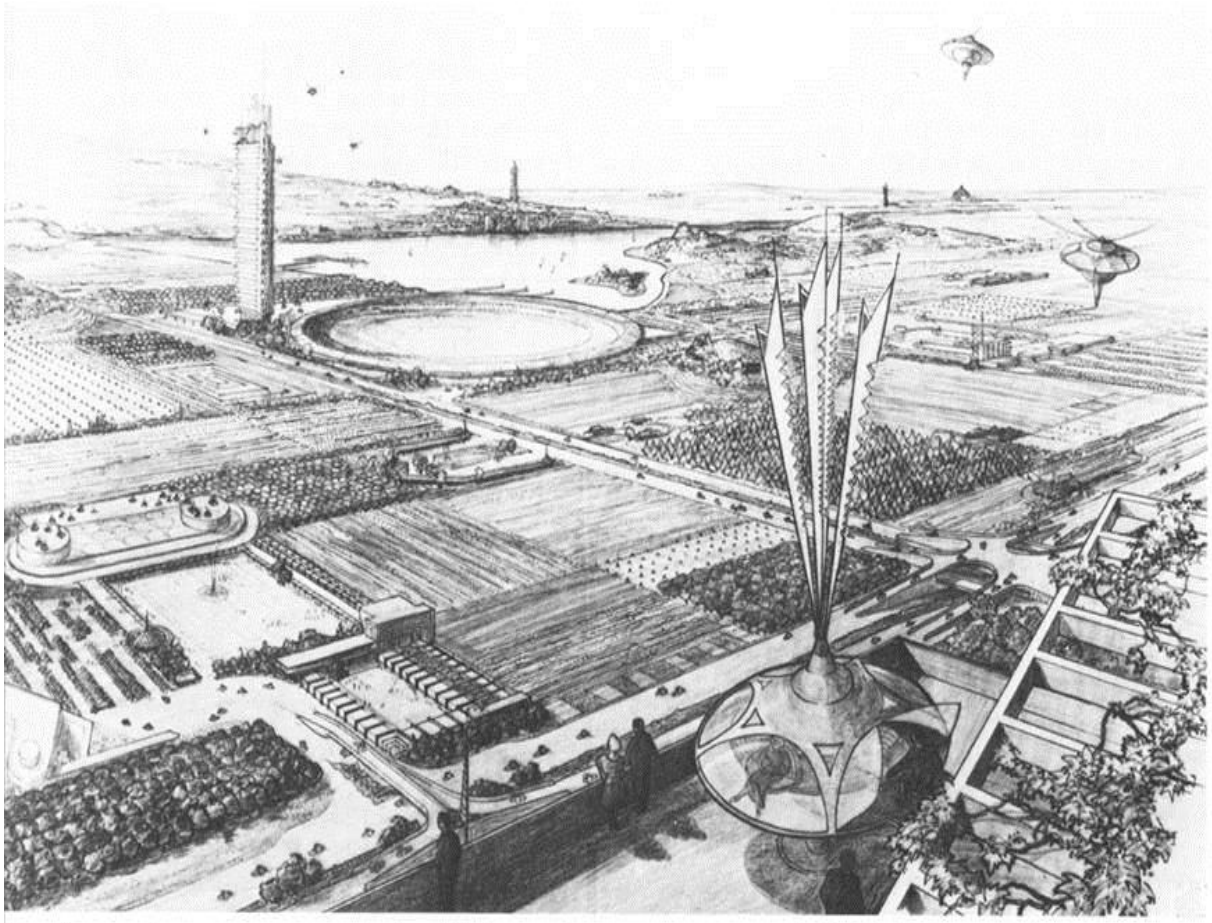
# Le Corbusier's Radiant City, 1922: Perhaps the most influential urban drawing that has inspired cities globally



## Climate Implications

- Automobile is central
- Concrete and glass – carbon imbedded materials
- Elevated streets
- Climate is less of a consideration than the architectural vocabulary

# Frank Lloyd Wright – Broadacre City, 1932. One acre of land for each family



Climate Implications

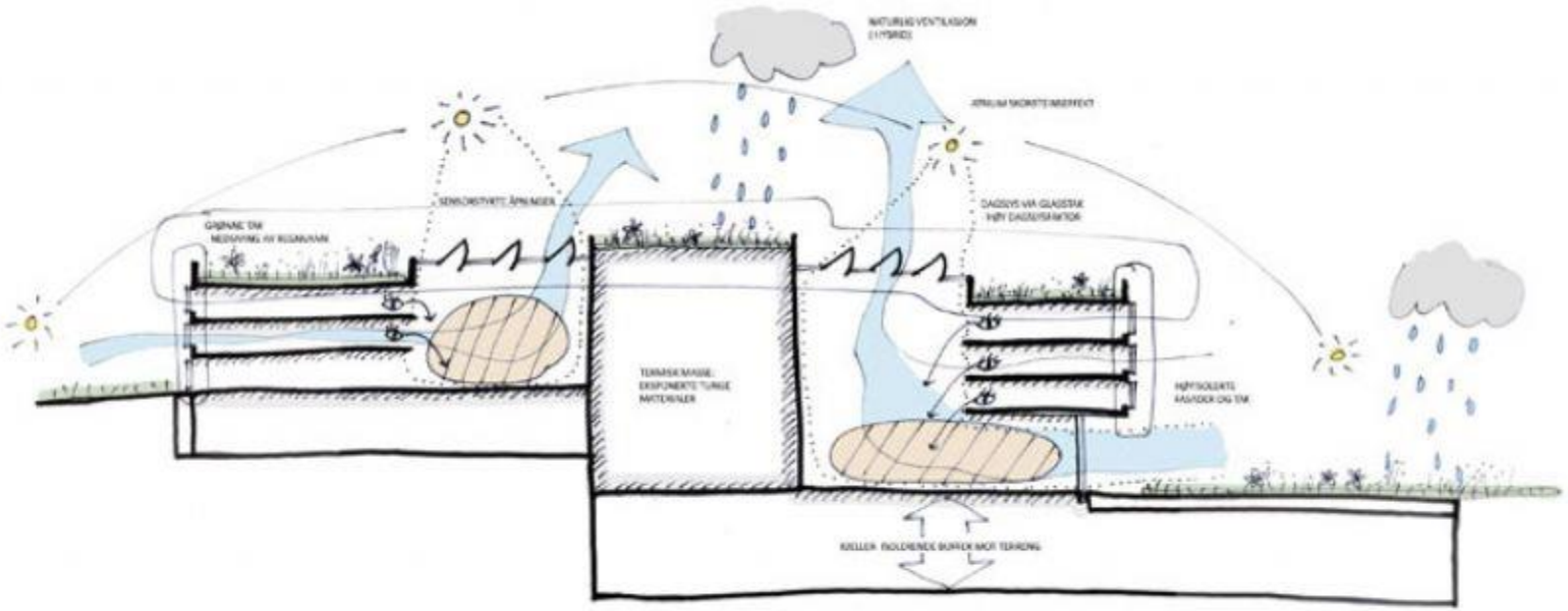
- Preservation of open space
- Low density overall
- Transportation need increased
- If self sufficient mixed uses are developed, it could be climate friendly
- Climate was not a consideration, but the American concept of expanse and vastness of land

Green Tower in KL by
Ken Yeang, Kuala Lumpur

Seattle Waterfront –
First Prize in Green Design by Harvard 2002

Green Roof Australia

Optima Green roofs, Scottsdale and Phoenix, AZ



Schematic – Climate Friendly Design

Presentation by Ambika P. Adhikari, Dr. Des, AICP

Green Urban Design –Proposal for Chongqing –
Team: COBE and Chongqing University.
Climate Utopia?

**Green buildings attached to existing buildings for carbon sink, energy efficiency, recreation and air filtration – Artist's rendering**

# Planning Approaches

- Land use planning to minimize emissions – compact, dense and mixed use
- Preserving agriculture, open space, vegetated lands, forests, and deserts
- Public transportation
- New Urbanism
- Walkability and pedestrian orientation
- Decreasing auto use and energy intensity
- Water Conservation
- Minimizing heat islands

# Urban and Building Design Approaches

- LEED (leadership in Energy and Environmental Design), ESTIDAMA, BREEAM (Building Research Establishment Environmental Assessment Methodology), and Green buildings
- Creating self-sufficient neighborhoods
- Making sustainability the core design principle
- Energy efficiency in buildings
- Integrating passive and active solar energy, and natural lighting and ventilation features
- Urban design for climate preservation

# Planner's Roles

- Mitigation of GHG emissions
  - Climate friendly General Plans
  - Appropriate land use mix
  - Building Design
  - Conservation of Energy, water and other resources
  - Preserving Nature
- Planning adaptation mechanisms for the impacts of Climate Change
  - Safeguarding health and safety
  - Protecting agriculture
  - Institutional mechanisms to help residents
  - Health care


Source: Design Centre for Sustainability, University of British Columbia

North Vancouver Design Examples to Tackle Climate Change

Source: Urban Planning Tools for Climate Change Mitigation, LILP 2009

FIGURE 2

**Scales of Urban Form and Policy Instruments to Impact GHG Emissions**

| Scales | Scale | Urban Form | Common Policies |
|---|---|---|---|
| | Building, parcel |  | Building codes, zoning bylaws, development guidelines |
| | Block, neighborhood, district |  | Local area plans, concept plans, community visions, development guidelines |
| | Municipality |  | Municipal development plans, comprehensive plans |
| | Region, bioregion, megaregion |  | Regional growth strategies, regional visions, regional transportation plans |

Source: Design Centre for Sustainability, University of British Columbia

Source: Urban Planning Tools for Climate Change Mitigation, LILP 2009

## Type of Urban Research Needs

| | Residential | Commercial | Institutional | Open Space |
|---|---|---|---|---|
| **Flood** | Land use and tidal basin research | Building size, and building foot prints where surfaces add to flood damage via run off | Risk assessments of prolonged floods and droughts on ground cracking or softening. Impacts on animal life of floods | Better design to carry water—examination of old stream beds and movement channels that may re-emerge in flood periods and across open space causing more damage<br>Retarding basins for flood mitigation |
| **Rising sea level** | Coastal community, beach erosion and tidal change scenarios | Building locations near water, with piling and footings as well as underground facilities such as car parks | Examining coastal building regulations, moving residential areas away form high risk locations | Coastal and beach areas Studies of flora and fauna as sea level rises<br>Studies into unstable dune systems |
| **Heat Waves** | Impact of continuous heat on energy systems; building materials, house orientations to the sun, roofing materials and construction | Building energy use, roof materials and elevator systems as well as evacuation | Long term city government plans to replace roofing material and invest in energy wise materials and regulatory practices | Cooling sink research on open areas-looking at type of tree and performance of open areas-like ball fields in heat periods |
| **Wind and Rain Storms** | Building design, street trees and other materials in residential areas as protectors or dangers | Building foot prints and wind tunnel effects | City wind research units to measure impacts of winds and storms on city | Open areas as wind carriers—open area wind tunnels or wind shields |

Source: Blakely, Edward, Urban Planning for Climate Change, LILP, 2007

| Sector | Indicators | Remarks[8] |
|---|---|---|
| Environmental | Air pollution levels: concentrate of major pollutants | Indicator in use |
| | Water pollution levels: extent of major pollutants in drinking water | Regular monitoring needed |
| | Waste management - solid waste diversion rate | Critical indicator in current situation |
| | Waste management – capacity and number of landfills and transfer stations compared to waste generation | Weak area at present |
| | Environmental and Carbon Footprint of Residents | Needs to be developed |
| Water Supply | Capacity of water supply sources to serve the valley | Needs to be developed |
| | Proportion of population served by potable water supply | Reasonable data |
| and Distribution | | exists |
| | Water consumption per capita | Reasonable data exists |
| Transportation and Accessibility | Rate of use of public transportation | Weak information |
| | Percentage of population with car ownership | Data presently exists |
| | Percentage of residents with access to public transportation | Weak information |
| Energy Use | Proportion of energy from renewable sources | Information exists |
| | Energy use per capita | Data exists |
| | Effectiveness of energy conservation programs | Needs to be developed |
| | Proportion of energy from local sources | Needs to be developed |
| Housing and Urban Design and Management | Percentage of housing that is affordable | Needs to be developed |
| | Public green open space per capita | Data exists |
| | Percentage of population living in squatter homes and slums | Data is scattered |
| | Percentage of land with urban agriculture | Needs work |
| | Percentage of land with urban forestry | Needs to be developed |
| | Population density by neighborhoods | Some data exists |

Table 1: Proposed Sustainability Indicators for Kathmandu, Nepal.

Source: A. Adhikari, 2009

# Comparative Measure of Sustainability Indicators

| City | Environmental Quality | Water Supply | Transportation & Accessibility | Energy Use | Housing and Urban Design |
|---|---|---|---|---|---|
| **Kathmandu** | Poor | Poor | Fair-Poor | Fair | Fair-Poor |
| **Calcutta** | Poor | Poor-Fair | Fair | Fair | Poor |
| **New Delhi** | Poor-Fair | Poor-Fair | Fair | Fair | Poor |
| **Manila** | Poor-Fair | Fair | Fair | Fair | Poor |
| **Bangkok** | Poor | Fair | Fair | Good | Fair |
| **Seoul** | Good | Good | Excellent | Good | Good |
| **Singapore** | Excellent | Excellent - Good | Excellent | Good | Excellent |

Table 2: Comparative Quality of Some Sustainability Indicators for Selected Asian Cities

Source: A. Adhikari, 2009

# Adaptation (Based on US EPA)

**Human Health**

- Provision of financial and public health resources, including training, surveillance and emergency response, and prevention and control programs.
- Urban forestry to moderate temperature increases
- Weather advisories to alert the public about dangerous heat conditions
- Food storage, emergency feeding stations
- Adjusting clothing and activity levels, increasing fluid intake

# What Can you Do? Contd...

Examples by US EPA:

- Carpool: Leaving your car at home just two days a week will reduce your carbon dioxide emissions by 1,590 pounds per year.

- Recycle aluminum cans, glass bottles, plastic, cardboard, and newspapers. Recycling can reduce your home's carbon dioxide emissions by 850 pounds per year.

- Buy food and other products with reusable or recyclable packaging, or reduced packaging, to save the energy required to manufacture new containers. This simple action could reduce your emissions by 230 pounds a year.

**Average American's yearly Co2 emission = 17 Tons**
**China's per-capita annual emission – 6.7 Tons**
**India's per-capita annual emission = 1.7 Tons**
**Nepal's per-capita annual emission = 0.15 Tons**
**Av. worldwide annual per-capita emission = 5 Tons**
**Source: World Bank, 2014**

# Thank you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