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WATER SENSITIVE PLANNING STRATEGIES FOR ALUVA MUNICIPALITY

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Abstract - Due to urbanization and climate change, many cities are addressing a wide range of environmental concerns, many of which are linked to natural water resources. However, the increasing urbanization, densification, and related urban challenges of the modern urban environment are increasing the pressure on water cycle and its preservation. Due to the urbanization the land use and landcover of urban areas highly affected by the surface sealing which is directly impacting the water cycle of an area. This paper reviews Adopting water sensitivity at the stage of planning of existing Aluva municipality developments and analyzing it can helpful for maintain the water cycle by managing the supply and demand for water, storm water, wastewater and groundwater as well as bring benefits such as reduction in temperature with respect to climate change and adaptation of city. The study uses different types of data to resolve this: Water resource, The available park and open spaces, Pervious and impervious nature of developments, Land use and landcover change. Rainfall pattern. The study delivers sensitive planning strategies for existing development through integration of water sensitive planning interventions.

***Key Words*:** Water-sensitive planning, Surface sealing, Landcover and land use, Parks and open space, Green developments, WSUDP Strategies.

1.INTRODUCTION

Water is the most crucial resource for a community's survival, making a sufficient supply of high-quality water priceless beyond measure. However, the water sector hasn't had much of an influence on decisions affecting the size, population, and layout of cities. Infrastructure and services for the delivery of water were developed after the fact or as cities grew. Globally, nations are revaluating how they value, distribute, and manage water as a result of global warming and an ever-growing population that is placing more demands on freshwater resources and the ecosystem as a whole. Quantitative or qualitative water problems have a strong relationship with human endeavors and the intensity of land use and landcover changes of in urban areas. However, after an extended time of formation, fixing these issues is very expensive and, in some cases, unattainable. This is because when these human impacts such as a catastrophic flooding event or major water contamination eventually become evident. Major barriers to sustainable urban growth include pollution, drought, and flooding. A city that is environmentally sustainable must take water management into account while planning its urban growth. Water management and spatial planning are closely related, and both should take surface water bodies into account when determining their form and position in space. To achieve a balance between urban growth and the water system for a sustainable urban environment and future development, spatial planning must incorporate water management.

Water Sensitive urban design and planning (WSUDP), which was created in Australia, is a component of this critically needed comprehensive approach to water conservation. This research seeks to integrate the idea of water sensitive planning (WSP) into the Aluva municipality context and its sustainable resources, specifically in the form of stormwater, as playing a crucial role in urban planning and the overall sustainability of water resources in the municipality.

2. India's water crisis

Urban water systems are confronted with significantly changing conditions. The impacts of climate change, rapid urbanization, and deteriorating and outdated infrastructure aggravate current water challenges by causing flooding, water scarcity, and rehabilitation costs on a scale that will overwhelm the capacities of cities. (CSE, Water crisis of india, 2016)

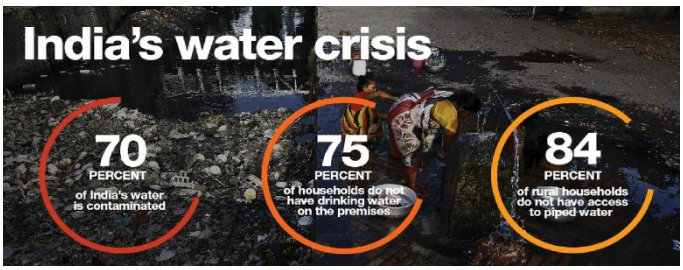

Fig- 1:India's water crisis

(Source: Composite water management index NITI AYOG 2108)

2.1 Water management initiatives in India

India, as a growing nation, is encouraging sensitive programs and planning regarding efficient water resources conservation and management such as Smart City mission, Water 4 Change, Urban water management, and Sponge Cities (Discussed in the 2022 budget presentation - Urban planning).The Kerala State Council for Science, Technology, and Environment and the Centre for Water Resources Development and Management are holding a workshop to discuss how cities may become water-sensitive cities by the year 2060.As a part of the "Water for Change" project: Integrative and functional water-sensitive design framework for rapidly expanding livable cities.

The Netherlands Organization for Scientific Research, the Government of India, and the Department of Science and Technology all sponsor it. (CHITHARANJAN, 2019, Nov 23) WSUDP It is one of the urban reforms which has to be implemented in urban areas in the state to avail special assistance for capital investment from the Centre for 2022-23. Envisaged Kochi Thiruvananthapuram and Kozhikode too.

2.2. Water sensitive concept

Water-sensitive urban design and planning (WSUDP) integrates the urban water cycle, water supply, wastewater, stormwater, and groundwater management with spatial planning and urban design. This approach contributes to sustainability and livability, particularly when considered part of an overall urban strategy. (CSE, Water sensitive city, 2018)

WSUDP is an approach that integrates and optimizes the use of available water sources and completes the water cycle. (S.K, 2018). The sustainable approach needs to include elements of water quantity, water quality, and ecology, along with community involvement.

Water-sensitive planning (WSP) is an approach to sustainable development that integrates water considerations into urban and regional planning. WSP aims to promote sustainable development and construction.

2.3. History of evolvement of water sensitive city in Indian context.

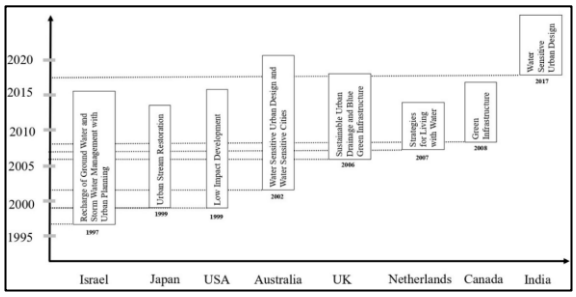

Fig- 2: Evolution of water sensitive city concept in India.

(Source: Water sensitive global south 2021)

2.4. Vision

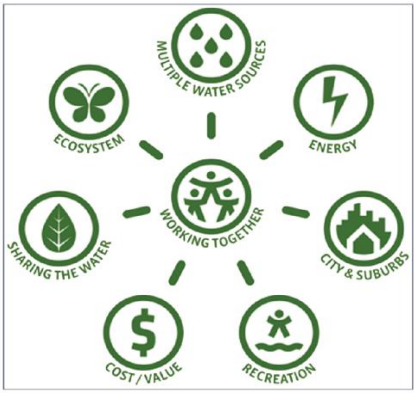

Fig- 3: Vision for water sensitive planning

(Source: Water sensitive city study tour 2009)

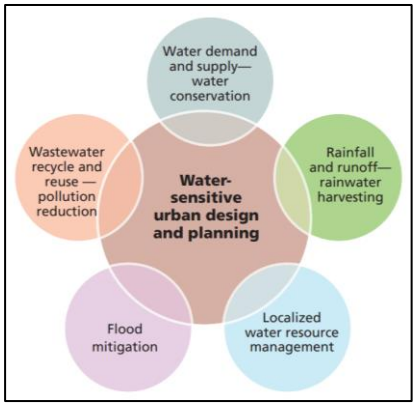

Fig- 4: WSUDP: Integrating water-cycle management

(Source: CSE, water sensitive urban design and planning-Practitioners Guide, India .2018)

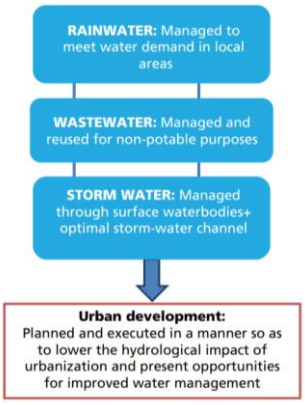

Fig- 5: WSUDP: Integrating water-cycle management

(Source: CSE, water sensitive urban design and planning-Practitioners Guide, India .2018)

2.5. What is water-sensitive urban planning and designing?

WSUDP is an approach that integrates and optimizes the use of available water sources and completes the water cycle by incorporating the following in planning and designing see (Fig-3,4: WSUDP: Integrating water-cycle management).

- Protecting local waterbodies (lakes, ponds and wetlands) for supplementary water sources
- Storm-water management at public places, including open areas in cities through elements of landscape design (e.g., vegetated swales and buffer strips, bio-retention systems)
- Recycling and reusing wastewater naturally (low cost/low energy) and not treating it as a liability
- Increasing water-conservation approaches at various scales (buildings/ campus)—i.e., by adopting water-efficient fixtures, xeriscaping landscape (i.e., planting native species) and using water-efficient irrigation methods— thereby minimizing load on the municipal supply system and groundwater sources. On-site water conservation with rainwater harvesting (RWH) is also important to reduce water scarcity.

- Adding value to the social and ecological aspects of areas by planning and designing the built environment in accordance with community needs and water issues
- Connecting the urban water cycle by collaborating with practitioners of different disciplines to bring different perspectives and expertise
- Associating upcoming policies, regulations and approvals with WSUDP4. (S.K, 2018)

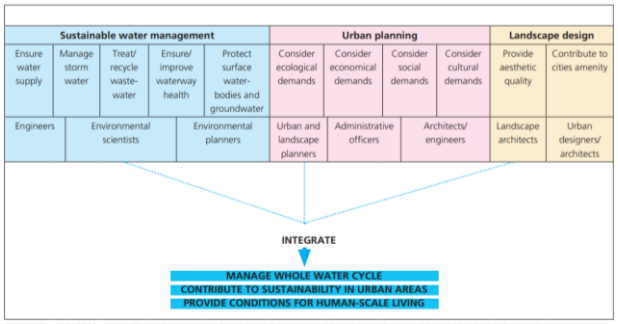

Fig- 6: Components of water-sensitive urban design and planning.

(Source: CSE, water sensitive urban design and planning-Practitioners Guide, India .2018)

Table 1: Scope of WSUDP interventions as per existing provisions

Scale	Existing documents/provisions	Opportunities
City level: Open spaces—parks and waterbodies, road infrastructure (planning stage)	• Master plans (20 years) • City development plan (five years) • City sanitation plan • Environmental management plan	• Waterbodies, parks, recreational areas, green areas, public and transport • Future locations of storm-water management facilities and proposed STPs
Zone level (planning and designing stages)	• Zonal plan • Storm-water management including water bodies • ULB schemes and sanitation schemes • Detailed project reports (DPRs)	• Parking lots, roads, parks, open space blocks and storm-water management facilities defined in planning documents • DPRs for water supply, sewerage including STPs, sanitation, storm-water drainage
Individual level (designing stage)	• Site plan—guided by bylaws	• Site-specific on-site water-sensitive facilities • Water-efficient fittings, sustainable landscaping, RWH and wastewater recycling and reuse.

Fig- 7: Scope of WSUDP interventions as per existing provisions.

(Source: CSE, water sensitive urban design and planning-Practitioners Guide, India .2018)

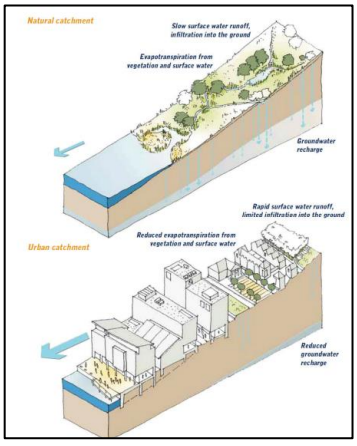

Fig- 8: Need of WSP Approaches

(Source: CSE, water sensitive urban design and planning-Practitioners Guide, India .2018)

2.6. Typical Urban Water Cycle in Indian small and medium cities and Towns.

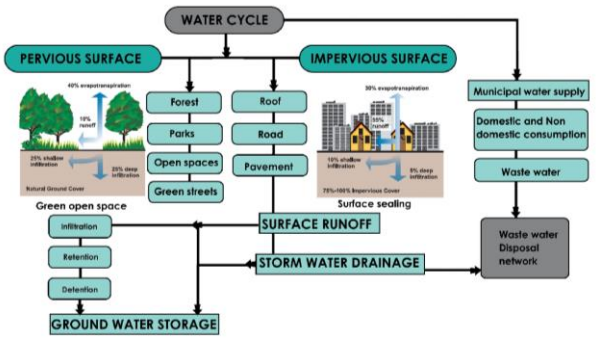

Fig- 9: Water cycle and urban development

(Source: Author generated 2023)

2.7. Significance of open/buffer areas in water-sensitive planning.

Table 2: Significances of open spaces

Wetlands/lakes	Recreational areas	Roads and streets	Inclusion of storm-water streams in urban fabric
Waterbodies and lakes can be planned with a green buffer area that can act as a treatment zone.	Open spaces are located in consideration with the natural stream system	Roads and streets constitute up to 70 percent of the impervious urban area and serve primarily to transport people and goods.	Maintenance of water quality, habitat retention and restoration, water conservation, and a wider choice of recreational opportunities in an integrated fashion.
Waterbodies play a major role in the natural hydrological cycle and offer healthy recreational spaces.	Can be also used to prevent and mitigate floods by retaining and detaining storm water	They also act as important conveyors of stormwater; they constitute the major drainage system that serves as an important flow path, Drainage pipes underneath go beyond their capacity	They provide accessible open spaces to people. Their linear nature also offers opportunities to integrate offroad pedestrian and cycle paths
Since the source of the pollution-degrading waterbody may be unknown, these buffer areas act as protective layers.	Purify and infiltrate runoff, thus recharging groundwater with clean water.		
	Storm water that reaches open spaces may be used for irrigation and as landscaping elements.		

(Source: Author generated with respect to CSE,.2018)

2.8. Water sensitive parameters, indicators and measure

Table 3: Water sensitive parameters

Water sensitive parameters	Indicators	Measures
Water quality	Pollution control Ph value, BOD, COD Groundwater contamination Rainwater contamination	• Built and natural ratio, • Open area and green surfaces, Green roofs, • Permeable road surfaces, Parks, Parking areas, Public areas • Ensure quality urban space • Natural Infiltration Bioswales • Bio retention areas
Water balance	Groundwater recharge Runoff control Water cycle maintain	• Disturbance to soil and landscape is minimized by the maintenance of natural landforms. Waterways protected by a provision of a buffer of natural vegetation for urban development • Natural channel design and landscaping are used so that the drainage network mimics the natural ecosystem • Minimizing the use of hard-engineered structures • Using native vegetation in storm-water management and all landscaping to maximize habitat values • Detention ponds
Water safety and security	Drinking water Demand and supply	• Rainwater tanks collect roof runoff to supply toilet, laundry and outdoor uses. Houses connected to (or utilize) a grey-water or sewage recycling system to provide an alternative source of water for toilet flushing and outdoor use. • Houses incorporate water-efficient appliances and plants that need little water (preferably of local provenance) grown extensively in gardens
Water ecology	Ecology habitat preservation	• All storm-water runoff from hard surfaces is treated through infiltration, sedimentation, storage, or biological treatment before leaving the site • Infiltration trenches • Filtration strips in roadways • Infiltration basin
Water environment	Flood plain protection Flood-prone areas identification Wetland conservation Rainwater contamination Maximum flow	• Sensitive construction practices • Green recreation area • Buffer area • Wetlands • Flood control
Water resources	Infiltrated water Retained water Reused water	• The volume of infiltrated water • The volume of reused water • The volume of retained water

(Source: Author generated 2023)

2.9. Water sensitive principles and practices

The water-sensitive city is underpinned by 3 key pillars of practice that are seamlessly integrated into the urban environment:

Cities as Water Supply Catchments: access to a diversity of water sources, supplied by an integrated mix of centralized and decentralized infrastructure

Cities Providing Ecosystem Services: provision of ecosystem services for the built and natural environment

Cities Comprising Water-Sensitive Communities: socio-political capital for sustainability and water-sensitive decision making and behaviors. (CSE, Water sensitive city, 2018)

2.10. Research questions

1. What are the sensitive methods being used in water-sensitive planning to manage urban water effectively?
2. What are the parameters and indicators of water-sensitive concepts that can be integrated to sustainable riverfront development?
3. What are the challenges of preparing water-sensitive planning in Aluva municipality?

2.11. Aim

To develop a strategy for water-sensitive planning for Aluva municipality.

2.12. Objectives

1. To study the concept of water sensitive city and its parameters.
2. To identify the applicability of water-sensitive planning parameters in Aluva municipality.
3. To analyze the data based on the identified planning parameters.
4. To formulate proposals and prepare water sensitive plan for Aluva municipality.

2.13. Methodology

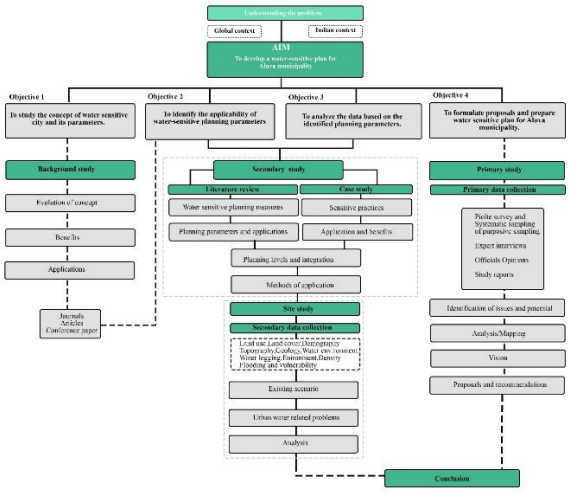

Fig- 10: Methodology

(Source: Author generated 2023)

2.14. Scope & limitation

Turning cities into more sustainable urban water cities are widely recognized as complicated. So, these initiatives and planning parameters can help to address the water and water resource-related issues and challenges in terms of management, Environment, Ecology, Quality, and Quantity.

Innovation of new concepts such as Water Sensitive Urban Design (WSUD) and 'Integrated urban water cycle planning and management' (IUWCM) already exist so these strategies and proposals can be integrated to support the planning level interventions too.

WSUDP It is one of the urban reforms which has to be implemented in urban areas in the state to avail special assistance for capital investment from the Centre for 2022-23. Envisaged for Kochi Thiruvananthapuram and Kozhikode too.

Water-sensitive concepts can be applied in a range of circumstances, from the micro to the macro, or from the neighborhood to the whole urban city. Here we analyze the micro which is highly sensitive and has high potential at the same time vulnerable. (Kochi-Aluva municipality).

3.STUDY AREA

Total area of municipality - 7.18 sq.km

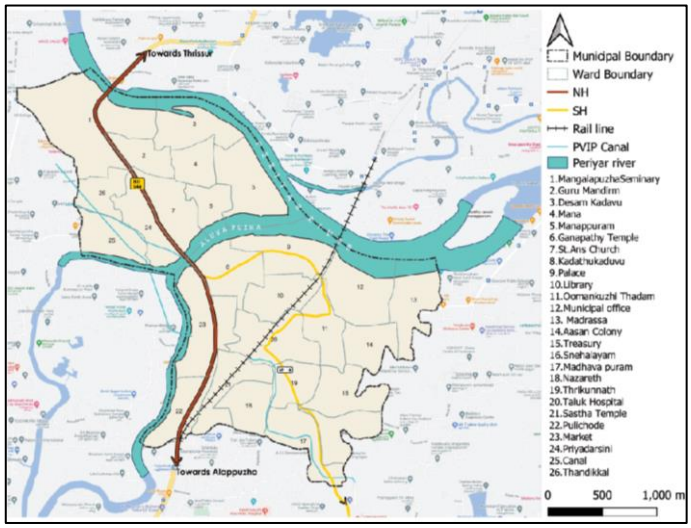

Fig- 11: Base map of Aluva municipality

(Source: Author generated using GIS 2023)

National commission on urbanization (NCU) identified Kochi region as one of the national priority cities (NPC). As per their report Kochi – Thrissur corridor is spatial priority urban region. Aluva is one of the townships in this corridor. The regional linkage of Aluva is shown in Aluva municipality is part of the Kochi urban agglomeration which is the first order urban center of the state as per the state urbanization report (SUR) of Kerala. As per the future urban profile of the state delineated in the state urbanization report for 2021, Aluva forms part of the delineated urban cluster of Kochi. Due to its location, Aluva is fast developing into a satellite town in Kochi. The town occupies a

strategic position owing to its connectivity to other major urban centers through rail, road and water. By 2030 surrounding municipalities and panchayats such as Kandungallur and Chengamanad will also be increasingly urbanized. Such a development will increase Aluva current role and sphere of influence in terms of population as key commercial center for the wider area.

3.1. Functional character

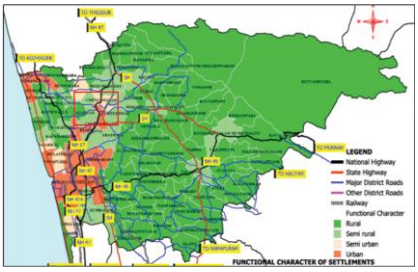

Fig- 12: Functional character

(Source: District urbanization report 2011)

Table 4: Demographical detail of Aluva municipality

Population	22428
Decadal growth	-6.98%
Floating Population	2000
Slum Population (if any)	100
Tribal Population	0
Population Density	3472 persons/sqkm
Households	6205

(Source: Author generated 2023)

Without adequate planning measures, the town risks both losing its identity and heritage value, and a huge decline in leisure areas Now the green open areas are inadequate in the municipality. Forcing out current residents through gentrification and importantly missing out on the opportunity to provide efficiencies such as reduction in carbon emissions. The current trend of commercialization of central area consists of transportation hub, government hospital and public buildings are coming under CBD area (Proposed mater plan 2031).

3.2. Focus area

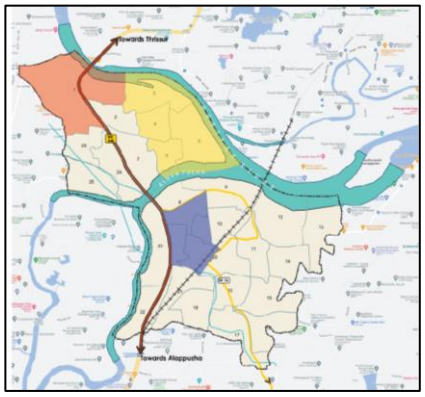

Fig- 13: Focused area for analysis

(Source: Author generated using GIS 2023)

Development and land use has a large impact on the water cycle, The core of water sensitive planning is land use and its distribution. Now all the urban development and land use distribution have different character and function which directly impacting the water cycle. In Aluva municipality green and open space lacking in existing land use and this will be highly affecting climate and future developments. So, the sensitive planning must consider the green development also. So, for the deep assessment selecting 3 types of land use such as

1. Institutional area
2.Residential area
3.Commercial area

separately to assess the pervious area and runoff etc.

3.3. Land use analysis

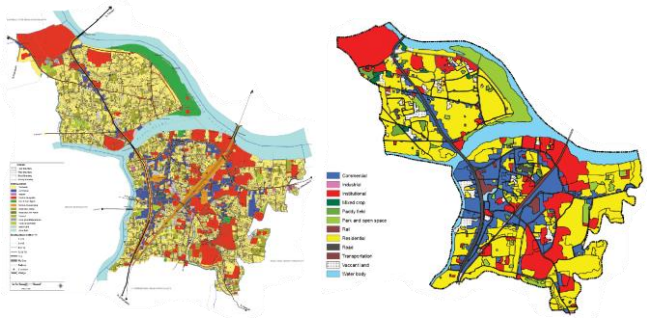

Fig- 14: Land use changes over the years of 2011 to 2023

(Source: TPO (Land use map of 2011)
Author generated with respect to google earth pro using ArcGIS 2023(Land use map of 2023))

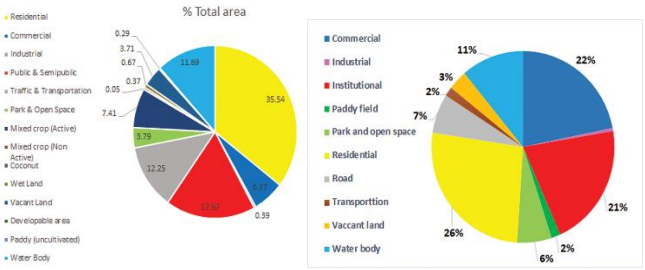

Fig- 15: Land use distribution percentage

(Source: Author generated 2023)

Aluva becomes saturated year by year. Urban functional characters of municipality are one most affected factor of land use change. This urban character and the land use changes directly affecting environment and the natural resources. Green and open space reducing and surface sealing of urban environment increasing rapidly. Due to increase of surface sealing, it may result to high runoff and waterlogging, flooding issues. Public and semipublic area 17.67% Of the total area. One of the critical opportunities in terms of water sensitive development. Because the municipality lacking the open spaces so these institutional areas can be utilized for sensitive practice implementation.

3.4. Landcover analysis

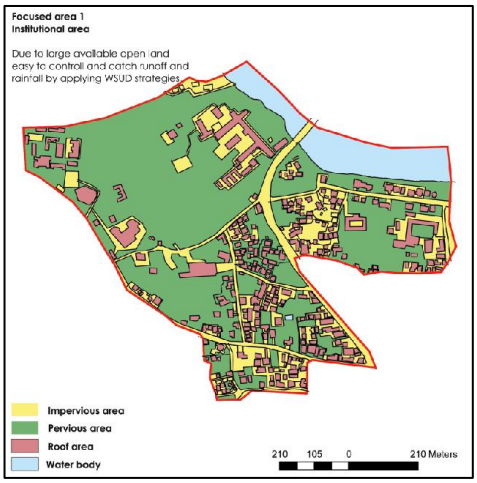

Fig- 16: Focused area 1 Institutional area land cover

(Source: Author generated using ArcGIS 2023)

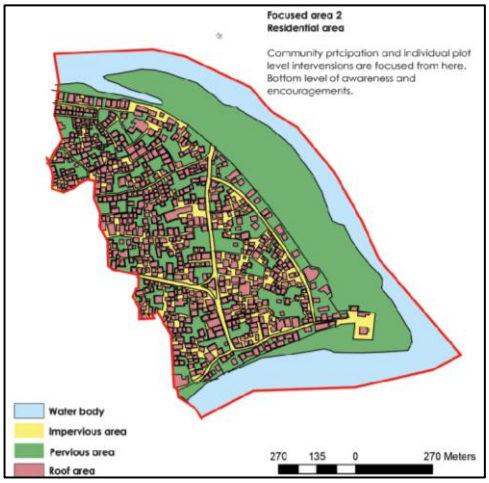

Fig- 17: Focused area 2Residentail area land cover

(Source: Author generated using ArcGIS 2023)

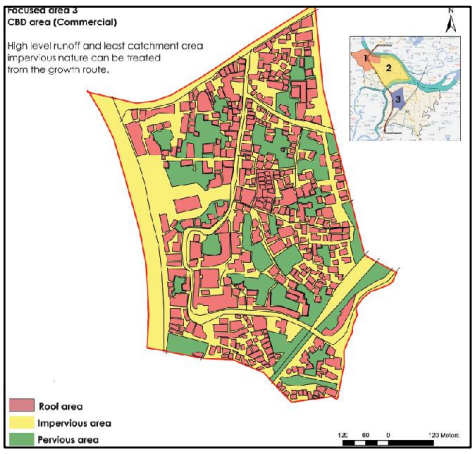

Fig- 18: Focused area 2Residentail area land cover

(Source: Author generated using ArcGIS 2023)

Table 5: Surface sealing analysis of different land use pattern

Location	Area in sq km	% Roof	%Pervious	% Impervious(Road +Pavement)	Surface sealing	Imp/Perv	Roof/Perv
Institutional	0.7	17	53	21	38	0.7	0.3
Residential	1.51	34	33	14	48	1.4	1.03
Commercail	0.5	33	20	47	80	0.8	1.65

(Source: Author generated using ArcGIS 2023)

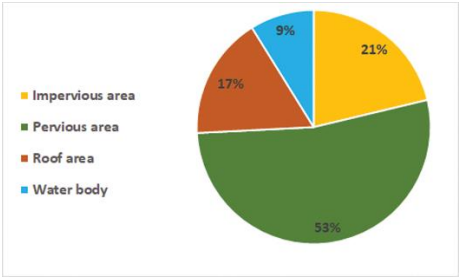

Fig- 19: Institutional area

(Source: Author generated using ArcGIS 2023)

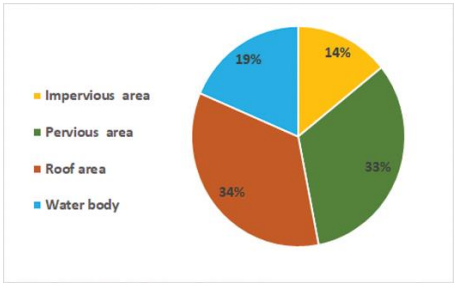

Fig- 20: Residential area

(Source: Author generated using ArcGIS 2023)

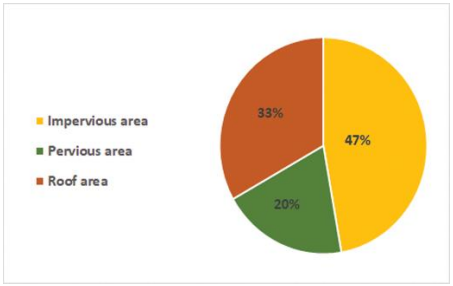

Fig- 21: Commercial area

(Source: Author generated using ArcGIS 2023)

Chart

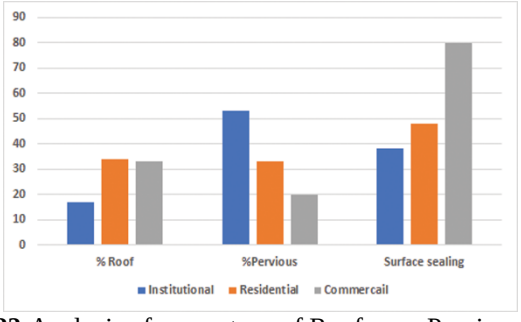

Fig- 22: Analysis of percentage of Roof area, Pervious area, Surface sealing

(Source: Author generated using ArcGIS 2023)

The amount of imperviousness or the surface sealing is highest in a commercial area and residential area it is much lesser in institutional area. This corresponds directly to the changes in

percentages of built-up area and perviousness in the three study areas.

4.Case study

Water sensitive planning for the Chennai city. Chennai is heavy urbanized city there are so many studies regarding environment threats of Chennai (IIT)(IGCS) one is about (Future city) water table and cycle the studies says that an increase in urban built-up areas is accompanied by decrease in water tables cycle and wetlands. According to a World Bank study, of the 27 Asian cities with populations of over 1,000,000, Chennai and Delhi are ranked as the worst performing metropolitan cities in terms of hours of water availability per day.

4.1. Need for the water sensitive planning

Chennai, the only metropolitan city without a perennial source of drinking water, is now in the grip of acute water scarcity.

The rapid growth of Chennai city's population and its development activities over the years has adversely affected the groundwater regime.

Even though Chennai gets an average rainfall of 1260 mm, the residents of Chennai allow the rainwater to flow through the city roads and join the Bay of Bengal. Thus, the infiltration rate is very less. The emergence of the availability, quality, and sustainability of drinking water in Chennai is a serious concern for policymakers.

Therefore, there is a need for sensitive planning of water for effective management of this vital and scarce resource. (priya, 2008)

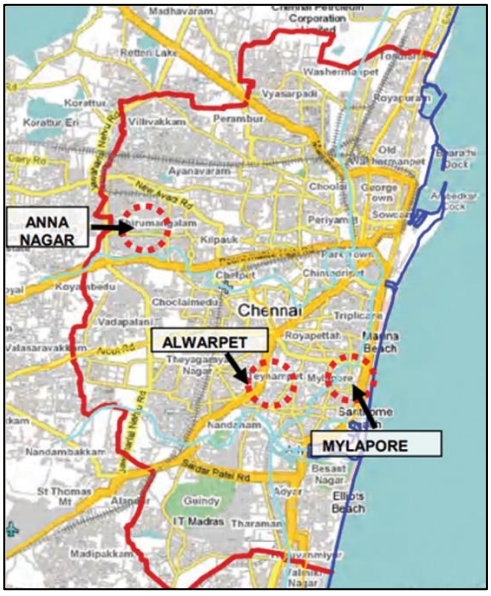

Fig- 23: Focused areas of Chennai city

(Source: WSP Guidelines, Prof. Soamnth Sen and Priya 2008)

Water sensitive planning for Chennai city assessing the land use and landcover data based on the pervious and impervious nature of development and proposing accurate ratio for coming developments to follow for the sustainable development and maintain water cycle.

Developing landcover data of each distribution and calculating the imp/per ratio, surface sealing, and with the help of rainfall, runoff data and predicting the future challenges etc. By this intense analysis they propose Some recommendation and strategies.

3 levels of planning consider the micro and macro level needs and uses their ability for resource management, planning interventions in land use management and built-up area management are strictly promoting the water sensitive elements in design and planning level. These element and consideration must help to restore their urban rivers and sustainable development and keeps the livable cities. **(priya, 2008)**

5.Water sensitive Strategies for Aluva municipality

5.1. Institutional area

Storm-water management at public and semipublic places, including open areas in cities through elements of landscape design (e.g., vegetated swales and buffer strips, bio-retention systems).

The bio-retention areas can be located after identifying low-lying areas within the institutional area, surrounded by vegetation nodes

Trench with filter strips and swales can be located along the footpath.

A small rain-garden can be incorporate with provision of overflow;

5.2. Residential area

Community participation can be motivated in each individual plot level.

WSP interventions can implemented with the help of resident people.ie RWH, SWH etc.

Community garden, Farming, other irrigation at residential level can be included in this level.

5.3.CBD area (Commercial)

Green Growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies.

In water sensitive planning it promotes green developments to catch treat water and preserve it for future.

While we analyzing the 2031 proposed master plan this area is marked as a central business district.

So, the future economic activities may concentrate to this area. Thus, this area become a driving engine of Aluva municipality.

As a commercial center of municipality this area possess high

percentage of pervious area. So, the water sensitive planning and design intervention may help to reduce the future vulnerabilities and can keep the area as an example of green development and sensitive practices.

6. Recommendations

1) The ratio of pervious to impervious land cover in most common constructions Patterns.
Policy 1: To minimize building footprints, future structures shall have limited ground coverage and vertical growth.

2) The amount of open (pervious) space present in the region
Policy-2: Introduce green places for increased runoff infiltration.

3) Dividing the region into tiny catchments, or "micro catchments."
Policy-3: Encourage on-site infiltration is

4) Including buildings intended to capture, hold, and permeate water from precipitation into the urban fabric.
Policy 4: Include infiltration facilities at all planning scales, from a single property to a significant metropolitan area.

5) Permeable paving components Reducing imperviousness even on hard surfaces.
Policy-5: Two tiers of suggestions are provided for new developments based on the elements of urban planning.

7. CONCLUSIONS

As a growing urban center Water-sensitive planning of Aluva municipality can conserve water resources while offering numerous benefits by way of improving the urban environment, reducing the danger of flooding, increasing opportunities for recreation and leisure activities, and reducing flooding damage and cost of drainage systems. The effects of urban growth on the climate, such as the maintenance of the water cycle and urban heat islands, may be managed through water-sensitive planning. Any open space created using the concepts of water-sensitive planning offers aesthetic and recreational advantages while filtering runoff that infiltrates to rehydrate the groundwater. It also serves as a detention reservoir intended to lessen pollution loadings and flood discharges. Due to excessive building and paved areas, the water cycle is lost in urban regions; this is evident in landcover studies, even in significant recharge zones such lake catchments, riverbanks, and wetlands. The loss of potable water is further exacerbated by the sewage pollution of existing water supplies. To restore the lost water cycle, it is necessary to make the most of open places. Land uses must be distributed in accordance with the hydro-geographic pattern when planning for new and existing regions. The location of open spaces, playgrounds, highways, etc., has a significant role in adhering to the water-sensitive principles.

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