CLIMATRANS Case City Presentation
Bengaluru

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Key Insights

- 7th most urbanized State
- Bangalore is the Capital
- 5th largest metropolitan city in India in terms of population
- ‘Silicon Valley’ of India
- District Population: 96,21,551
- District area: 2196 sq. km
- Density: 6,851 persons/Sq.km
- City added about 2 million people in just last decade
- Most urbanized district with 90.94% in Urban areas

Figure.1: Bangalore Map
Mobility:

- Long travel times
- Peak hour travel speed in the city is 17 km/hr
- Poor road safety, inadequate infrastructure and environmental pollution
- Over 0.4 million new vehicles were registered between 2013 and 2014
- Public transport in suburban areas has not developed in pace with urban expansion.

Fig. 2: Peak hour traffic at Commercial Street
Household Growth

Area

Karnataka State Government Notification, January 2007

- 100 wards of Bangalore Mahanagara Palike
- 7 City Municipal Council’s
- 1 Town Municipal Council
- 111 villages Around City

Bruhat Bangalore Mahanagara Palike
Total Metropolitan Urban Surface Area

- Urban Surface Area (sq.km)
- 2007: 741 sq.km
- 2011: 1241 sq.km
Urban Expansion

Figure 4: Map showing urban expansion of Bangalore
Economy

- Initially driven by Public Sector Undertakings and the textile industry.
- Shifted to high-technology service industries in the last decade.
- Bangalore Urban District contributes 33.8% to GSDP at Current Prices.
- Second highest literacy rate (83%) for an Indian metropolis, after Mumbai.
- City's workforce structure is predominantly non-agrarian
- Only 6% is engaged in agriculture-related activities.

<table>
<thead>
<tr>
<th>Total Workers</th>
<th>Main Workers</th>
<th>Cultivators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons</td>
<td>3,835,520</td>
<td>Persons 24,273</td>
</tr>
<tr>
<td>Males</td>
<td>2,818,101</td>
<td>Males 15,819</td>
</tr>
<tr>
<td>Females</td>
<td>1,017,419</td>
<td>Females 8,454</td>
</tr>
</tbody>
</table>

Table 1: Distribution of work force
Connectivity

Air
- Airport is 45km from City Center
- 3rd busiest in India after Delhi & Mumbai in terms of passenger traffic and the number of air traffic movements (ATMs)
- Volvo buses (BMTC) & Taxi service

Rail
- Divisional headquarters in South Western Railway zone
- 4 Major Railway stations

Road
- Bangalore Metropolitan Transport Corporation
- One of the most successful bus operations in India
- AC buses on all Major routes
Land Use

- Radial growth from 1973 to 2010.

- Temporal data analysis reveals
  - 584% increase in Built up area during the last four decades
  - Vegetation - Decreased by 66%
  - Water bodies - Decreased by 74%

% Increase in Urban Builtup area

- 1992-1999: 129.56
- 1999-2002: 106.7
- 2002-2006: 114.51
- 2006-2010: 126.19
Figure.5: Growth of Bengaluru city

Source: CDP 2009
City Development plan for Bengaluru identifies five major zones in the existing land occupation:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>Traditional business areas, the Administrative centre, and the central business district.</td>
</tr>
<tr>
<td>Zone 2</td>
<td>Peri-central area has older, planned residential areas, surrounding the core area.</td>
</tr>
<tr>
<td>Zone 3</td>
<td>Recent extensions of the city (past 5-7 years) flanking both sides of the Outer Ring Road.</td>
</tr>
<tr>
<td>Zone 4</td>
<td>New layouts that have developed in the peripheries of the city, with some vacant lots and agricultural lands.</td>
</tr>
<tr>
<td>Zone 5</td>
<td>Green belt and agricultural area in the city’s outskirts including small villages.</td>
</tr>
</tbody>
</table>
Transportation System

Road Network:

- Total road network of the city is about 13,000 km.
- No strong circumferential road system, except for the Outer Ring Road.
- Road network is mostly underdeveloped in terms of size, structure, continuity and connectivity.
- V/C ratios > 1.0 in Major roads
- Total motorway network (arterial + sub arterial) is 1,940 kms.
- Road length per sq.km is 8.2 kilometers
Rail Network:

- Major junction on the South-Western railway network.
- 4 Major railway stations in Bengaluru.
- Served by 5 radial rail corridors.
- Short distance passenger trains – Morning & Evening hours to nearby towns.
- On April 6\textsuperscript{th}, 2010 Government of Karnataka in association with SWR has introduced train services from Yeshwanthpur to Hosur and Yeshwanthpur to Bengaluru International Airport (BIA) at Devanahalli on trial basis.
Public Transportation

Bus:

- Considered best in the country
- Operated in the Public Sector by Bengaluru Metropolitan Transport Corporation (BMTC)
- Services on 2,428 routes with fleet strength of 6518.
- Bus day on the fourth of every month.

<table>
<thead>
<tr>
<th>Table 2: BMTC Statistics</th>
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</thead>
<tbody>
<tr>
<td><strong>BMTC Figures at a glance (as on May, 2015)</strong></td>
</tr>
<tr>
<td>Fleet Strength</td>
</tr>
<tr>
<td>No. of Schedules</td>
</tr>
<tr>
<td>Service kms (in Million)</td>
</tr>
<tr>
<td>No. of trips</td>
</tr>
<tr>
<td>Revenue (in Million)</td>
</tr>
<tr>
<td>Daily passengers carried (in million)</td>
</tr>
<tr>
<td>Depots</td>
</tr>
<tr>
<td>Bus stations</td>
</tr>
<tr>
<td>Staff strength</td>
</tr>
</tbody>
</table>

*Source: BMTC Website*
Mass Rapid Transit:

- Namma Metro
- 7-kilometre (4 mi), Bayappanahalli to MG Road, 20 October 2011.
- 10 kilometers (6 miles), Malleswaram to Peenya, 1 March 2014.

**Phase 1**
- 42.30 km
- Completion by end of 2015

**Phase II**
- 72.1 km
- 42.3 km (26.3 mi) elevated and underground & 41 stations.

**Phase III**
- 127.57 km
- Connects important areas and connects phase 1 and Phase 2 lines

City’s primary response to the worsening intra-city transport infrastructure.
Fig. 6: Map showing Phase I of Metro
Fig.7: Map showing Phase II of Metro
Fig. 8: Map showing Phase III of Metro
Intermediate Public Transport (Auto rickshaw/Taxi):

- Auto rickshaws (3 wheeler) and taxi/cabs.
- 12-13% average growth rate per annum.
- 4% of total vehicular registrations over the last decade (2001-2011).
- Not well enough regulated to effectively respond to the urban transport problems.

Fig.9: Auto rickshaw as IPT mode
Personal Motor Vehicles:

- Tremendous growth rate.

- 2Wh > 70% of total volume

- Cars - 15%

- Autos - 4%

- Buses, Vans & Tempos - 8%

90% of Total Registered Vehicles
Traffic Scenario

Vehicular Growth:

- Higher the income levels, higher is the vehicle ownership.

Figure 10: Graphical representation of Registered Cars

Figure 11: Graphical representation of Registered Motorcycles
Congestion:

Problems faced by Bengaluru

- Increasing motorization
- Congestion
- Long travel times
- Parking management
- Inadequate road infrastructure
- Poor quality of roads

All these resulted in the reduction of Peak Hour Travel Speeds.
Non-Motorized Traffic:

- Cycle paths – 45km
- 80% of roads with footpaths
- Bicycles being promoted as a feeder to metro Systems.
- Bicycle sharing is implemented at Indian Institute of Science campus.

Figure 12: Graphical representation of Bicycle ownership
Air Pollution:

- Major concern in Bengaluru city
- Vehicles over paved roads leads to re-suspension of road dust that also contributes to particulate matter emissions
- No major polluting industries in the city
- KSPCB monitors the ambient air quality at various locations in the city.

Fig. 13: Air quality in major cities in India (April 2015)


Fig. 14: Total emission loads (Tonnes/day) in Bengaluru

Source: CPCB
Institutional arrangement in Transport Sector:

- One of the most diverse institutional frameworks in India when it comes to urban transportation.
- Separate organizations have been formed to deal with urban transportation related activities.

List of Organizations:

- Transport Department, GoK
- Greater Bangalore City Corporation- Bruhat Bangalore Mahanagara Palike (BBMP)
- Bangalore Development Authority (BDA)
- Department of Urban land transport (DULT)
- Bangalore Metropolitan Land Transport Authority (BMLTA)
- Bangalore Metropolitan Region Development Authority (BMRDA)
- Bangalore City Police
- Bangalore Metropolitan Transport Corporation (BMTC)
- Bangalore Metro Rail Corporation Ltd (BMRCL)
- Regional Transport Office (RTO)
A salubrious climate all-round the year.

- Summer temperatures -18º C to 38º C,
- Winter temperature -12 ºC to 25 ºC.
- Both the northeast and the southwest monsoons
- Wettest months are September, October and August
- Mean annual rainfall - 975 mm with about 59 rainy days a year.
- Heaviest rainfall in 24 hours has been 153.9 mm on May 6 1909.
- City received 65.3 mm of rain in the month of May 2015, the highest since 2005.
Urban Flooding:

- Improper city planning changed natural catchments or drainage areas.
- Loss of interconnectivity due to lake reclamation etc.
- Serious effects to low lying areas.
- 147 low lying areas are present as surveyed by BBMP.

Figure.15: Flooding of road after heavy rains in September 2013
State Action Plan on Climate Change:

- Karnataka SAPCC provides suggestions towards conserving the ecology of the state.
- Reducing unwarranted release of pollutants and GHGs into the environment.
- Suggests adaptive and mitigation measures to reduce the impact of climate change in Karnataka.
- SAPCC does not include vulnerability assessment of different sectors.
- Plan does not adequately address the urban transport sector & its linkage with climate change.
Key Challenges:

- Small amount of rain floods the motorways and brings the city to a halt
- Climate change is most likely to aggravate the events like urban flooding
- Effects people of the city and also simultaneously hindering development
- Vulnerability assessment of the transport infrastructure as well as the population and vulnerable groups will positively contribute.
Policies focusing on limiting GHG emissions:

- Karnataka State *Bio-fuel Policy 2009*.
- 5% as a target for bio-fuel blending in 2012 which as of date was not achieved and 10% by 2017.
- **Dept. of Transport** - Prohibiting commercial vehicles older than 15 years.
- State Action Plan on Climate Change (SAPCC).
- **Pedestrian policy** guidelines to improve NMT.
- **Parking Policy** initiated by DULT to reduce vehicle usage.
- **Tender Sure** project by BBMP as a means to promote NMT.
Urban Context

Land use:

- A non-mono-centric urban structure
- Real urban dynamics are occurring outside the city core
- Growing beyond the bounds of its central area
- 2 types of non-central agglomeration growth
  - Urban sub-centers and located in the outlying areas of the central zone in the Bangalore Development Area
  - Five satellites ("integrated townships") under the jurisdiction of BMRDA
Summary

- Slow peak hour speeds due to private vehicles taking up 90% of the road space.
- Projections show 1.8 million cars in 2020 and 4.7 million cars by 2030.
- Policies focused on constructing elevated roads, underpasses rather than improving public transit facilities and NMT.
- 76% increase of private vehicles in 3 years despite low road space and high vehicle costs.
- 44% of the households in the city do not possess a vehicle and use PT.
- Passenger km travelled per person per day by bus was 62.73 million km in 2011.
- Annual vehicle km travelled/day was 465.5 million km.
- These figures imply that adequacy of bus service is more than sufficient to meet the demand.
- Bus fares high than other metropolis.
- Climate Change has not been central to the urban transport policies in the city.
- Policies failed to change the behavioral pattern of commuters.
Mitigation Policy Bundles

POLICY BUNDLE 1. Promoting the use of public transit to encourage public to shift from private to public transit

1. Subsidise public transit
2. Increase sales tax on private vehicles
3. Provision of sophisticated and robust infrastructure for public transit
4. Defining car restricted zones and pedestrian friendly zones
5. Paid parking
6. Limiting parking spaces
7. Heavy taxes on more than one car per household
8. High density mix building use along main transport corridors

POLICY BUNDLE 2. Discouraging the use of private vehicles

1. Park and ride
2. Paid parking
3. Congestion Pricing
4. Defining car restricted zones and pedestrian friendly zones
5. Heavy taxes on more than one car per household
6. Encouraging car pooling
7. Increase sales tax on private vehicles
8. High density mix building use along main transport corridors
9. Limiting parking spaces

POLICY BUNDLE 3. Reducing the Carbon emission

1. Park and ride
2. Paid parking
3. Congestion Pricing
4. Defining car restricted zones and pedestrian friendly zones
5. Heavy taxes on more than one car per household
6. Encouraging car pooling
7. Increase sales tax on private vehicles
8. High density mix building use along main transport corridors
9. Limiting parking spaces
10. Subsidise public transit
11. Provision of sophisticated and robust infrastructure for public transit

POLICY BUNDLE 4. Controlling the irregular growth if the city (Urban Sprawl)

1. High density mix building use along main transport corridors
2. Town Planning Schemes and incentives for high densities urbanization to reduce the upcoming slums
3. Transfer Development Right (TDR)
4. Heavy taxes on more than one car per household
5. Increase sales tax on private vehicles
Mitigation Policy Bundles

POLICY BUNDLE 5. Polluters Pay Principle

1. Congestion Pricing
2. Paid parking
3. Taxes on vehicles with high emission
4. Heavy taxes on more than one car per household
5. Increase sales tax on private vehicles

Adaptation Policy Bundles

POLICY BUNDLE 1. Vulnerable areas

1. Replacement of impermeable road surface with permeable material in all vulnerable areas
2. Slum relocation and rehabilitation

POLICY BUNDLE 2. Information and Relocation

1. Replacement of impermeable road surface with permeable material in all vulnerable areas
2. Sending alerts via apps and messages about alternative route from hazard prone network
3. Restricting development in low lying or vulnerable areas
4. Slum relocation and rehabilitation

POLICY BUNDLE 3. Infrastructure Development

1. Drainage in vulnerable road sections to be parallel to the slope of the area
2. Road closure during extreme weather conditions

POLICY BUNDLE 4. Information and Relocation

1. Replacement of impermeable road surface with permeable material in all vulnerable areas
2. Integrate land use development and transportation planning

POLICY BUNDLE 5. Land use regulation

1. Mix use development to reduce vehicle miles travelled
2. Increase in FAR (floor area ratio)
3. Restricting development in low lying or vulnerable areas

POLICY BUNDLE 6. Regulation and relocation

1. Drainage in vulnerable road sections to be parallel to the slope of the area
2. Restricting development in low lying or vulnerable areas
3. Slum relocation and rehabilitation
Thank you