# M.Tech Geoinformatics

# Urban Studies

## Units- I to IV

Prakash. K
Guest Faculty
Department of Geography
Bharathidasan University, Tiruchirappalli.

# Basic Concepts

Urban Morphology – Urban hierarchy - Urbanization in India and World – Problems of Urbanization - Urban Indicators and Monitoring – Urban Information System.

# BASIC CONCEPTS

- The study of urban  centers in the perspective of geography.
- Investigates the impact of urban processes on the earth surface, social and physical structures
- Analyze the spatial suitability of the urban centers for sustainable growth.
- Recognition vs definition

# DEFINITION

- Among the 233 countries for which urban data was reported in the UN world urbanization prospects in 2018, 104 use single criteria.
- The criteria could be anyone of,
  - Administrative function (59 countries)
  - Population size/density (37 countries)
  - Urban characteristics (8 countries)

https://unhabitat.org/sites/default/files/2020/06/city_definition_what_is_a_city.pdf

## United States:

- Agglomerations of 2,500 or more inhabitants
- Population densities of 1,000 persons per square mile or more.

## France:

- >2,000 inhabitants living in contiguous houses or with not more than 200 metres between houses

According to the Census of India 2011, Urban is a place with:

- >5,000 population
- >400 persons per square kilometer (1,000/sq mi)
- >75% of the male employed in non-agricultural activities

- Places administered by a municipal corporation, cantonment board or notified town area committee
- The Census of India 2011 also defined the term “Urban Agglomeration" as an integrated urban area consisting of a core town together with its Outgrowths (contiguous suburbs).

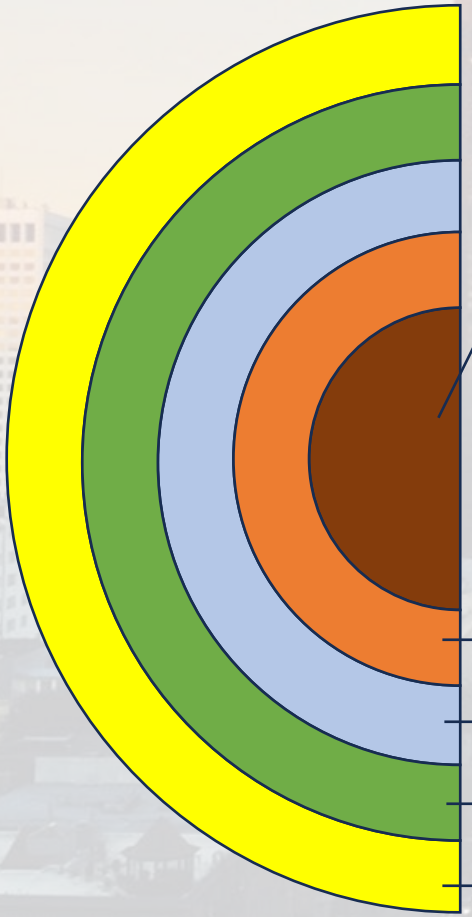
- In just 65 years, the world has experienced a population shift from rural to urban
- People living in urban areas increased from 29.6% in 1950 to 54% in 2015.
- Estimates indicate that at the close of the monitoring period for the SDG (2030), 60% of the world population will be in urban.

1. The five fundamental aspects of urban study:
   - Demography
   - Economy
   - Morphological
   - Functional
   - Social

# URBAN MORPHOLOGY

1. Urban morphology is the study of the structure of human settlements
2. Urban Morphology
   - The study of urban forms and of the agents and processes responsible for their transformation.
3. Urban Form
   - Refers to the main physical elements that structure and shape the urban buildings, open spaces, streets and utilities.
4. Some of the landmark contributions are,
   - The Concentric Zone Model - E.W. Burgess - 1923
   - The Sector Model - Homer Hoyt - 1939
   - The Multiple Nuclei Model - Harris and Ullman - 1945

# CONCENTRIC ZONE THEORY



**Central Business District**

**Transitional Zone**
- *Recent immigrants*
- *Deteriorated Housing*
- *Factories*
- *Abandoned Buildings*

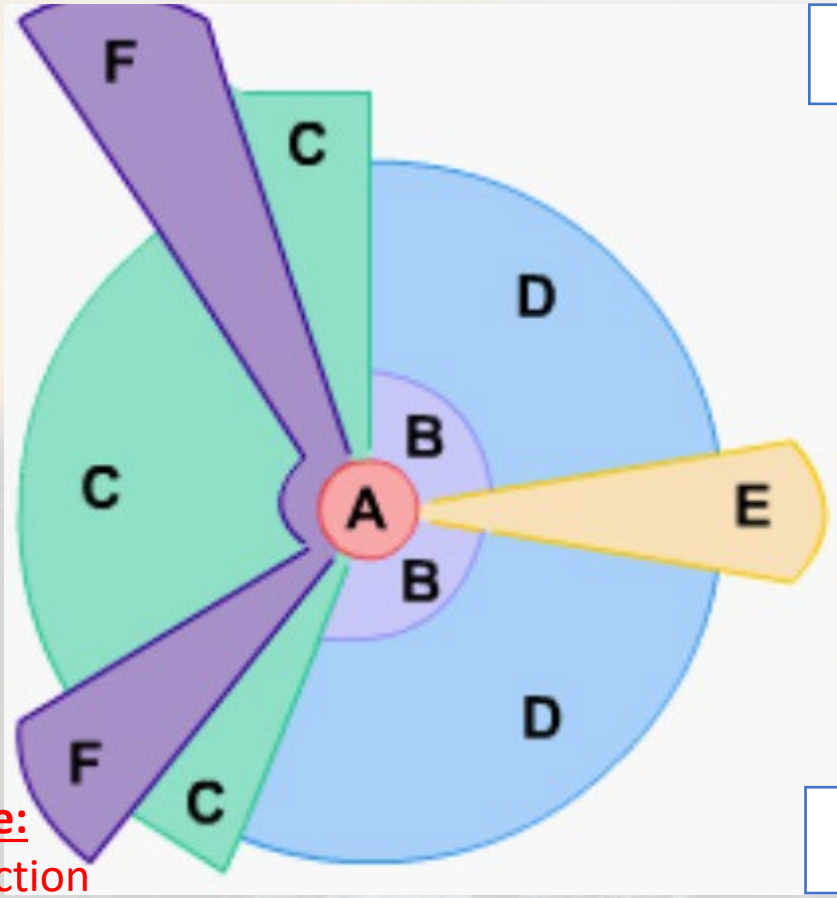
**Working Class Zones**
- *Single family homes*

**Residential Zone**
- *Single family homes*

**Commuter Zone**
- *Suburbs*

**Learn more:**
- Introduction
- Assumptions
- Explanation
- Criticism

# SECTOR THEORY

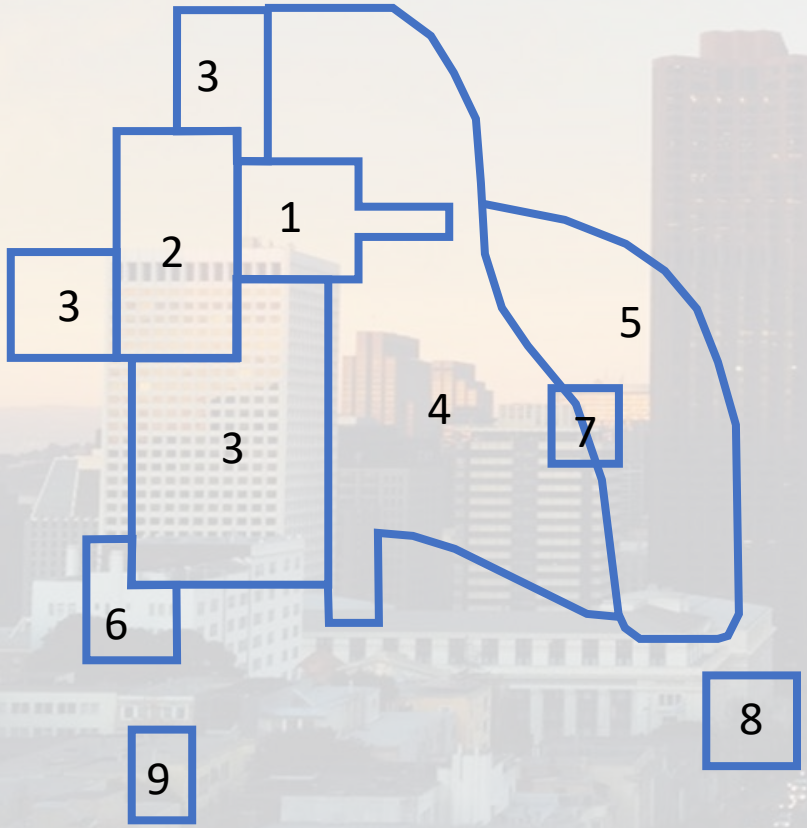



- **A** CBD – Central Business District
- **B** Zone of Transition
- **C** Residential (Lower class)
- **D** Residential (Middle class)
- **E** Residential (Upper class)
- **F** Industry

**Learn more:**

- Introduction
- Assumptions
- Explanation
- Criticism

# SECTOR THEORY




1. Central Business District
2. Wholesale Light Manufacturing
3. Low-class Residential
4. Middle-class Residential
5. High-class Residential
6. Heavy Manufacturing
7. Outlying Business District
8. Residential Suburb
9. Industrial Suburb

**Learn more:**

- Introduction
- Assumptions
- Explanation
- Criticism

# URBAN CLASSIFICATION AND HIERARCHY

1. India has (Census of India (2011))
   - 3784 Census Towns
   - 4041 Statutory Towns

   Census of India classifies towns and cities into,

| | |
|---|---|
| Class - 1 | 1,00,000 |
| Class - 2 | 50,000 – 99,999 |
| Class – 3 | 20,000 – 49,999 |
| Class – 4 | 10,000 – 19,999 |
| Class – 5 | 5,000 – 4,999 |
| Class - 6 | <5,000 |

# FUNCTIONAL CLASSIFICATION OF TOWNS - M.K. JAIN

1. Primary Activities:
   - a. Cultivators
   - b. Agricultural Laborers
   - c. Livestock, fishing, forestry, hunting, plantation and allied activities
   - d. Mining and Quarrying
2. Industrial Activities:
   - e. Manufacturing i.e. Household and Other than Household,
   - f. Construction
3. Trade:
   - g. Trade and Commerce
4. Transport:
   - h. Transport, Storage and Communication
5. Services:
   - i. Other Services

# MUMFORD'S ORGANIC CLASSIFICATION OF CITIES

## 1. Eopolis

- Eopolis refers to a small settlement with rural culture.
- As the time progresses, the people learned to practice agriculture.
- People start to sell the surplus food. Hence, a class of producers and traders emerge.

## 2. Polis

- Eopolis increases spatial interaction with neighboring villages.
- The terms of trade are generally in favor of the traders of the eopolis or central village which leads to accumulation of wealth in the eopolis.
- Slowly, the market area in the center of settlement expands and becomes a Polis (city).
- A social hierarchy also emerges where priests and traders command highest position while the rest work as peasants.

## 3. Metropolis

- The town and its peripheral villages grow spatially and merge to form a Metropolis
- The metropolis increase its economic efficiency through specialization of trades. For example, some area of the city is allocated for industrial use and some for leisure and some for residential purposes.
- They produce one component of a larger product. The specialization leads to decline in wastage and betterment of quality.
- Therefore, the metropolis contains sufficient water, food and housing amenities.

## 4. Megapolis

- In this stage, the immigration of people from different parts of the country leads to diversification of culture.
- The society starts to become individualistic and people grow indifferent to others' plight.
- The crowding of megapolis results in shortage of resources which leads to class conflict.
- At the end of this stage, the city starts to decline.

## 5. Tyrannopolis

- In this stage, the society becomes completely individualistic.
- The city takes away the surplus resources from rest of the country for its own pleasure.
- Due to environmental degradation, the people start to move towards the villages.
- The economy goes through Trade or Business Cycles.

## 6. Necropolis

- Necropolis means dead city.
- In this stage, the environmental degradation, resource scarcity and erosion of cultural institutions leads to famine, wars and epidemics.
- Eventually, the city goes through great turmoil and decays.

# FUNCTIONAL CLASSIFICATION OF CITIES

- **Marcel Aurousseau** was the first social scientist to classify the cities on the basis of function (1921).
- He classified towns into six major and 28 minor types.

  - Administrative Towns
  - Defense Towns
  - Cultural Towns
  - Production Tows
  - Communication Towns
  - Recreation Towns

**Learn more!**

- Explain the types
- Criticism

# FUNCTIONAL CLASSIFICATION OF CITIES BY HARRIS

1. Any city having a higher proportion of workers in a certain industry was classified as specialized in that industry.
   - Manufacturing (M)
   - Retailing (R)
   - Diversified (D)
   - Wholesaling (W)
   - Transportation (T)
   - Mining (S)
   - Educational (E)
   - Resort or retirement (X) and
   - Others (P).

**Learn more!**

- Basis of the theory
- Threshold values
- Criticism

# QUANTIFYING URBAN HIERARCHY

1. Urban is an indication of growth and modernity.
2. At the same time, consider its
3. Spatial distribution
4. Size with reference to other urban centres
5. Rate of growth and other functional aspects

# CONCEPT OF PRIMATE CITY

1. Propounded by Mark Jefferson
2. A country's most important city is always disproportionately large and remarkably expressive of national capacity
3. It exerts supremacy on all others not only in population size but also in its role as a political, economic and social center

4. Index of Primacy = P1/P 2

Where: P1 = Population of the largest town and

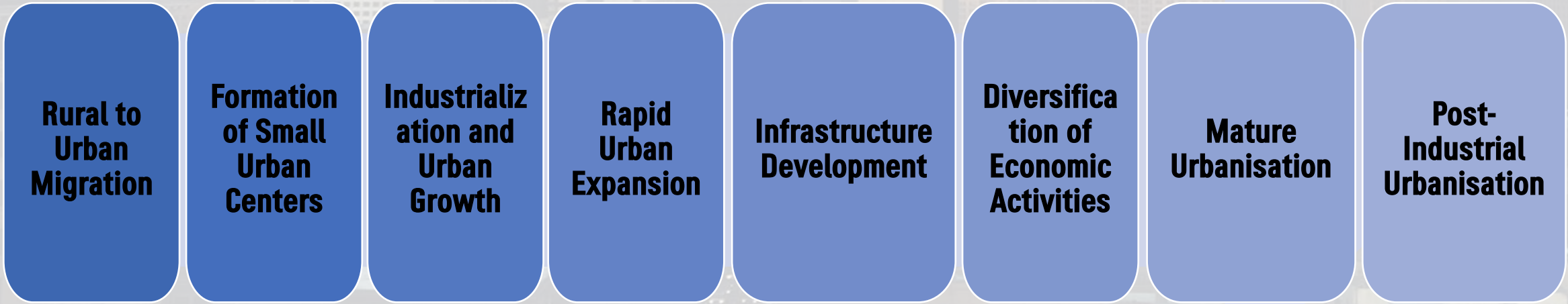
P2 = population of the second largest town

# RANK-SIZE RULE

- If all cities in a country are placed in order from the largest to the smallest, each one will have a population half the size of the preceding city.
  - –Rank 1 – Largest City
  - –Rank 2 – 1/2 the number of people as Rank 1 city
  - –Rank 3 – 1/3 the number of people as Rank 1 city
  - –Rank 4 – 1/4 the number of people as Rank 1 city
  - –Rank 5 – 1/5 the number of people as Rank 1 city

# URBANIZATION

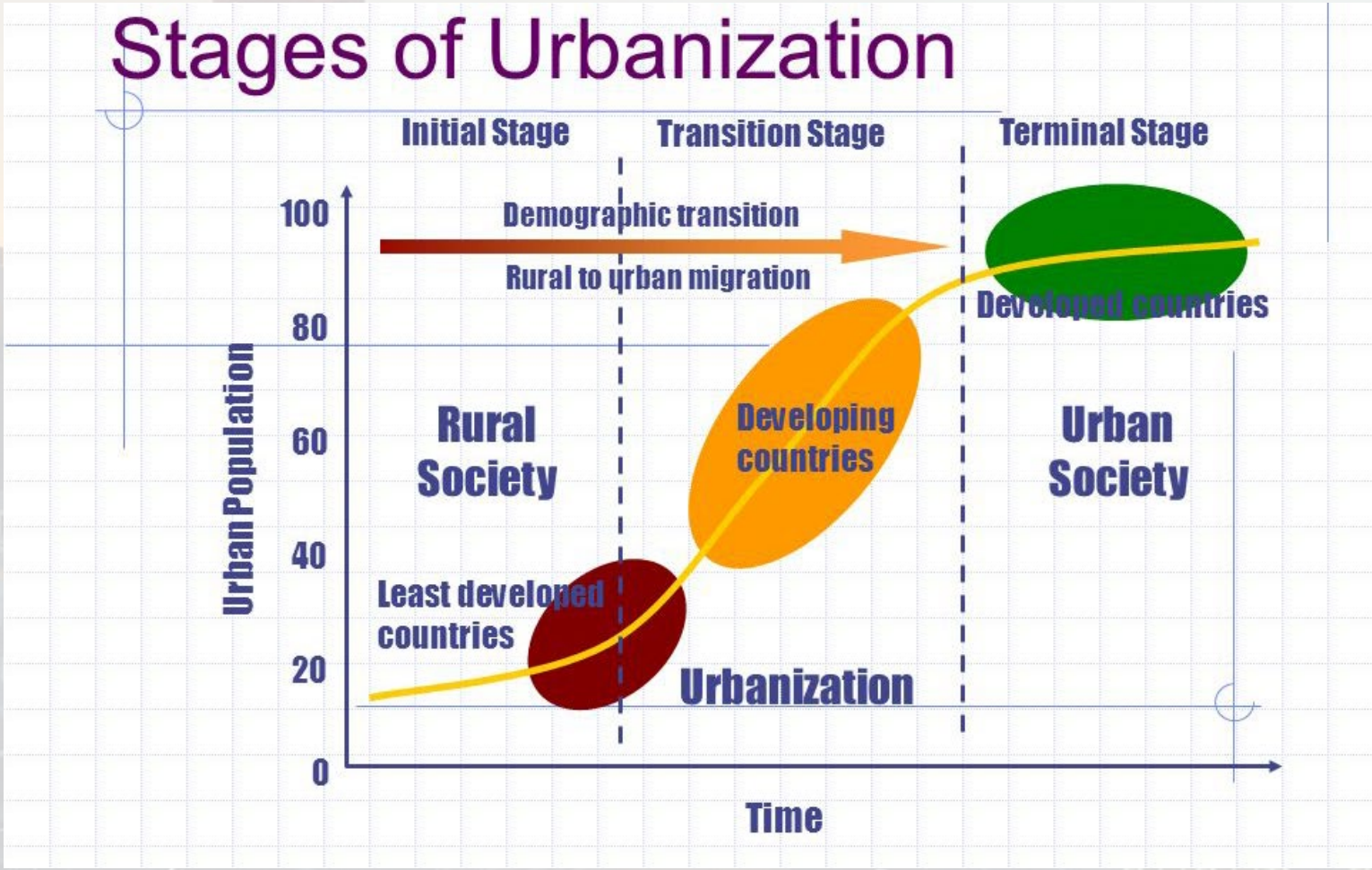
1. Urbanisation is the increase in the proportion of people living in towns and cities.
2. Urbanization typically occurs in stages
3. Each stage is marked by distinct demographic, economic, and social changes

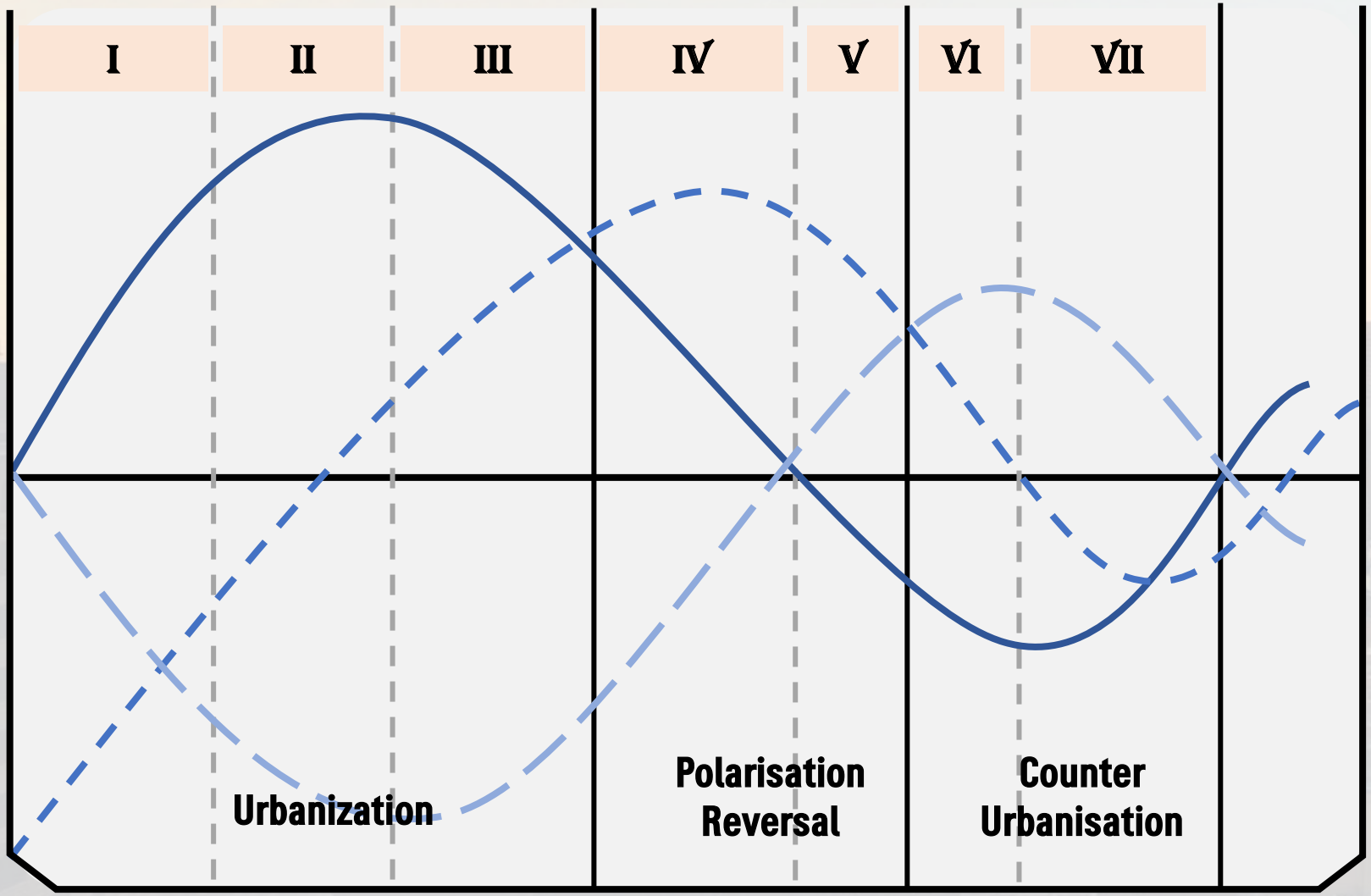



*Discuss the factors of urbanisation!*

# STAGES OF URBAN DEVELOPMENT

1. Urbanisation
2. Ex-urbanisation
3. Counter-urbanisation
4. Re-urbanisation






I Early Primate City

II Intermediate Primate City

III Advanced Primate City

IV Early Intermediate City

V Advanced Intermediate City

VI Early Small City

VII Advanced Small City

Primate City

Intermediate City

Small City

# URBAN GROWTH IN INDIA

| Urban Growth in India, 1971-2011 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Population in Million | | | | Percentage of Change | | | |
| | 1971-81 | 1981-91 | 1991-01 | 2001-11 | 1971-81 | 1981-91 | 1991-01 | 2001-11 |
| Urban Increment | 49.9 | 56.8 | 68.2 | 91 | 100 | 100 | 100 | 100 |
| Natural Increase (of initial population plus intercensal migrants) | 24.9 | 35.4 | 393 | 39.9 | 50 | 62.3 | 57.6 | 43.8 |
| Net rural-urban migration | 9.3 | 10.6 | 14.2 | 18.7 | 18.6 | 18.7 | 20.8 | 20.6 |
| Net reclassification from rural to urban including jurisdictional changes and out growths | 15.7 | 10.8 | 14.7 | 32.3 | 31.4 | 19 | 21.5 | 35.6 |

# PROBLEMS OF URBANIZATION

1. Overcrowding
2. Unemployment
3. Slums and Squatter Settlements
4. Degradation of Natural Resources
5. Health and Sanitation
6. Transportation
7. Sewage
8. Water Quality
9. Urban Waste
10. Urban Crime

# …

- 4.4 billion in 2020; 6.7 billion by 2050.
- Despite these problems, some Governments have been able to address the spatial, economic and social aspects of the urban divide and promote inclusive urbanization, including in rapidly growing cities.
- Their successful strategies have four elements in common.
  - ***First,*** they have established land and property rights, paying particular attention to security of tenure for people living in poverty.
  - ***Second,*** they have improved the availability of affordable housing, infrastructure and basic services.
  - ***Third,*** they have facilitated access to education and decent employment for all urban residents.
  - ***Fourth,*** they have introduced mechanisms to allow participation in decision-making, encouraging input from all stakeholders on the allocation of public funds and on the formulation, monitoring and evaluation of all policies.

https://www.un.org/development/desa/en/news/social/urbanization-expanding-opportunities-but-deeper-divides.html

## Critical issues that need to be addressed in India are:

- Poor local governance
- Weak finances
- Inappropriate planning
- Critical infrastructure shortages and service deficiencies
- Rapidly deteriorating environment

https://www.worldbank.org/en/news/feature/2011/07/04/indias-urban-challenges

# URBAN VS CLIMATE

1. Beyond its administrative boundaries, urban is influencing climate change in many ways.
2. Contributes 70% of the world's greenhouse gas emissions
3. Climate change may render hundreds of millions of urban residents increasingly vulnerable to floods, landslides, extreme weather and other natural disasters.
   - Who are affected more?
   - 1 Metre away from Sinking
4. Part of the solution lies in how cities are planned, governed, and provide services to their citizens.

# URBAN INDICATORS

- MDG / UN Urban Habitat
  - Shelter
  - Social Development
  - Environmental Management
  - Economic Development
  - Governance

# SDG.11

- 11.1: Ensure access for all to adequate, safe and affordable **housing and basic services** and upgrade slums.
- 11.2: Provide access to safe, affordable, accessible and **sustainable transport** systems
- 11.3: Enhance inclusive and sustainable urbanization and capacity for participatory, integrated and **sustainable human settlement** planning and management in all countries.
- 11.4: Strengthen efforts to protect and safeguard the **cultural and natural heritage**.
- 11.5: Significantly reduce the **number of deaths and the number of people affected** by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.
- 11.6: Reduce the adverse per capita environmental impact of cities, including by paying special attention to **air quality and municipal and other waste management**.

- **11.7:** Provide universal access to safe, **inclusive and accessible, green and public spaces**, in particular for women and children, older persons and persons with disabilities.
- **11.a:** Support positive **economic, social and environmental** links between urban, peri-urban and rural areas
- **11.b:** Substantially increase the number of cities and human settlements adopting the **Sendai Framework for Disaster Risk Reduction**
- **1.4:** Ensure that all men and women, particularly the poor and the vulnerable, have equal rights
- **6.3:** Improve water quality

https://data.unhabitat.org/pages/sdgs

# URBAN MONITORING FRAMEWORK

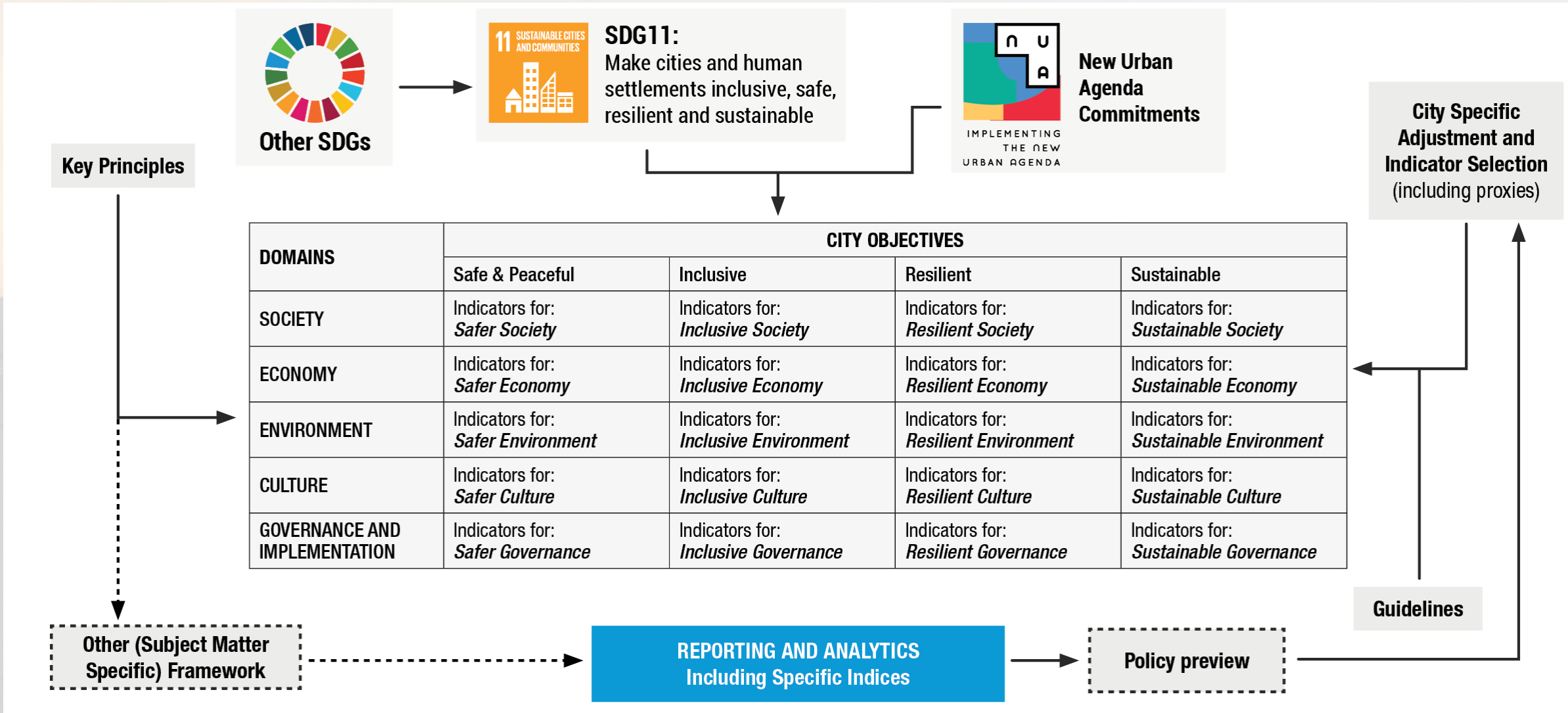
**Domains**

- Society
- Economy
- Environment
- Culture
- Governance

**City Objectives**

- Safe & Peaceful
- Inclusive
- Resilient
- Sustainable

# URBAN MONITORING FRAMEWORK




| DOMAINS | CITY OBJECTIVES | | | |
|---|---|---|---|---|
| | Safe & Peaceful | Inclusive | Resilient | Sustainable |
| SOCIETY | Indicators for: *Safer Society* | Indicators for: *Inclusive Society* | Indicators for: *Resilient Society* | Indicators for: *Sustainable Society* |
| ECONOMY | Indicators for: *Safer Economy* | Indicators for: *Inclusive Economy* | Indicators for: *Resilient Economy* | Indicators for: *Sustainable Economy* |
| ENVIRONMENT | Indicators for: *Safer Environment* | Indicators for: *Inclusive Environment* | Indicators for: *Resilient Environment* | Indicators for: *Sustainable Environment* |
| CULTURE | Indicators for: *Safer Culture* | Indicators for: *Inclusive Culture* | Indicators for: *Resilient Culture* | Indicators for: *Sustainable Culture* |
| GOVERNANCE AND IMPLEMENTATION | Indicators for: *Safer Governance* | Indicators for: *Inclusive Governance* | Indicators for: *Resilient Governance* | Indicators for: *Sustainable Governance* |

## Society

- Under-5 Mortality Rate
- Safely Managed Drinking Water
- Safely Managed Sanitation Services
- Hand-Washing Facility with Soap and Water
- Proportion of Births in all Health Facilities
- Neighborhood Safety
- Adolescent Birth Rate
- Traffic Fatalities
- Basic Services
- Access to Public Transport
- Education Completion Rate
- Secure Tenure Rights to Land
- Prevalence of Malnutrition
- Vaccinated Children
- Welfare of Migrants
- Multilingual Education
- Life Expectancy at Birth
- Mortality Rate (Diseases)
- Mortality Rate (Suicide)
- Population Affected by Hazardous Events
- Mortgage Debt Relative to GDP
- Food Insecurity
- Slum Population
- Gini Coefficient

## Economy

- Children Engaged in Child Labour
- Time Spent on Unpaid Domestic and Care Work
- The Global Urban Monitoring Framework
- Unemployment Rate
- Youth not in Education, Employment or Training (NEET)
- Use of Public Transport
- Internet Use
- Annual Growth Rate of GDP per Capita
- Youth and Adults in Formal and Non-formal Education and Training
- Adult Population with a Qualification from a Recognized Institution
- Fixed Internet Broadband Subscriptions
- Small-scale Industries in Total Industry Value Added
- Days to Start a Business
- Patent Application
- Sub National Debt
- Mean Household Income

## Environment

- Wastewater Safely Treated
- Solid Waste Collection and Disposal
- Air Quality
- Hazardous Waste
- Access to Open Public Spaces
- Education for Sustainable Development
- Renewable Energy Share
- Green Area per Capita
- Change in Tree Cover
- Protected Natural Areas
- Greenhouse Gas Emissions
- Efficient Land Use
- Budget on Climate Change Mitigation and Adaptation

## Culture

- Culture for Social Cohesion
- Cultural Knowledge
- Access to Cultural Infrastructure
- Cultural Participation
- Cultural Employment
- Expenditure on Heritage
- Sustainable Management of Heritage
- Climate Adaptation and Resilience
- Open Space for Culture

## Governance

- Victims of Intentional Homicide
- Victims of Physical and Sexual Violence
- Intimate Partner Violence
- Reporting of Violence
- Bribery
- Direct Participation Structure of Civil Society in Urban Planning and Management
- Utilization of E-Governance and Digital Governance Tools
- Proportion of Seats Held by Women in Sub-national/Local Governments
- Legal Frameworks for Equality
- Efficiency in Urban Governance
- Own Source Revenue Collection
- Financial Autonomy
- Local Disaster Risk Reduction Strategies
- Registered Births
- National Urban Policies/ Regional Development Plans
- Governance of Culture

# THE NEW URBAN AGENDA (NUA)

- Blueprint for our **shared and sustainable urban future**
- Adopted at the UN Conference on **Housing and Sustainable Urban Development (Habitat III)** in Quito, Ecuador, on 20 October 2016
- The NUA aims at making cities **spatially effective** for sustainable development
- All SDGs are connected and linked with the NUA

| | |
|---|---|
| **Leave no one behind** | **end poverty, ensure public participation, equal rights and opportunities, socioeconomic and cultural diversity, health and welfare** |
| **Inclusive Economies** | **planned urbanization, productivity, opportunities, competitiveness, innovation** |
| **Environmental Sustainability** | **clean energy and sustainable use of land and resources, protect ecosystems and biodiversity, build resilient urban, reduce disaster risks** |

# URBAN INFORMATION SYSTEM

**Data**

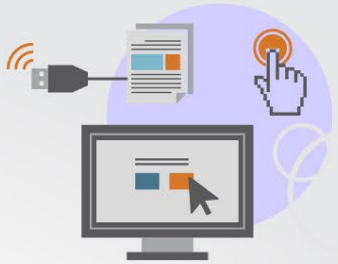
Indicator framework, methods & tools, analyzed data, e.t.c.

**Stakeholders network**

Observatory managers, data producers, e.t.c.

**Data Disseminantion Platform**

Website, stand alone apps etc

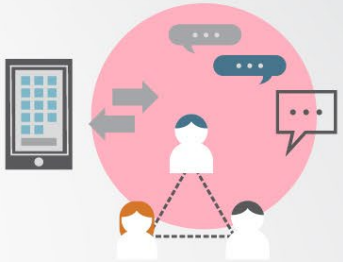


**Observatory Support System**

UN-Habitat for guidance & certification, external donors, GUO-Network


**Decision Support Interface**

Reports, community engagement system, feedback mechanism etc

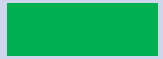
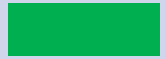
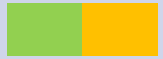
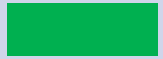
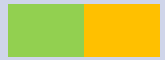
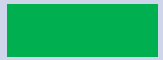
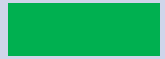
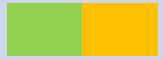


# Urban Database

**Satellite Platforms:** 1.1: Hyperspectral, 1.2: RADAR, 1.3: LIDAR, 1.4: Drone - Scope and Limitations

**Data Sources:** 2.1: GNNS Survey for Data Collection – 2.2: BHUVAN Thematic Map Services – 2.3: Organizational Reports – 2.4: Cadastral Mapping – 2.5: Utility and Infrastructure Mapping.

# URBAN DATABASE

| | Satellite Data | Survey Data |
|---|---|---|
| Housing, slums and informal settlements |  |  |
| Urban population trends |  |  |
| Open spaces and green areas |  |  |
| Urban transport |  |  |
| Access to basic services in cities and urban areas |  |  |
| City Prosperity Index |  |  |
| Economic indicators |  |  |
| Urban environment and quality of life |  |  |
| Spatial growth of cities and urban areas |  |  |
| Social inclusion indicators |  |  |

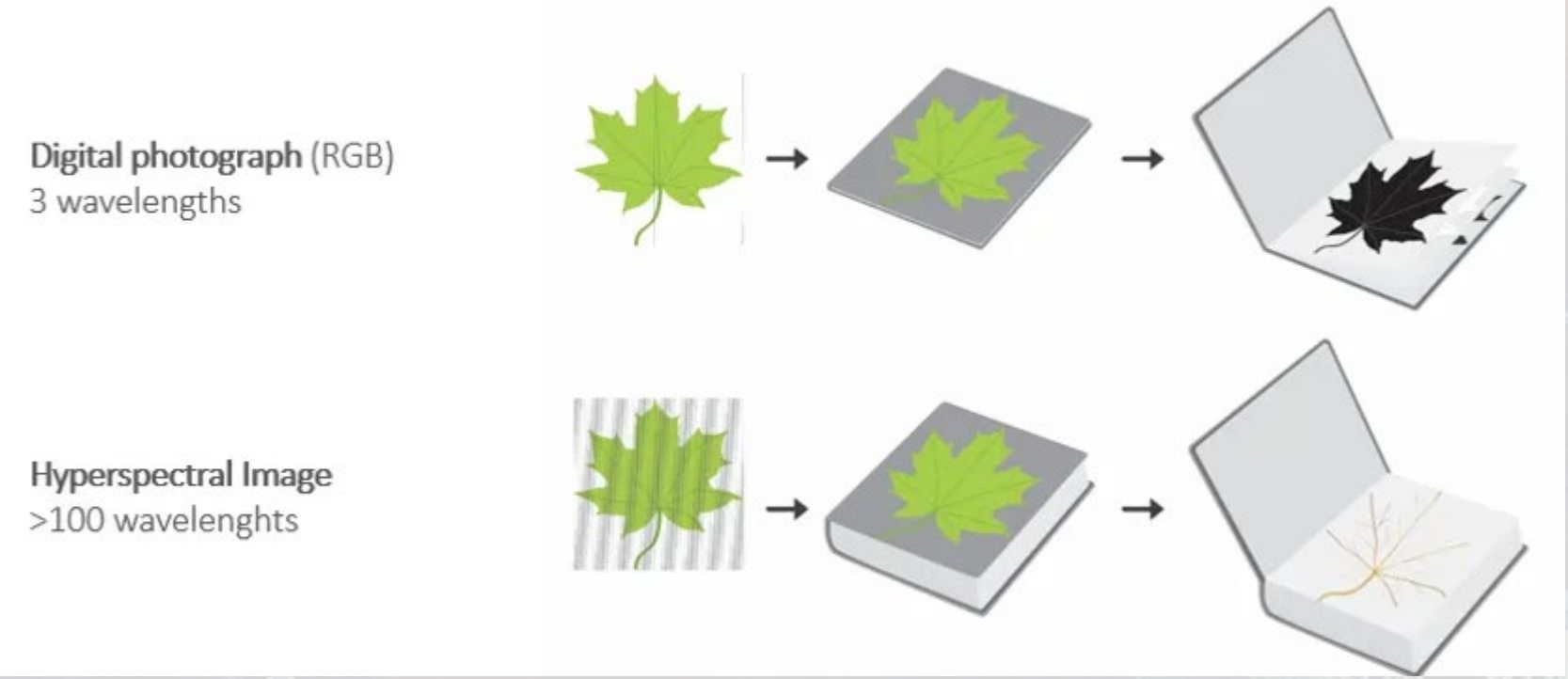
*https://data.unhabitat.org/pages/datasets*

# 1.1 HYPERSPECTRAL IMAGING

**Imaging spectrometer**, also called a hyperspectral camera, to collect spectral information.

It provides both spatial and spectral information about the object's **physical** and **chemical** properties.

**Applied extensively for material identification**



# Urban Classes by Hyperspectral Image

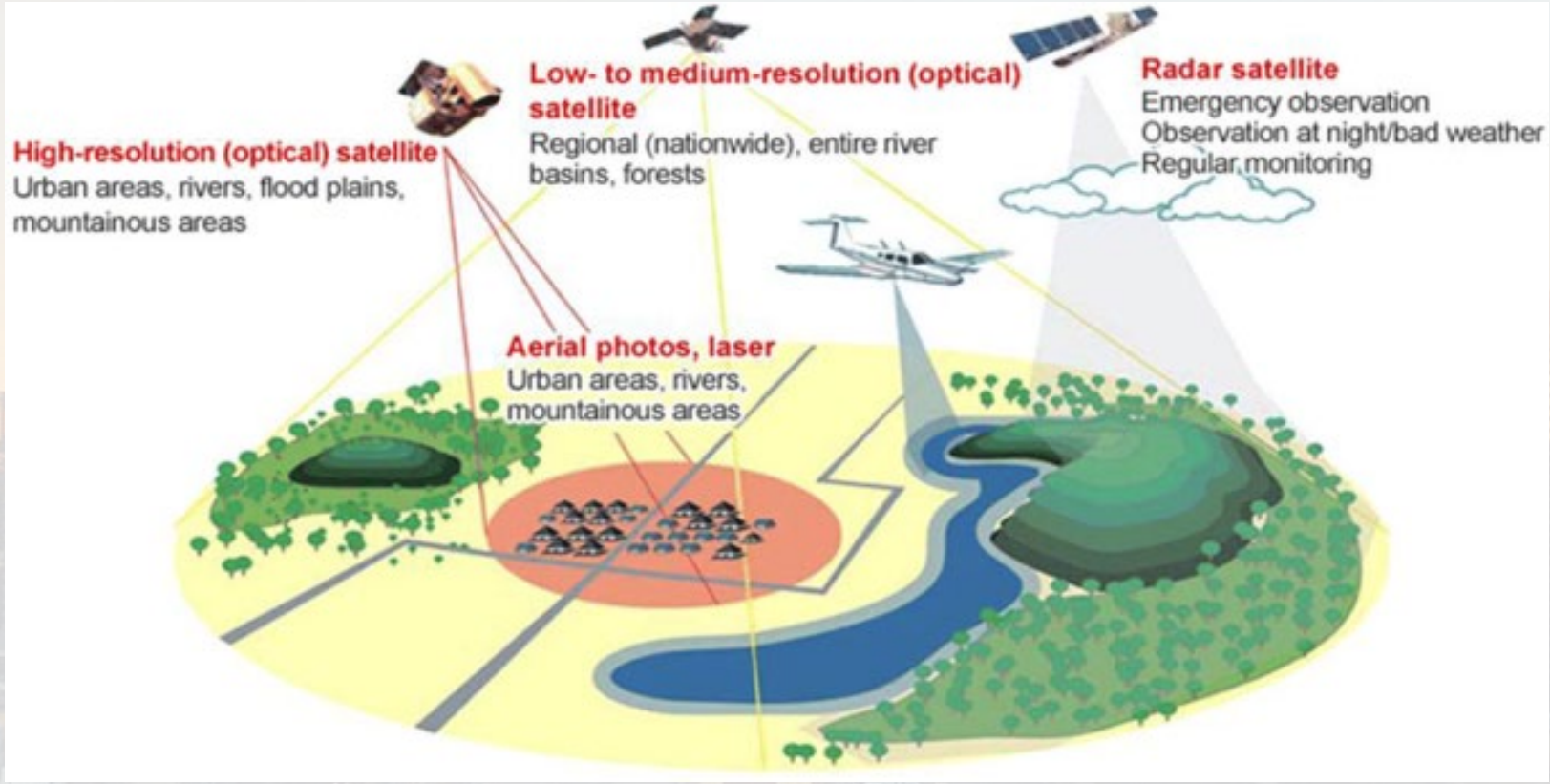
| Level 1 | Level 2: Land cover | Level 3: Material types | Level 4: Surface materials |
|---|---|---|---|
| Man-made/artificial surfaces | Buildings/roofs | Mineral materials | Asbestos |
| | | | Bitumen roof sheeting |
| | | | Clay tiles |
| | | | Concrete slabs |
| | | | Concrete tiles |
| | | | Fiber cement |
| | | | Glass |
| | | | Gravel |
| | | | Slate |
| | | Metallic materials | Aluminum |
| | | | Copper |
| | | | Zinc |
| | | | Steel with protective coating |
| | | | Corrugated metal sheet |
| | | | Lead |
| | | | Gold leaf |
| | | | Tin |
| | | Hydrocarbon materials | Coated corrugated metal sheet (PVC, Polyethylene, coating color) |
| | | | Polyvinylchloride (PVC) |
| | | | Polyethylene (PE) |
| | | | Polyisobutylene (PIB) |
| | | | Plexiglas |
| | | | Tar Paper |
| | | Biomass materials | Green roof |
| | | | Thatched roof |
| | | | Wood shingles |
| | Artificial open spaces | Partially impervious surfaces | Cinder |
| | | | Clay-baked paving stones |
| | | | Cobblestone pavement |
| | | | Concrete paving stones |
| | | | Gravel |
| | | | Grass pavers |
| | | | Loose chippings |
| | | | Railway tracks |
| | | | Fully impervious surfaces Asphalt |
| | | | Concrete |
| | | | Flagstone (Granite) |
| | | | Synthetic turf |
| | | | Tartan |
| | | | Water bodies with artificial |
| | | | bottom |
| | | | Pool |
| | | | Garden pond |

| | | | |
|---|---|---|---|
| Natural surfaces | Vegetation | Trees | Coniferous |
| | | | Deciduous |
| | | | Shrubs/bushes |
| | | | Meadow/lawn Meadow - dry |
| | | | Meadow - fresh |
| | | | Ornamental lawn |
| | | | Sports turf |
| | Bare ground | Soil | Soil - dark |
| | | | Soil - bright |
| | | Sand | Sand - coarse |
| | | | Sand - fine |
| | | Rock | |
| | Water bodies | Ocean/sea | |
| | | Inland waters | Lakes |
| | | | Ponds |
| | | | Rivers |

# 1.2 RADAR

## Main applications:

- DEM
- Feature Extraction
  - Water
  - Vegetation
  - Settlements
- Traffic
- Subsidence
- Disaster Studies
- 3D Modelling (LEO)



# 1.3 LIDAR

- Urban Topography
- Infrastructure
- 3D Modelling

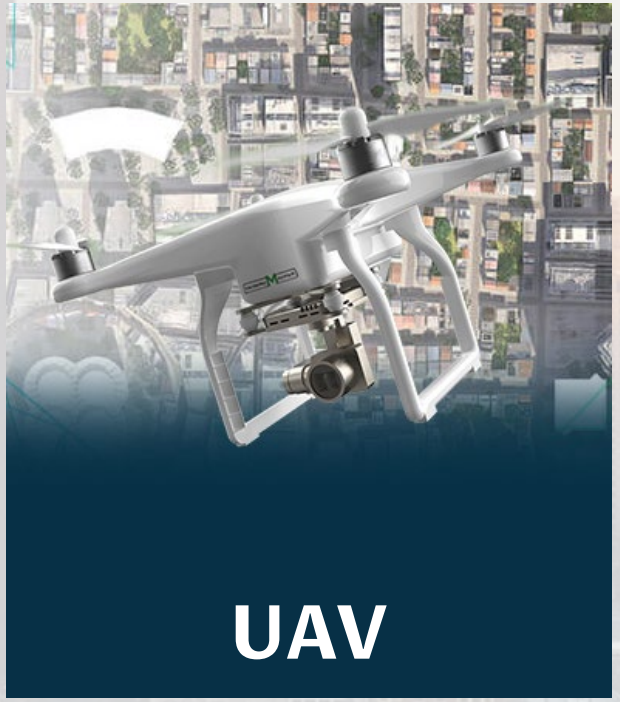
In addition to its wide applications...

- Detailed Structural Assessments
- Monitoring Structural Health
- Detecting Environmental Impact
- Disaster Risk Reduction and Mitigation

# Operational Capabilities

Aerial


Vehicle



UAV

Terrestrial

# LIDAR USE CASE

## Smart City Solutions

- Urban Master Planning
- Property Tax Management
- Solar Rooftop Management
- Urban Forest Management

# 1.4 DRONE

- City Planning
- Engineering Monitoring
- Municipal Waste Management
- Urban Security
- Environmental Management
- Emergency Response

| | Characteristics | Disadvantages | Applications |
|---|---|---|---|
| Multispectral | Resolution<br>Source of Energy<br>Area Coverage | | |
| Hyperspectral | | | |
| RADAR | | | |
| LIDAR | | | |
| Drone | | | |

# Data Sources:

2.1 GNNS Survey for Data Collection
2.2 BHUVAN Thematic Map Services
2.3 Organizational Reports
2.4 Cadastral Mapping
2.5 Utility and Infrastructure Mapping

# BEST PRACTICES FOR DATA COLLECTION

1. Choose the right equipment
2. Plan the fieldwork
3. Optimize the settings
4. Collect the data
5. Process the data

# 2.1 TYPES OF GNSS MEASUREMENTS

## Single Point Positioning (SPP)

- Single Point Positioning is the most basic form of GNSS surveying, where a single receiver collects satellite signals to determine its position.
- However, SPP has limitations in terms of accuracy, typically within a few meters due to factors like atmospheric interference and satellite geometry.

## Differential Positioning (DGPS)

- Differential Positioning improves accuracy by using a reference station with known coordinates. By comparing the reference station's position with the receiver's measurements.
- DGPS can eliminate errors caused by atmospheric disturbances, clock inaccuracies, and satellite orbit errors, achieving sub-meter to decimeter accuracy.

## Real-Time Kinematic (RTK)

- RTK is a surveying method that provides high-precision real-time positioning. It employs a base station and one or more rovers to receive GNSS signals.
- The base station receives signals from satellites and transmits correction data to the rovers, allowing them to compute precise coordinates.
- RTK can achieve centimeter-level accuracy, making it suitable for applications that demand high precision.

## Post-Processing Kinematic (PPK)

- PPK involves recording raw GNSS data during the survey and processing it after data collection.
- By using a base station or virtual reference station data, PPK calculates the precise coordinates of the survey points.
- PPK can achieve similar accuracy to RTK, but it requires additional post-processing time.

# GNSS ACCURACY LEVELS


## Navigation accuracy

(phones & tablets for consumer use)


## DGNSS / PPP accuracy

(for general tracking, and navigation of autonomous vehicles)


## RTK / SSR accuracy

(for engineering, mapping and scientific users)

# 2.2 BHUVAN THEMATIC MAP SERVICES

## General Applications:

- Bhuvan 2D
- Bhuvan 3D
- Climate and Environment

## Specific Applications

- Urban: UIS – Municipal GIS – Urban Growth
- Rural: MGNREGA - PMGSY
- Tourism: Tourism GIS - Archealogy
- Agriculture: Pest - Plantation
- Water: WRIS - National Hydrology Project
- Forestry - MoEFCC

# Thematic Services (for urban)

- Urban Land Use
  - 10k scale
  - 4k scale
- Urban Sprawl
  - For select states

# 2.3 ORGANIZATIONAL REPORTS

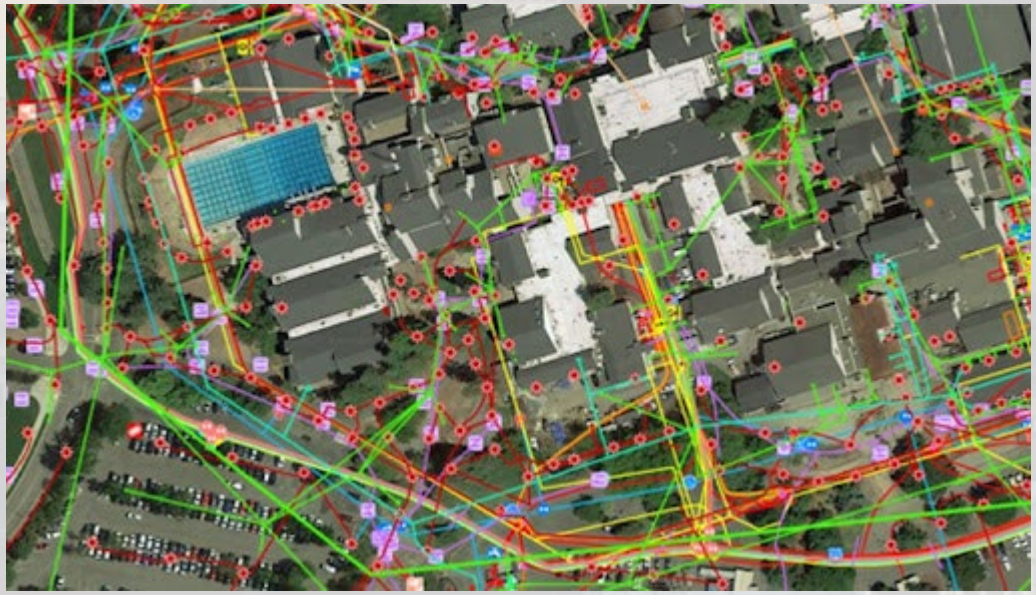
| | |
|---|---|
| **Census of India** | • Demography and Socioeconomic data |
| **Ministry of Housing and Urban Affairs** | • Handbook of Urban Statistics<br>• India Smart Cities Report |
| **WRI** | • Research Articles |
| **UN-Habitat** | • World Cities Report<br>• The Sustainable Development Goals Report<br>• City Prosperity Index<br>• Global Report on Sanitation and Wastewater Management in Cities and Human Settlements<br>• Urban Climate Action<br>• UN World Water Development Report<br>• Global Environment Outlook (GEO) for Cities report<br>• Global State of National Urban Policy |
| **World Bank Group** | • Annual Report<br>• Global Economic Prospects<br>• Global Financial Development Report<br>• International Debt Statistics<br>• Policy Research Reports (PRRs)<br>• World Development Indicators<br>• World Development Reports |

## 2.4 Cadastral Mapping

- A cadastre or cadaster is a comprehensive recording of the real estate or real property bounds of a country.


## 2.5 Utility Mapping

- A utility map shows the positioning and identification of buried pipes and cables beneath the ground. The procedure involves detecting things like sewers, electric cables, telecoms cables, gas and water mains.



# CHARACTERISTICS OF REPORTS, CADASTRAL & UTILITY MAPS

1. Nature of data: numeric / spatial data
2. Temporal coverage: low / high and static / dynamic
3. Spatial coverage: Global / local
4. Technical coverage: limited / complex
5. Skill adequacy: basic / advanced
6. Visualization effects: limited / high

# Modelling Urban Dynamics

## Image Processing: Image Classification - Feature Extraction Techniques - Land Use & Land Cover Classification (NRSC) - Change Detection – Urban Expansion: Sprawl and Density – Morphological Patterns and Forms

# GENERAL PROCEDURE FOR LULC MAPPING

## 1. SPECTRAL INFORMATION

1. Different features reflect light uniquely across spectral bands
2. Indices like NDVI, NDWI, NDBI help identify vegetation, water bodies, and urban areas

## 2. SPATIAL INFORMATION

1. Identifying physical arrangement and distribution
2. Edge detection, texture analysis, morphological operations

## 3. TEMPORAL INFORMATION

1. Monitoring changes over time
2. Useful for detecting urban growth, deforestation, seasonal activities, and disaster impacts

## 4. PREPROCESSING OF SATELLITE IMAGES

1. Radiometric correction
2. Geometric correction
3. Noise reduction
4. Image enhancement

# Machine Learning & AI-Based Classification

# BASIC CONCEPTS OF CLASSIFICATION

1. Classification involves assigning each pixel (or group of pixels) in an image to a specific class or category (e.g., water, forest, urban area, agriculture).
2. **Supervised learning:** A type of ML where the algorithm is trained on labeled data—images where the class for each pixel or object is known.
3. **Unsupervised learning:** A method where the algorithm tries to discover the natural groupings or clusters of pixels without labeled data.

# 1. TRADITIONAL MACHINE LEARNING

1. Supervised Learning:
   - SVM, Random Forest, k-NN

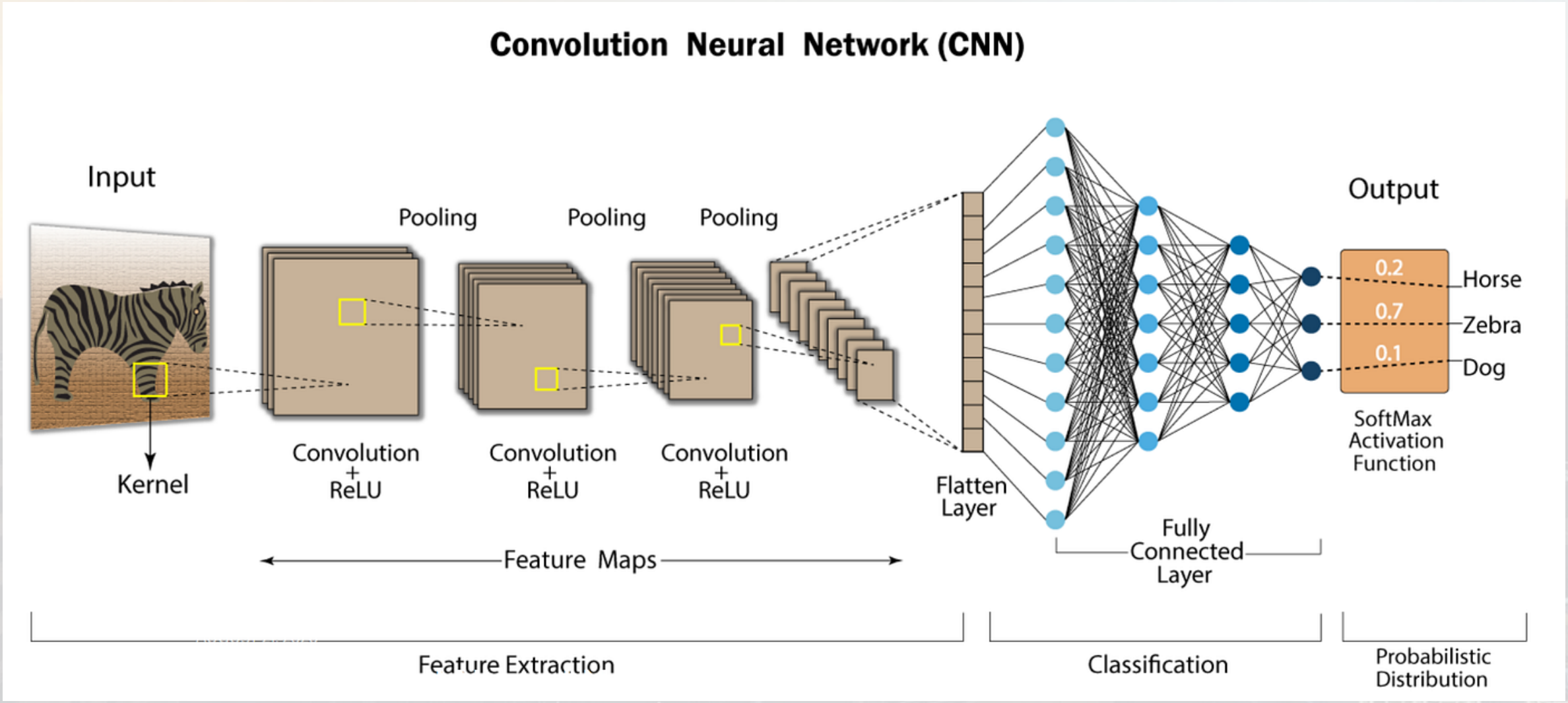
2. Unsupervised Learning:
   - K-means clustering, ISODATA

# 2. DEEP LEARNING

## 1. CNNs for automatic feature learning

CNNs are particularly powerful for image classification tasks because they can automatically learn spatial hierarchies of features, making them ideal for complex satellite imagery analysis. CNNs include:

- **Convolutional layers:** These layers use filters (kernels) to detect features like edges, textures, and objects. Learns which filters are important during training.
- **Pooling layers:** These layers reduce the spatial dimensions of the image, which helps reduce computational complexity.
- **Fully connected layers:** In the final stages of the network, classifies the image into categories.


Convolution Neural Network (CNN)
Input
Kernel
Convolution + ReLU
Pooling
Convolution + ReLU
Pooling
Convolution + ReLU
Pooling
Feature Maps
Flatten Layer
Fully Connected Layer
Output
0.2
0.7
0.1
Horse
Zebra
Dog
SoftMax Activation Function
Feature Extraction
Classification
Probabilistic Distribution

## CNNs are highly effective in:

- **Land cover classification**: Automatically identifying different types of terrain.
- **Building and road detection**: Mapping urban areas.
- **Object detection**: Identifying specific objects like ships, cars, or planes.

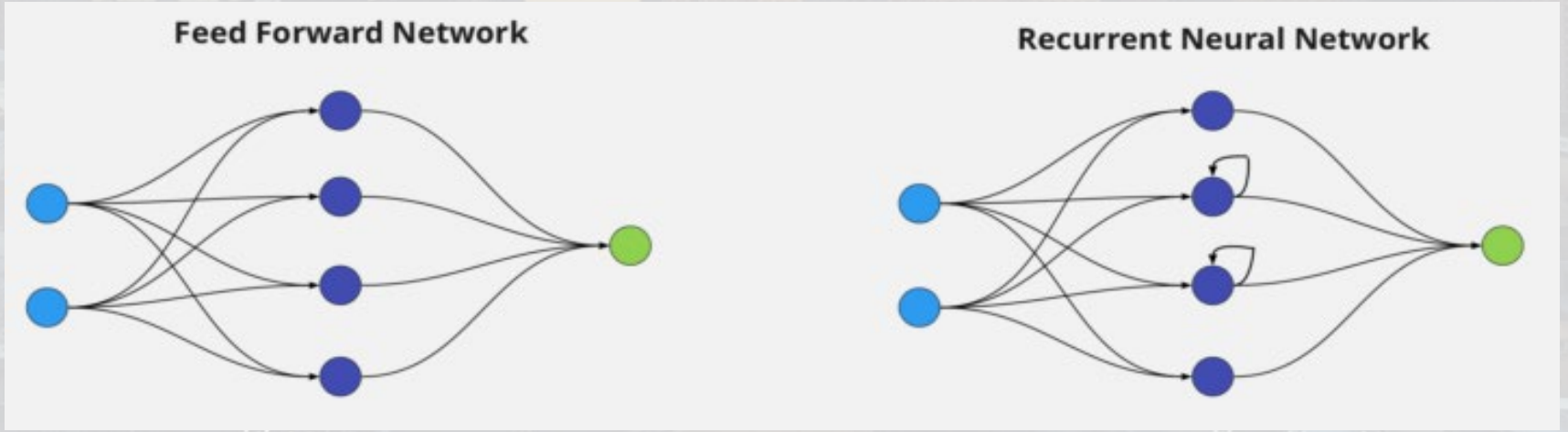
https://www.ibm.com/topics/convolutional-neural-networks

# 2. Recurrent Neural Networks (RNNs) for Temporal Analysis

**Recurrent Neural Networks (RNNs)**, particularly **Long Short-Term Memory (LSTM) networks**, can analyse temporal sequences of satellite data to detect changes over time.

Satellite images are often collected over time, making temporal analysis important for monitoring changes like

- Deforestation
- Urban sprawl
- Vegetation patterns




https://www.ibm.com/topics/recurrent-neural-networks

# 3. OBIA AND TRANSFER LEARNING

Object-Based Image Analysis (OBIA) reduces pixel variability and improves accuracy

Transfer learning uses pre-trained models for satellite imagery tasks

# FEATURE EXTRACTION – A CRUCIAL STEP

For ML models to perform classification effectively, feature extraction is a crucial step. In satellite imagery, features can be derived from:

- Spectral information (from various bands, such as RGB, IR etc.).
- Texture features (e.g., roughness, smoothness, homogeneity).
- Spatial relationships (e.g., edges, patterns, shapes).
- Temporal changes (from multi-temporal imagery).

Deep learning models like **CNNs can automatically learn** these features, while **traditional ML models** (like SVMs or Random Forests) often rely on manually engineered features or indices like NDVI.

# 4. CHALLENGES AND APPLICATIONS

1. Challenges:
   - Limited labeled data
   - Complex satellite data
   - Generalization issues
2. Applications:
   - LULC Mapping
   - Urban Growth
   - Agriculture
   - Disaster Management
   - Environmental Monitoring

# NRSC – LULC CLASSIFICATION

Land Cover is defined as **observed physical features** on the Earth's Surface. When an **economic function** is added to it, it becomes Land Use. (FAO, 2005).

1. Natural Resources Census (NRC) Project of National Natural Resources Repository (NRR) Program.
2. The LULC classification scheme at 1:50,000 scale
3. Consists of 3 levels of classification:
   - Level-I: 8 classes
   - Level-II: 31 classes and
   - Level-III: 54 classes.

| Sl. | Description-1 | Description-2 | Classes from NRC LULC50K Mapping Project |
|---|---|---|---|
| 1 | Builtup | Urban | Built up – Compact (Continuous), Built up – Sparse (Discontinuous), Built up – Vegetated / Open area, Industrial area, Ash / Cooling Pond / effluent and other waste |
| | | Rural | Rural |
| | | Mining | Mining – Active, Mining – Abandoned, Quarry |
| 2 | Agriculture | Crop land | Kharif, Rabi, Zaid, Cropped in 2 seasons, Cropped in more than 2 seasons |
| | | Plantation | Agriculture Plantation |
| | | Fallow | Fallow land |
| | | Current Shifting cultivation | Shifting cultivation – Current |
| 3 | Forest | Evergreen / Semi evergreen | Dense / Closed and Open category of Evergreen / Semi evergreen |
| | | Deciduous | Dense / Closed and Open category of Deciduous and Tree Clad Area |
| | | Forest Plantation | Forest Plantation |
| | | Scrub Forest | Scrub Forest, Shifting Cultivation – Abandoned |
| | | Swamp / Mangroves | Dense / Closed & Open Mangrove |
| 4 | Grass/ Grazing | Grass/ Grazing | Grassland: Alpine / Sub-Alpine, Temperate / Sub Tropical, Tropical / Desertic |
| 5 | Barren/unculturable/Wastela | Salt Affected Land | Salt Affected Land |
| | | Gullied / Ravinous Land | Gullied, Ravinous |
| | | Scrub land | Dense / Closed and Open category of scrub land |
| | | Sandy area | Desertic, Coastal, Riverine sandy area |
| | | Barren rocky | Barren rocky |
| | | Rann | Rann |
| 6 | Wetlands / Water Bodies | Inland Wetland | Wetland - Inland Natural (Ox-bow lake, cut off meander, waterlogged etc.), Inland Manmade (Water logged, saltpans etc.) |
| | | Coastal Wetland | Wetland – Lagoon, creeks, mudflats, Saltpan etc. |
| | | River / Stream / canals | Perennial & Non-Perennial River, Canal / Drain |
| | | Water bodies | Aquaculture, Permanent & seasonal Lake/Ponds, Reservoir/Tanks |
| 7 | | Snow | Snow |

# CHANGE DETECTION

Changes in the land use and land cover impact the earth in many ways,

- Habitat
- Water quality
- Quality of Life
- Air quality
- Global Carbon Cycle
- Population growth / decline
- Economic growth
- Agricultural and Forest products

1. Post-Classification methods
   - Follows a usual routine
   - Applicable for large datasets
     - Maximum Likelihood
     - K-Means Neighbour
     - Fuzzy Classifier

2. Pre-Classification methods
   - Uses algorithms directly on the image sets
   - Preferred for smaller datasets
     - Image Differencing
     - Change Vector Method
     - Multidate Comparison Regression

**Why we analyse LULC Changes?**

# URBAN EXPANSION

1. The process by which cities and towns grow into the surrounding areas, including villages and towns.
2. Factors of Expansion:

# FORMS OF EXPANSION

## Extension

New land use is developed next to existing land uses, such as by expanding streets and utilities

## Linear Development

Similar to extension, but the expansion is shaped by an existing circulation corridor, such as a highway or transit line

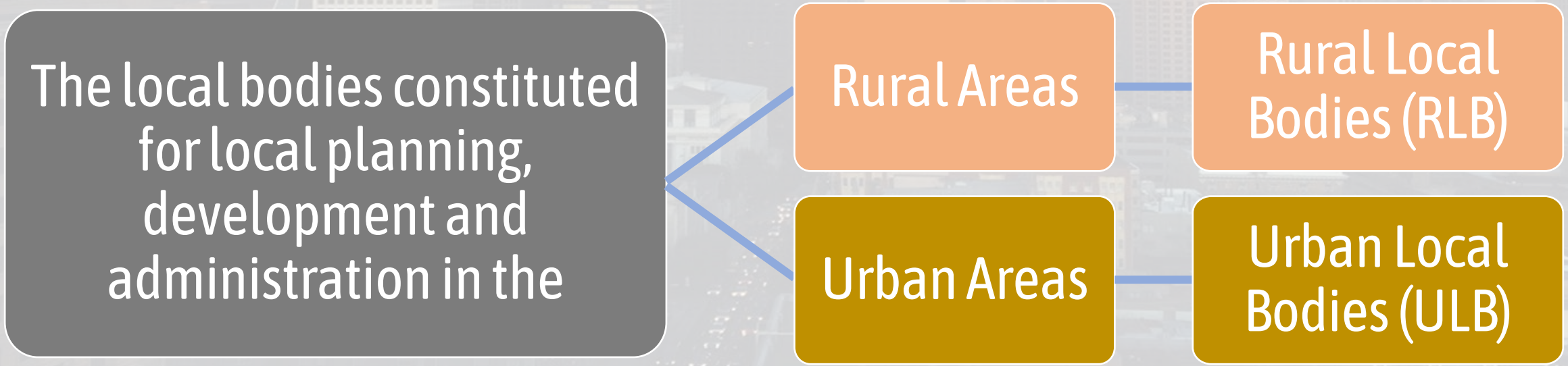
## Sprawl

A common form of suburban development that takes advantage of scattered lots

# Urban Administration

# LOCAL BODY / GOVERNMENT

- Local bodies are institutions of the local self governance, which look after the administration of an area or small community such as villages, towns, or cities.
- The Local bodies in India are broadly classified into two categories.



# ROLE OF LOCAL BODIES

- A Regulator, namely the administration of various acts and regulations
- A Provider, that involves providing urban services efficiently and equitably by managing its accounts effectively and efficiently.
- An Agent that takes the schemes of higher levels government to the people. This includes promotion of popular participation
- A Welfare Agency, which provides active assistance to higher level governments in the equitable distribution and delivery
- An Agent of Development, who strives for improvement in the quality of life through the augmentation of infrastructure

## Rural Local Body

- Panchayat
- Panchayat area
- Village
- Gram Sabha
- Village Level Panchayat
- Intermediate Level Panchayat
- District Level Panchayat

## Urban Local Body

- Town Panchayat
- Municipal Council
- Municipal Corporation

***Economic Development and social justice is the core principle of the local bodies.***

- Municipal governance is another name for urban administration.
- It is in charge of all responsibilities relating to the **quality of living** in urban areas.
- A key focus of Urban Administration is the **strengthening of policies and institutional frameworks** for increasing equitable access to urban basic services and improving the standard of living of the urban poor.

UN-Habitat provides assistance in developing policies for better urban service as follows:

1. To rehabilitate and expand urban infrastructure and services to keep pace with growing demand
2. To ensure institutional efficiency and effectiveness in service provision
3. To provide adequate levels of service for the urban poor.

- It also takes into account the needs and priorities of women, men and vulnerable groups in decision-making
- Addresses inequalities in the provision of sustainable water and sanitation, urban infrastructure, energy, transport and waste management.

# Urban Demography

Demography is the scientific study of human populations, including their size, composition, and how they change over time/space.

- Urbanization
- Urban Population Growth
- Urbanization Patterns

# DEMOGRAPHIC CYCLE

## FIRST STAGE (High stationary)

- A high birth rate and A high death rate
- Therefore, the population remains stationary
- It is seen when the country is economically most weak India was in this stage till 1920

## SECOND STAGE (Early expanding)

- Declining of death rate while Birth rate still remains high.
- As a result, a huge increase of population occurs.
- The DR decline is mainly due to improvements in food supply, health care and sanitation).
- At present many developing countries of Asia and Africa are in this stage.
- The BRs have actually increased in some of these countries probably because of:
  - improved health care provisions, and
  - shortening periods of breast-feeding

## THIRD STAGE (Late expanding)

- Death rate declines further and Birth rate now begins to fall.
- However, as the BR still exceeds the DR, there is an increase of population
- The fall in BR results mostly from access to contraceptives, women empowerment etc.
- India appears to be this stage.
- In some developing countries (e.g. China, Singapore) birth rates too have declined fast.

## FOURTH STAGE (Low stationary)

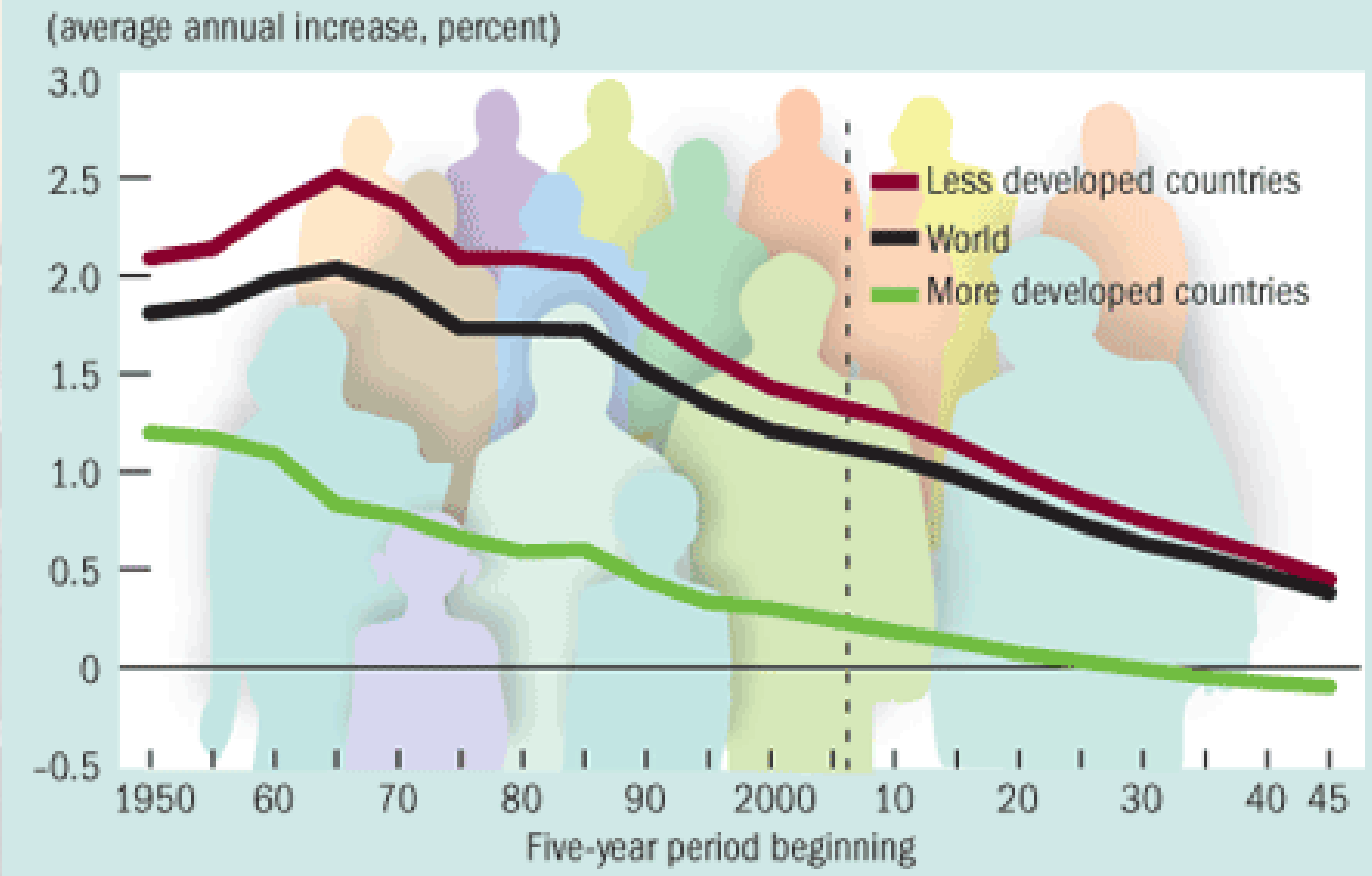
- Low birth rate and Low death rate
- Consequently, the population remains stationary.
- An aging population is a feature of this stage. Japan, Sweden, Belgium, Denmark and Switzerland are in this stage
- Most industrialized countries have undergone a demographic transition From a high BR and high DR To low BR and low DR
- Zero population growth has already been recorded in Austria during 1980- 85.
- Growth rate as low as 0.1 was recorded in UK, Denmark, Sweden and Belgium during 1980-85.

## FIFTH STAGE (Declining)

- Birth rate is now lower than death rate
- Hence the population begins to decline
- Some East European countries (e.g. Germany and Hungary) and some north European countries (e.g. Sweden, Norway) are now in this stage

Source: Park K. Demography and Family Planning. In: Park's Textbook of Preventive and Social Medicine.

**Even so, the growth rate of the world's population has been on a downward trend and, in developed countries, will turn negative by 2030.**




*Source: IMF*

Population Decline

Very Low Fertility

Rapid Ageing

International Migration

# Four most challenging demographic trends


Thank you!