Banking on cities for secondary resources to release the pressure on natural environment and progress towards Environmentally Sustainable urban integrated systems

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India's tallest garbage mountain to be higher than Taj Mahal in 2020

Chennai
Population - 7.08 million

Delhi
Population - 18.98 million


Visakhapatnam
Population - 2.09 million
VISSAKHAPATNAM

Legend:
- Municipal Boundary
- 1941
- 1975
- 1995
- 2005
- 2016

11,161 Sq. Km
682 Sq.Km (U)

Population of
2.09 million(U)
0.8 million(I.S)

Port City
Industrial City
Naval Headquarters
Education center
Tourism
Pilgrimage City

Landmarks in the city

http://visakhapatnam.nic.in/
PROBLEM ANALYSIS
Current Metabolism of the cities

Resources
- Food
- Water
- Energy
- Fuel
- Goods

Output
- Waste Gases
- Liquid Waste
- Solid Waste

LINEAR METABOLISM

Source: World map showing projected increase in the amount of waste generated
The linear process of disposing the outputs

*Solid Waste - Municipal Solid Waste*

*Liquid Waste - Sewage water*
Linear Flow of Municipal Solid Waste Disposal

- At sources of waste generation
- Waste Collection Centers
- Temporary Storage Site
- Dumping in the landfill site

Analysis of Municipal Solid Waste

a) Waste generated at different sources

b) Composition of domestic waste

DOMESTIC WASTE - 60% of total waste

ORGANIC WASTE - 47% of domestic waste

FOOD WASTE
Linear Flow of Wastewater Disposal

Containment → Emptying → Transport → Treatment → Disposal & Reuse

- Sewer Connections
  - 32%
  - On-Site Facilities
    - 60%
  - No Facilities
    - 8%

- Safely emptied
- Left to overflow
- Residential Environment
- Natural Environment/Receiving waters

- Sewage Treatment
  - Untreated
    - Open Channel
  - 18%
- Effluent & Sludge Disposal
- Farms Golf course

Source: GVMC, INDIA CENSUS 2011
Environmental Impacts due to improper waste disposal

Pollution

Vector borne diseases

Environmental risks & vulnerability

Soil Pollution

Underground water contamination

Dengue

Malaria

Cyclonic wind vulnerability

Storm surge areas - flooding

Tsunami

Environmental impacts and vulnerability in Visakhapatnam District
Identifying the regions vulnerable to the environmental impacts

Overlay map of the negative environmental impacts
Analysing the current approaches in practice

a) Drawbacks in the existing system

b) Drawbacks in Clean India Mission
Urban Resources

Sectoral planning system

National Level

State Level

District Level - ULB

Swacchh Bharat - Clean India Mission

Comparing the steps developed in CIM to circular model of Ellen Mc Arthur
How to integrate resource management into urban planning by developing local scale spatial strategies for an environmentally sustainable Visakhapatnam?

“meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them,” (Morelli, John (2011))

integrative approach of governance, socio-ecological systems and socio technical sytems

using resources efficiently and reusing the waste streams as secondary resources by circular principles
CONCEPTUAL FRAMEWORK

Fig 4.1: Conceptual Framework
RESOURCE FLOW ANALYSIS
SYSTEMIC DIAGRAM OF RESOURCE FLOWS
MAPPING THE FOOD FLOWS

PRODUCTION OF FOOD

(Source)

Fig: Food production on the arable land in and around the city

Fig: Pictures of farms in and around the city
Fig: Map showing food processing industries, markets and the larger chains of retail outlets

Legend:
- Municipal Border
- National highway
- Railways
- Fishing Harbour, Market & Container Terminal
- Rythu bazaar (Farmer’s Market)
- Super Markets
- Sea Food Processing Industries
- Co-operative retail outlets

Source: Google Images

Sea Food Processing Industry

Famers Market
CONSUMPTION

Fig: Map showing the number of consumers in each ward

Source: Urban observatory Data, 2016

Legend:
- Municipal Boundary
- High
- Low

Food waste at household

Unseggregated waste at neighborhood

Source: Google Images
WASTE COLLECTION AND DISPOSAL (SINK)

Fig: Map showing the current temporary storage sites and landfill site

Legend:
- Landfill site
- Temporary storage center
- National Highway
- Primary Roads
- Arterial Roads

MSW Temporary storage site

MSW Landfill site

Source: gvmc.gov.in
MAPPING THE FOOD FLOWS

SOURCES OF WATER IN THE REGION (Source)

Fig: Map showing the sources of water in the region supplying to the city

Source: Google Images

Legend:
- Major Sources of water
- Sources of water in the city

Reservoir

Source: Water Body Information System
https://bhuvan-noeda.nrsc.gov.in/gis/thematic/wbis/#!/map/17.814071002942764,82.58285522460936@10z
SOURCES OF WATER IN THE CITY

Legend:
- Municipal Border
- Water Treatment Plants
- Natural streams of water
- Overhead Water Tanks
- ULB Tubewells
- Reservoirs
- Reservoir under construction
- Canal

Fig: Map showing the overhead water tanks and drainages in the city

Dried reservoir in the city

Overhead water tank in the city
HOUSEHOLDS DEPEND ON UNDERGROUND WATER

Fig: Map showing the number of houses depending on underground water sources

Legend:
- Municipal Border
- 0 - 1000
- > 1000 - 1984
- > 1984 - 3000
- > 3000 - 7349

Underground water borewell

Water Tankers - water supply

Source: Google Images
HOUSEHOLDS WITH SEWAGE ACCESS

Fig: Map showing the number of houses that have connections to the sewage

Legend:
- Municipal Border
- less than 250
- 250-500
- 500-1000
- 1000 and above

Source: Urban observatory Data, 2016

Source: Google Images
Fig: Map showing the Sewage Treatment plants and the canals polluted due to discharge of sewage water

Source: www.gvmc.gov.in

STP located next to the sea
OVERLAY MAP OF FLOWS ANALYSIS & THE ENVIRONMENTAL IMPACT ANALYSIS

Fig: Map showing identified problem locations
CITIZENS

Resistance towards change

Gaps in knowledge and implementation

Fig: Image showing the current scenario towards waste and using it as a resource
VISION
"LOCAL - ADAPTABLE CITY"

- Organic waste used in new material loops
- Natural streams of fresh surface water
- Export of secondary resources
- Food flows into the city
- Limited dependency on natural sources of water
- Organic waste taken to local compost center
- Secondary resources from recycled waste feeding into the city
- Food flows into the city
- Organic compost used in food production
- Multi-functional spaces for circular flows and community building
- Recharge of groundwater tables through aquifers
VISION TO STRATEGIES

GOVERNANCE

CONSUMER BEHAVIOUR

TECHNOLOGY
Strategies for food and water flows

Local City

Looping City
LOCAL CITY

Local city focuses on developing local scale solutions for resource reuse and developing secondary resources. It emphasises on developing decentralised solutions for both food and water flows.

LOOPING CITY

Looping city focuses on linking the existing centralised systems in place to bring circularity to the resources. The resources are looped within the city and byproducts in the circular processes are exported for economic benefits.
Fig: Map showing the clusters of local and looping city

Strategies for water flows
Legend:
- Macro scale
- Micro scale

XX° Horizontal Integration - collaboration, coordination and the building of working relationships

YY° Vertical Integration - linkages between different tiers of government

- Strong Based on high frequency and high interdependence of resources
- Ad-hoc Low frequency and low interdependence (e.g. service provision)
- Indirect Contextual relation (e.g. related to legal framework or public opinion)
- Aid and support from International organisations

Note: The text highlighted in white represents the current roles and relationships while the text in black is the proposed synchronicity.

Fig: Stakeholder diagram for water strategy
Urban Resources

Food production
Food processing
Food waste from markets
Waste after processing
Food waste by non-consumption
Markets
Prevention at Source
Storage
Cooking
Eating
Waste after eating/leftovers
Waste during cooking
Waste Disposal
Organic waste
Segregation
Landfill
Compost
Organic Manure

Fig: Stages of food waste generation and new strategy

Strategies for Food flows
Urban Resources

Strategies for Food flows

Legend:
- Municipal Border
- National highway
- State highway
- Railways
- Airport
- Agriculture Plantation
- Crops grown once a season
- Crops grown more than two seasons
- Zaid Crop
- Fishing Harbour, Market & Container Terminal
- Rythu bazaar (Farmer’s Market)
- Super Markets
- Sea Food Processing Industries
- Co-operative retail outlets
- Looping city - organic centers
- Local city - compost centers

Fig: Map showing the clusters of local city and looping city for the food flows

Urban observatory Data - 2011
Legend:
- Macro scale
- Micro scale
- Micro scale

*XX* Horizontal Integration - collaboration, coordination and the building of working relationships

*YY* Vertical Integration - linkages between different tiers of government

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Fig: Stakeholder diagram for water strategy
Looping City - Lavender Canal
Urban Resources

Fig: Location of the problematic Zone

Fig: Schematic diagram of flows in the region
Fig: Map showing the existing landuse of the location

Scale - 1:8000

Legend:
- Municipal Boundary
- National Highway
- Secondary roads
- Ocean
- Inner Harbour
- Lavender Canal
- Open area canal
- Hill/Tourist spot
- Open areas
- Informal Settlements
- Residential
- Commercial
- Industrial
- Natural water stream
- Polluted water stream
- Remote area
- Wildlife Sanctuary
- Vegetation
- Reservoir
- Floating Solar panels
- Golf Park
- Birds Park
- Municipal Land
- Nursery
- Marshy Land
- Probable zones of intervention

Legend:
• Prohibition of discharge of waste water
• Storage of rainwater at household
• Lesser taxes for using recycled water
• Zoning the canal belt under public/recreational zone in the master plan
• Mandatory organic waste segregation

• Public awareness and education by demonstration of sustainable practices led by NGOs, educational institutions, technocrats and other local actors.

• Lowering the consumption of water from natural sources and using recycled water.

• Responsible consumption of food

• Improving the current technologies of STP and linking with drinking water facilities

• Revitalising the lavender canal into productive recreational space
SHORT TERM GOALS

- Lesser pollution of lavender canal
- Change in consumer attitude towards waste reuse
- Upgradation of the infrastructure aiding transition towards looping of flows

A. Refilling with solid waste
B. Acceptance
C. Acceptance
Urban Resources

Phase - A:

Rainwater Harvesting

ULB  NGO  Tax Rebate

Cleaning of Canal

ULB

Segregation & Re-routing of waste

Media  ULB  Private Investors/Contractors

Urban Resources
Urban Resources

Phase - B:

Connecting STP to Water board

出租 + Court + Com + Court

National, Regional, ULB

Environmental policies

Court + Court + Court

Ministries and research institutes at National Scale

Community compost centers

ULB + Crowd Funding + Local Community + Social Media

Food Waste Prevention

出租 + NGO + Media + Local Community
Urban Resources

Distribution of water to the looping city

Wastewater from the looping city

Purified water pumped to drinking water

Food flows from sources to markets in the city

Organic waste/compost is sent to industrial zone for a new material loop

Food flow distribution to each household

Port Zone

Informal settlements

MIddle income group housing

Floating wetland systems are constructed with recycled materials and local plant species purifying the water

250m

Community Park

Floating Wetland System

Segment & Re-routing of waste

Canal Purification

National Gov

Research institutes local & national

Private Investors

NGO

ULB

Private Investors

Local Community

Crowd Funding

Regeneration & Re-routing of waste

Private Investors

NGO

Local Community

Phase - C:
**Urban Resources**

**Wastewater from the looping city**
- Food flows from sources to markets in the city
- Organic waste/compost is sent to industrial zone for a new material loop
- Roads and pavements laid for informal settlements with biochar, made from organic material

**Food flow distribution to each household**

**Nualgi and Aquaponics**
- The water near informal settlements is treated with Nualgi and the purified water is used in aquaponics developed by the people of informal settlements

**Canal Purification & Aquaponics**

**Building Social Capital**

**Phase - D:**
Distribution of water to the looping city

Wastewater from the looping city

Purified water pumped to drinking water

Food flows from sources to markets in the city

Organic waste/compost is sent to industrial zone for a new material loop

Food flow distribution to each household

Food grown in this center is distributed in rest of the city

Port Zone

Development as tourist center
The community center for circular initiatives is developed into a cultural center and attracts tourists

Center for eco-innovative solutions & Tourism

ULB + Crowd Funding + Private Investors + Local Community

Research Institutes
Local City - Sagar Nagar
Local City - Sagar Nagar

Fig: Location of the problematic Zone

Fig: Schematic diagram of flows in the region

Legend:
- Local Scale
- Regional/National Scale
- Global
Fig. Map showing the existing landuse of the location
Organic waste in the location

Waste water being released into the sea without any treatment

Stream of waste water eroding the coast

The images above show the amount of environmental degradation in the location.
Prohibition of discharge of waste water into the canals/ natural water sources.

Storage of stormwater runoff at household and community scale

Using the recycled water for non-potable usage

Lower water taxes and guidance from the municipality to install the decentralised systems.

Depending on the soil quality, the guidelines for installation of decentralized wastewater system should be determined by the urban local body.

Public awareness and education by demonstration of sustainable practices.

Responsible consumption of resources.

- Developing decentralised rainwater harvesting systems, food compost and wastewater treatment systems.
Short Term Goals:
- Lesser pollution of natural streams of water
- Policies and guidelines for implementing decentralised wastewater systems
- Household scale rain water harvesting
- Quality standards of the food distribution to weaker sections
- Refilling with solid waste
- Acceptance
### Phase - A:

**Rainwater Harvesting**
- ULB
- NGO
- Tax Rebate

**Cleaning of Canal**
- ULB

**Segregation & Re-routing of waste**
- Media
- ULB
- Private Investors/Contractors

**Temporary Septic Tanks**
- ULB
- VMRDA
- Funded by ULB

**Policies & Guidelines for decentralised wastewater treatment**
- Levels of governance
- Research Institutes

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**Urban Resources**

**Food flows from sources to markets in the city**

**Food flow distribution to each household**

**Common organic waste segregation bins for informal settlements**

**Informal settlements**

**Middle income group housing**

**Organic waste segregation bins in the compound limits of every household**

**Common waste segregation bins for informal settlements**

**Organic waste segregation bins in the compound limits of every household**

**Detoxification filters**

**Canal water filters**

**Rainwater harvesting filters to trap solid waste in the canal**

**Common waste segregation bins for informal settlements**

**Food flows from informal settlements through canvas spread roofs tapping the water and further filtered**

**Recharge tank/pit**

**Collection of sludge and water from the septic tank**

**Segregation & Re-routing of waste**

**Canal water filters**

**Upgradation of STP**

**Cleaning of Canal**

**Policies & Guidelines for decentralised wastewater treatment**

**Levels of governance**

**Research Institutes**

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Food flows from sources to markets in the city.

Organic compost sold at subsidised prices to farmers.

Food flow distribution to each household.

Community organic compost center.

Wastewater from the houses is collected and treated. The purified water is used by the houses for non-potable usage and the byproducts such as biogas is sold to economically weaker sections at low costs and the nutrients are linked to the food flow loop.

Informal settlements
Middle income group housing

Food Waste Prevention
Private Investors
NGO
Media
Local Community

Implementation of decentralised wastewater treatment
Local Community
Local Research
Workshops

Environmental policies
Ministries and research institutes at National Scale

Community compost centers
ULB
Crowd Funding
Local Community
Social Media

Wastewater Treatment
Wastewater from the houses is collected and treated. The purified water is used by the houses for non-potable usage and the byproducts such as biogas is sold to economically weaker sections at low costs and the nutrients are linked to the food flow loop.
Urban Resources
Urban Resources

LONG TERM GOALS

- Improved decentralised wastewater systems and circularity in usage of the resources
- Improved waste prevention systems and dependance on locally grown food
- Social awareness and responsibility towards environment and immediate ecological systems

SCENARIO 1

Demographic

Quality Standards

Resistance to reclamation and reuse of wastewater

SCENARIO 2

Efficiency, Operation & Maintenance

SHORT TERM GOALS

- Quality standards of the food distribution to weaker sections
- Working with adolescents
Food flows from sources to markets in the city

Organic compost sold at subsidised prices to farmers

Food flow distribution to each household

Community organic compost center

The level of decentralisation is gradually upgraded from on-site treatment to block/neighborhood treatment

Floating wetland system purifying the polluted natural streams of water

250m

Wastewater treatment

Community compost center

Middle income group housing

Phase - C:

Water stream purification

ULB National Gov Research institutes local & national

Local Private NGO

Community Investors

Implementation of decentralised wastewater treatment

Local Community Local Research Workshops

NGO Crowd Funding Tax Rebate

Food Waste Prevention

Private NGO Media Local Community

UPC: Universal Product Code

ULB: Urban Local Body

NGO: Non-Governmental Organisation

Tax Rebate: Tax rebate for investments in green initiatives

Workshops: Workshops for capacity building

Crowd Funding: Funding through crowd sourcing

Media: Media coverage and promotion
Urban Resources

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Food flows from sources to markets in the city. Organic compost is sold at subsidised prices to farmers. Food flow distribution to each household.

Community organic compost center

The level of decentralisation is gradually upgraded from on-site treatment to block/neighborhood treatment.

Informal settlements

Middle income group housing

Community Rainwater harvesting pits

The surface run-off is collected in recharge pits in the public spaces of the community. This water is purified by natural filters like gravel bed and directed towards surface water sources and aquifers for groundwater recharge.

Urban Resources

Phase - D:

Upscaling of decentralised wastewater treatment

Local Community + Local Research + Workshops

NGO + Crowd Funding + Tax Rebate

Community scale rainwater harvesting

Local Community + Local Research + Crowd Funding

Wastewater treatment

The level of decentralisation is gradually upgraded from on-site treatment to block/neighborhood treatment.
CONCLUSIONS AND REFLECTIONS
How to integrate **resource management** into **urban planning** by developing **local scale spatial strategies** for an **environmentally sustainable Visakhapatnam**?

Understanding Resource Flows

Contrast Cities

Importance of co-existence of both centralised and decentralised systems

Evolutionary Transformation
SCOPE OF TRANSFERABILITY

The approach of integration can be transferred to other cities in the country facing similar challenges.

While the designed eco-innovative solutions can be replicable with changes according to the requirement.

FURTHER STEPS

Identifying solutions for other problematic zones

Further research in spatial design for eco-innovative solutions

Further research in the field of circular economy in India
THESIS CONTRIBUTION

[interaction between scales and approaches]

vertical integration

horizontal integration

Legend:
- Yadhuvanchi et al., Small scale solutions for MSW
- Top down approach of Clean India mission
- J. Fiksel et al., Transforming waste into resources for the Indian economy
- X • Points of integration discussed in this thesis

Vertical - Horizontal integration framework of urban planning
THANK YOU

ధాన్యం చేసేవారు