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Assessing the impact of urbanization on Catchment Dynamics: A Case Study of Narsinghgarh Town, Madhya Pradesh

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Abstract - *To meet the requirements of the growing population, there was urbanization and the associated changes in the water catchment areas of numerous gutters. Urbanization in watershed dynamics includes denudation through the junking of trees and foliage, land use changes due to the construction of structures, roads, and associated structures, and the diversion of face water runoff through sewers and reservoirs. constraint utmost of the impacts of these changes affects the hydrological systems of fairly small aqueducts, where the performing increase in flooding and river erosion can be significant. In general, there's a reduction in soil infiltration and erosion and an increase in sluice volume and peak surface runoff. This study has an imperative base on the effects of quickly tending urban life and its impact on water resources in Narsinghgarh Town. The data for this paper comes from in-depth interviews with local dwellers, political employees, and King's representative (Grandson) to break down how accelerating urban life is affecting the water catchment region. The finding indicates that the catchment region (Parasaram Lake) is virulently wormed by the local habitants, which results in flash flooding and a number of viral conditions.*

The encroachment within the town along the catchment region (Parasaram Lake) has caused deduction in the cross-sectional areas and the discharge carrying capacity of the lake therefore causing flooding in the low-lying areas due to the water spilling over the catchment zones. At times there are some localities in the town that stay water-logged in spite of rainfall having stopped before 24 hours.

These spots are waterlogged because people holding encroached on the entire stormwater disposal system(Ponds and Lakes). A thorough study is carried out on the encroachments over the natural drainage system and its consequences by considering Narsinghgarh city as a study area.

Key Words*: *Urbanization, Catchment Area, Encroachment, Pollution, Parsaram Lake, Narsinghgarh

1. INTRODUCTION

Urbanization is a population move from pastoral to urban areas and the patterns in which society adapts to the remaking, generally result in the physical growth of urban areas, Eventually, it leads to a horizontal or vertical growth of urban areas. A Country is called to be urbanized when over 50 % of populants live in urban areas. Population density, area, and economic organization are some factors that may be utilized to describe an urban setting (Grannis, 1998).

The effect of urbanization varies in various parts of the world. According to the United Nations by the end of 2008, 50% of the world's population would live in urban areas instead of rural as estimated.

It is anticipated that by the end of 2050, 64.1% and 85.9% of the developing and developed world respectively, will be an urbanized international (Tribune, 2008). The issue of Urbanization is not new; however, since the urbanization procedure is continuing; it is dynamic and multifaceted. Numerous studies have examined the connection between changing land use and improved water quality. Human activities such as fast urbanization, industrialization, and conversion of rural land have an impact on both of these elements. Unexpected population growth is related to water quality degradation and is causing a large increase in nutrients and microbial loads (Ghosh et al., 2014; Krishnan et al., 2013; Maillard and Santos, 2008). Therefore, urban areas hold the possibility that produce ecological and environmental impacts at multiple scales (Ghosh etal., 2014). These special ecosystems deliver the solutions to challenges as well as challenges for sustainable development in a rapidly urbanizing world (Breuste and Qureshi, 2011; Grimm et al., 2008; Hanjra and Qureshi, 2010).

Urbanization in the context of an evolving country like India refers to the rapid expansion in the proportion of the population residing in urban regions as equated to rural areas. It's driven by various factors, embracing population growth, rural-to-urban migration, and economic breaks in urban capitals. Urbanization is a complicated and

transformative procedure that has deep social, economic, and environmental implications. The continued degradation of the environment poses a risk to people's health, their way of life, the survival of species, and the ecosystem at large in any given nation (Banister, 1998; Chen et al., 2014).

In the case of India, urbanization presents both opportunities and challenges:

1.1 Opportunities

i. Economic Growth
ii. Infrastructure Development
iii. Innovation and Technology
iv. Cultural Exchange

1.2 Challenges

i. Lack of housing
ii. Infrastructure Stress
iii. Urbanization and High Unemployment Rates
iv. Social Disparities
v. Environmental Degradation
vi. Health Challenges

The population viscosity, profitable expansion, and employment possibilities in metropolitan areas make urbanization particularly prominent in India. The government is enforcing programs to ameliorate civic structure, give affordable casing, ameliorate public conveyance, and encourage sustainable development in trouble to alleviate the goods of urbanization. To make sure that urbanization benefits India's growth, ways are being made similar to smart megacity investments, slum recuperation, and effective civic planning.

At the present time, one of the biggest environmental hazards of any developed nation is encroachment on catchment areas, inadequate supply of clean water, the artificial method of cultivation, and rapid expansion in population, also Encroachment on catchment regions is a serious environmental issue that can have profound effects for ecosystems, water supplies, and populations. Catchment areas, referred to as watersheds or drainage basins, are land regions where water flows into a shared body of water such as a river, lake, or pond. In catchment regions, encroachment refers to the illegal possession, building, or usage of land within these important zones.

2. REVIEW OF LITERATURE

The maturity of urbanization occurs not just in developed countries, but also in coming ones. Although it's driving manpower for conversion, financial, and industrial progression, there's a growing establishment about its impact on the terrain.

Urban flash floods are an alarming danger to Asia's and Africa's expanding cities. A large share of the low-income population lives in locations prone to recurring and localized floods. Flood disasters disproportionately affect urban slum inhabitants with few resources. Accelerated flood tide frequency in urban areas is one of the most burning issues for policymakers and officers from public, domestic, and municipal authorities. Although scientific studies demonstrate that massive rainfall circumstances in urban regions are accelerating, they aren't the main cause of urban floods. Changes in watershed hydrology as a result of unregulated concrete space expansion, encroachment on natural drainage routes, trembling of wetlands, and other factors result in significant flooding risk.

Gupta et al discovered no significant rising or negative trend in rainfall during the previous 200 years, and even a drop in the last 20 years, despite a record of growing floods. Land-use concerns such as reduced natural spaces, loss of water bodies, encroachment of rivers, streams, and drainage systems, and unregulated building activity have all been recognized as contributing factors to Chennai's flood risk.

Apart from the city's rapid population growth, increased built-up area, increased rainfall, and shrinking water bodies, Ramachandra et al. pointed out that the local governance body lacks adequate powers to plan, decide, and administer the city. The State has established several parastatal organizations, each of which operates in its own geographic region, complicating the coordination of various tasks.

JODHPUR: Every monsoon, the city regions become islands due to persistent government apathy towards the city's drainage infrastructure and the refusal of municipal entities to hasten work to connect six major nullahs (drainage outlets) to the Jojari River.

During his tenure as mayor from 2009 to 2014, Rameshwar Dadhich drew out a master plan for the city's drainage system, but it has been accumulating dust for nearly a decade. He'd also planned other paths for the nullahs. According to Tarachand Gosai, former commissioner of the previous Jodhpur Municipal Corporation, the city would continue to flood during the monsoon unless this master plan is implemented. For a long time, the Rajasthan Urban Infrastructure Development Project (RUIDP) has taken up the development of two of these nullahs (Bhairav and Mata ka Than), but lack of money has held the work on hold for more than three years. MLA Panwar stated that work on these nullahs would begin soon because the state government just approved Rs340 crores for the city's sewage system, and the remaining work on these nullahs will be finished under this grant.

Another hazard to the drainage system is poor engineering and a lack of moxie. executive authorities frequently travel the roadways with officers and external bodies, but indeed these visits haven't supported the megacity in chancing feasible results

The current study examines the impact of slums and other encroachments on Narsinghgarh's aqueducts and near-water bodies on flash flooding by assaying two significant flood tide occurrences during the former decades.

3. INFORMATION AND PROCEDURE

Narsinghgarh town is situated at 23.7 degrees east latitude near the northern border of Madhya Pradesh. Its average height above sea level is 483 m. (1584 feet) and it is about 85 km north of Bhopal. It is situated far away. Narsinghgarh situated in the middle of forests and mountains is like a city situated in the valley. Locally known as "Chhota Kashmir", this town has immense tourism potential. The natural beauty of this city is at its peak in the rainy season.

The city is almost 300 years old and was founded in 1681 by Dewan Parasram. The beautiful lake of the city, which mirrors the old fortress and palace, still bears the name of the founder. The city is 83 km away from Bhopal.

The town is also dotted with numerous suitable lakes, which form part of the catchment of Natural water flow.

The overall ground level of the town varies from 8 m to 12 m bgl. It has an average periodic rainfall of 985.8 mm Monsoon is spread over the month of June to November. During the monsoon season, around 92 of the yearly rainfall is attained.

During the reign of Dewan Parasram (1681), there was overall development, and due to his better vision, he planned a better and acceptable system of stormwater operation, which included a storm sewer in the walled town and a system of connected lakes and ponds to the influent known as Parvati stream for stormwater discharge.

With the passage of time, the city has grown haphazardly due to unplanned development, population shifts from the hill to neighboring catchment areas, and a rapid surge in urbanization after 1975-76, along with a lack of appropriate planning and administration. People have encroached on the natural system of Parsaram lakes due to a lack of appropriate vision for a stormwater disposal system. Residential communities have been built in the flood plain of Parsaram Lake and on natural hill ridges. Filling the floodplain and ponds/lakes results in the formation of slums.

The development of industries in Narsinghgarh led to the influx of unskilled job seekers and daily wagers besides a skilled and educated workforce. The former has led to the growth of slums where poor working-class people live.

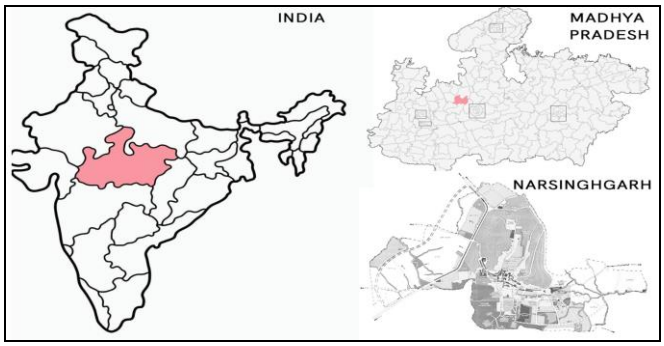

Fig -1: Figure of Study area Narsinghgrah town

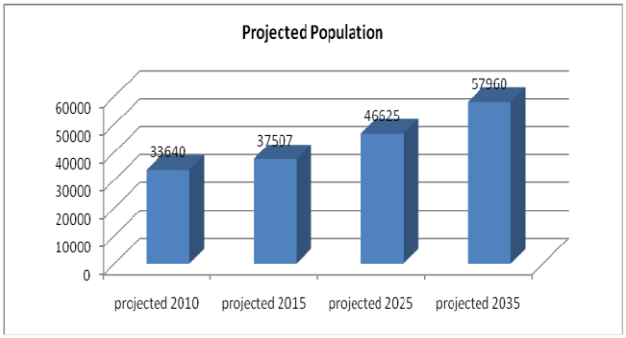

Fig -2: Population Projection of Narsinghgrah town

4. WATER STREAMS

The Parvati River enters the western region of Rajgarh district from the northern slope of the Vindhyachal range in Sehore district. Initially, it flows towards the northeast but near Biaora it turns towards the north. By the time it reaches Narsinghgarh, its size becomes remarkably large, at some places the distance between its banks is 3 km. Till then.

The Parasram Sagar Pond in Narsinghgarh is surrounded by hills on three sides, one of which has a fort on Shiva, the other on the Mahadev temple, and the third on the Hanuman temple. They were built in 1690 AD by Shri Dewan Parasram, the first king of Narsinghgarh state.

Overinflow of the Parsaram reservoir due to high rainfall in the catchment area, high water level of Parwati stream due to discharge from the reservoir, high intenseness rainfall in the town area, high runoff generation due to impermeable surfaces, and lack of discarding system due to encroachment on natural rainspouts and ponds are the major reasons for flood tide in Narsinghgarh Town. explorations show that the major climate revision is indicated in the town with the drastic change in rainfall pattern after 1970.

5. DATA COLLECTION

i. Narsinghgarh Municipal Corporation provided water level data during flood occurrences at Parsaram reservoir.

ii. Based on real-site inspection, satellite pictures from Google Earth are processed to depict the encroachment on the waterway.

iii. News 18 obtained some photographs of the actual flood scenario, while others were obtained via the social media site www.facebook.com.

iv. Narsinghgarh rainfall data from 1961 to 2014 was obtained from the Water Resource Department (MPWRD).

6. ANALYSIS

The Google Earth program is being used to analyze encroachment on the floodplains of the Parsaram lake, natural drains, and lakes in Narsinghgarh town. Field visits were used for ground truthing. Flood water levels, visits, and interviews with inhabitants at flood-inundated places were used to assess the impact of encroachment on two significant flood occurrences of the twenty-first century.

7. RESEARCH DESIGN

The current academic inquiry worked with a qualitative research design. In this case, an interview schedule has been used as a data-collecting technique. Ten in-depth interviews were done in each of the two settlements. The inclusion criteria were focused on local members, particularly those living along the banks of Parsaram Lake and the core market where flood occurs casually, and members of Local Government, and political workers.

8. OBSERVATION AND DECODING

The community members were interviewed in their native language, translated into English, and analyzed multiple times to avoid misinterpretation. The researchers established themes and sub-topics after multiple discussions over interview codes and contents, validating respondents' overt and covert notions.

9. EXISTING WITHDRAWAL SYSTEM

Due to the city's absence of a water-sewage infrastructure, unclean water is now running over the natural slope of the soil. The unclean water eventually combines with the rainwater. Flows into drains or accumulates in low-lying places. It is obvious that this condition is hazardous to one's life and health. Most residences in Narsinghgarh have private septic tanks, but there is no system in place to separate unclean water from rainwater. Each house's filthy water flows into a large drain via little drains built on the side of the road. The overall amount of filthy water/rainwater in the city has not been determined, nor has the complete length of the drains. The polluted water from the entire city is being drained into the city's main drain. Drains fill with water in their lowest sections, and stagnant water can cause major health concerns in the region.

Table 1: Demand and Gap of Storms Drains in Narsinghgarh

Year	Population	Existing Length (in km)	Desired Length	Difference
2010	27657	30	45	15
2015	37900	30	60	15
2025	46700		75	15
2035	56600		90	15

10. EXISTING SEWERAGE SYSTEM

The treatment of contaminated water is required for environmental and health reasons. Along with the unclean water from residences, the dirty water from industry and companies must be treated.

Narsinghgarh's waste management situation is appalling. There is no subterranean water-sewage system in this area. As a result of these conditions, unclean water enters the river via open drains and causes pollution.

10.1 The Possibility Factor

- The situation of submergence and flooding.
- Ignoring natural drainage in unplanned development leads to submergence and flooding during the rainy season.
- In the city, water drainage through drains is poorly organized. Water logging is a typical problem in marginal regions due to the absence of a drainage infrastructure.
- Because the drains' water carrying capacity has decreased due to siltation, water only flows out during the peak of the flow. The issue worsens during the wet season.

11. DEMAND GAP ANALYSIS

There is currently no underground sewerage system, thus all unclean water is released into sewers and drains. As a result, Table 2 provides estimates of the needed length of a sewerage system. According to the CPHEE handbook, the length of the sewage system is about 80% of the length of the roadways, on which the estimates are based.

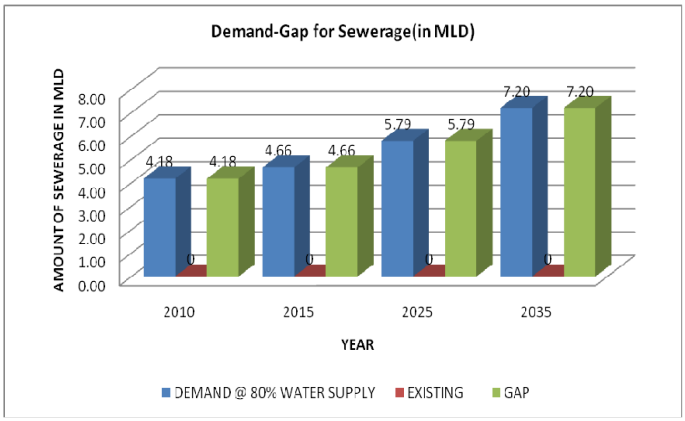

Fig -3: Demand-Gap for Sewerage (in MLD)

Table 2: Length and Spacing of Sewerage System in Narsinghgarh

Year	Population	Existing Length (in km)	Desired Length	Difference
2010	33640	0	34	34
2015	37507	0	38	4
2025	46625	0	47	9
2035	57960	0	58	11

12. SWOT ANALYSIS OF THE STUDY AREA

A SWOT analysis is a strategic planning technique that is used to evaluate the internal and external elements that might impact in this example, a flood zone region.

This study aids in identifying the area's advantages, problems, prospective growth avenues, and external dangers.

Table 3: SWOT Analysis of the Study Area

Strength	Natural drainage availability
Weakness	• Open drains are sometimes used for sewerage. Separate arrangements must be made for the disposal of rainwater and sewage. • During the rainy season, a flood scenario is formed in the shallow regions due to non-maintenance of drains, invasive plants, and congestion. As a result, health issues and unsanitary circumstances occur. • Solid waste is being dumped into sewers, which is completely unacceptable. Drain embankments across the city are in a state of ruin. • Open sewers are carrying sewage. • The drains are full in many areas, obstructed, damaged, or the flow of water exceeds their capacity owing to overcrowding.
Opportunities	• A well-designed and well-executed plan is required for sewage and rainwater drainage. • High population density can be used owing to minimal capital investment. • Public toilets are required to avoid open defecation.
Threats	• Water-sewage growth in drains complicates health issues. Unplanned construction has hindered the city's natural drainage canals. • Unorganized development is not controlled in shallow areas and natural drainage channels while development control is effective. • The burden on water and sewage will increase more as the population grows. • Poor sanitation in new settlements endangers people's lives.

13. RESULTS AND DISCUSSION

Respondents from the community believe that the city's population is fast increasing, which is producing a slew of problems, particularly with regard to water shortages and pollution. These are regarded as highly significant hazards to the local community and all city residents.

14. FLOOD PLAINS AND AFFECTED WATERWAYS

Changes in land use in catchment flood plains and flood-inundated regions in the city are calculated by comparing the earliest accessible Google Earth picture (December 2008) to the most current (April 2023). High-end bungalows and residential colonies near the Parsaram Lake (Fig.4) Another commercial market (Fig.4) upstream of the Pal Road Bridge is having the same problem. A relatively new building is being built near Chota Talab (Fig.5) on the ground that previously served as an inundation pond during major floods. This work appears to be affecting the outfall of the Chota Talab road rivulet as well. The installation of a food market (Fig. One of the oldest dense slums located near the catchment area is Thawariya Mohalla (Fig.). This slum is impacted when the lake floods. The slum downstream of the Parsaram Lake (Fig.6) has grown into the space that was formerly used as an inundation pond. The Parasaram and chota talab lakebanks slum is evacuated under this strategy. The figure depicts the evacuation of a slum on both banks of the lake near the Narsinghgarh town. The graphic clearly shows construction on a lake floodplain. Flooding in the east and west sections of Narsinghgarh is caused not just by local rainfall but also by overflow from outside the city limits.

Though slums have not been removed from the banks of Parsaram Lake (Fig6), and Chota Talab (Fig7), concrete construction has developed on the watercourse's floodplains. Slum encroachment was found in the Thawaria and Baradari wetlands (Fig6 A).

a) 2008

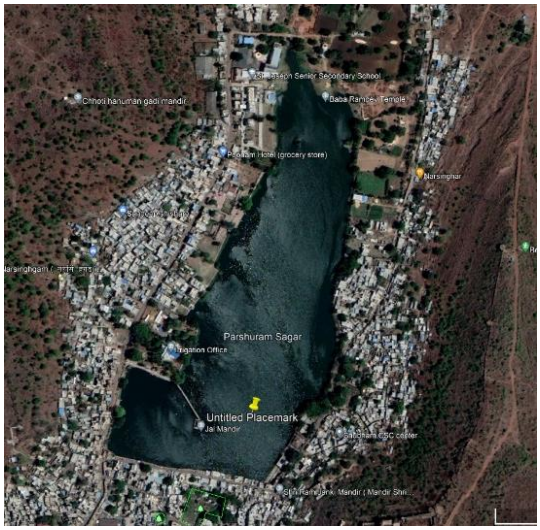

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Fig -4: Built-up area Near Parsaram Lake

(a) 2008

(b) 2023

Fig -5: Built-up area Near Chota Talab

(a) **Fig -6**: (A) Parsaram Lake

Fig -7(B) Chota Talab

These wetlands were exploited for flood inundation and contributed to the area's vulnerability. This is due to the fact that urbanization has had an impact on natural slopes and drainage systems near Chota Mahadev temple has dried up, and development has begun after the lake's area has been filled. The lake adjacent to the Mela ground has likewise dried up, and a road has been built following landfilling (Fig. Site investigations are used to validate the validity of satellite photographs of flood-prone areas against actual circumstances. Drainage blockages were most prevalent in the Parsram Lake drainage and its catchment region in Thawariya and Baradwari. Many minor natural drains were destroyed in this region by illegal landfills and accretion on both sides of the catchment area.

15. FLOOD IN NARSINGHGARH

To demonstrate variance throughout the months rather than just the monthly totals, here is the rainfall gathered over a sliding 31-day period centered on each day of the year. Monthly rainfall in Narsinghgarh varies drastically by season.

From May 14 to November 4, the rainy season lasts 5.7 months, with a typical 31-day rainfall of at least 0.5 inches. August is the wettest month in Narsinghgarh, with an average rainfall of 11.9 inches.

The year's rainless season lasts 6.3 months, from November 4 to May 14. April has the least rain in Narsinghgarh, with an average rainfall of 0.1 inches.

16. AVERAGE RAINFALL DATA

Rainfall falls in Narsinghgarh from June to September, with an annual average of 923 mm. Due to upper air cyclonic circulation, this moderate rain area in Rajgarh district got exceptional rainfall of roughly 1609 mm from June 24 to July 4, 2006. The worst occurrence was the Dudhi River in Narsinghgarh, where a roughly 100-foot-long breach emerged in the check dam-cum-reservoir (Kunwar Chain Sagar) when it overflowed and water spilled out towards communities downstream. Much of the excess water was drained into the Parwati River, which runs through the periphery of Narsinghgarh.

Fig -8: News snapshot while flood

17. CONCLUSION

Based on an analysis of Google Earth pictures, substitute localities were created skirting drainage ways and water disposal bodies throughout urban growth, performing in flash flood tide occurrences in the majority of Narsinghgarh Town. Satellite prints reveal the current state of the town of Narsinghgarh's water bodies. It's easy to see that the town contains a number of lakes on its periphery and there was a system of interconnecting lakes through streamlets that dissolved during construction.

Due to the lack of sewage infrastructure in Narsinghgarh, unclean water released from dwellings and business establishments now runs alongside rainwater on the open surface. This water eventually flows into the Parvati River via drains or fills in low-lying areas. In both circumstances, it is certain to have a negative impact on the health of the nearby inhabitants. It is obvious that the municipality of Narsinghgarh will have to prioritize the development of a sewerage plan for the entire city, so that unclean water and rainwater may be collected and transported to the right location for treatment, treatment, and released into the river, or for other purposes.

Drains, pumping facilities, and treatment plants will need to be built for purposes such as irrigation or community usage. Along with this, arrangements will be made for the city's future growth.

Sewerage pipes account for about 80% of the entire length of the water delivery system. On the basis of which 38 kilometers were covered in the first phase. Pipes will have to be laid, and the second phase will cover 19 kilometers.

Before building, a risk study for high flood conditions at such specific places should be performed. Spatial vulnerability to flooding should be assessed using temporal satellite data. Long-term land and water resource planning should be done by combining traditional approaches with high-resolution satellite data, which may be useful in calculating the risk of a flood hazard and disaster management to prevent damage.

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