

SUSTAINABLE LAND USE PLANNING FOR MANAGING URBAN GROWTH IN SRI GANGANAGAR, RAJASTHAN

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ABSTRACT

Urbanisation plays a key role in economic and social development in India, its unplanned nature can generate significant pressures on agricultural land, infrastructure, water resources and the urban environment. This worry is very pertinent in Sri Ganganagar, a major district headquarters in the productive canal irrigated agriculture area. The city is a centre of administration, trade, education, health services, agricultural marketing and transport. At the same time, there has been an outward extension to the growth, which has brought conversion pressure to peri-urban agricultural land and questions about the quantity and quality of water supplies, sewerage, drainage, roads, open space and environmental protection. The present research paper focuses on sustainable land-use planning for the urban growth in Sri Ganganagar. The study has been conducted based on the secondary data obtained from Sri Ganganagar Master Plan (2017-2035), Census of India publications, report on industrial potential of the area, report on urban water supply and sewerage by the Government of Rajasthan, district reports, Agricultural report etc. The results indicate that Sri Ganganagar had a major physical growth in the period of 2001-2017. The built-up area of the city has grown from 1501.81 ha to 2741 ha and the urbanised area has grown from 2388.32 ha to 4111 ha. All residential, commercial, industrial, institutional and circulation uses rose, reflecting a widespread shift in the city's spatial organisation. The planning record also reveals that the agricultural land on the urban fringe, particularly in the south towards the Hanumangarh Padampur bypass has been under development pressure. The paper suggests that Sri Ganganagar needs to manage future development using compact and phased development, safeguarding high value irrigated farm land, urban-growth boundary, infill development, green-blue infrastructure, water-sensitive planning, coordinated planning and infrastructure investment and GIS-based system monitoring. It concludes that sustainable land-use planning should not be used to halt the growth of cities, rather it should be used to allow cities to grow without putting at risk any other important land uses, including those for agriculture and the environment.

Keywords: Sustainable land-use planning¹, Urban growth², Urbanisation³, Agricultural land conversion⁴, Peri-urban development⁵, Sri Ganganagar⁶, Rajasthan and Master planning⁷.

1. INTRODUCTION

Urbanisation is one of the key processes which is changing the geographical and socio-economic face of India. Population growth, migration, diversification of economic activities, changing housing demands, the growth of education and health services, improved mobility and rising demand for commercial space are all driving urban growth. Rural-urban linkages can create jobs, better access to services and boost regional markets[1]. Where development takes place without adequate planning however, it can also lead to unplanned settlements, traffic jams, productive farmland being lost, water shortages, drainage issues, environmental pollution and inequitable provision of public services. Rapid urban growth and urban expansion into rural areas therefore requires sustainable land use planning. It aims to plan land for housing, economic, industrial, recreational, public facilities and environmental protection purposes in a balanced way[2]. The overarching purpose is to make urban development as space efficient, socially inclusive, environmentally responsible and economically viable as possible. In the context of cities in agricultural productive areas, sustainable land-use planning is particularly crucial as cities may expand at the expense of agricultural output and impact on rural livelihoods (Asian Development bank, 2013)[3].

Sri Ganganagar is one of the important urban centres in north Rajasthan. It is the administrative, commercial, educational, health-care and agricultural-market headquarters of the district of Sri Ganganagar. The city and the district have a historical association with canal irrigation, especially with the Gang Canal system. This water was used for canal irrigation and enabled a vast area to be cultivated and settlements, markets, transport and agro-economic activities to develop[4]. The district has a rich agro-cultural heritage with wheat, cotton, mustard, guar, rice, gram, sugarcane, kinnnow and other agricultural produce (Census of India, 2011). The management of urban growth is especially important because of the agricultural importance of the area. According to the industrial potential survey conducted in Sri Ganganagar, the area under cultivation and irrigation is huge in the district[5]. Sri Ganganagar is also one of the major districts of the state in terms of net irrigated area as per agricultural statistics of Rajasthan. Therefore, the land around the city is not only unoccupied fringe areas. Agricultural value, livelihood value and strategic importance for the regional economy to much of it[6].

The city of Sri Ganganagar has grown in the wake of population increase, housing needs, commercial development, institutions, transportation connectivity and as a service centre. Sri Ganganagar Master Plan 2017 2035 states that the city has expanded beyond the previous planning anticipations in certain directions. It shows the development of agricultural land into residential/commercial uses in south peripheral areas approaching Hanumangarh-Padampur bypass[7]. This pattern is an example of the conflict between urban growth and maintaining productive land. In the present study, the role of sustainable land-use planning for the management of urban growth in Sri Ganganagar, Rajasthan is analyzed. It is based only on secondary data and planning evidence in documentation. It looks at the context of urban growth, the shift and stress of land use, pressure on agricultural land, infrastructure and environmental considerations, and planning solutions needed to create a more sustainable urban future (Department of Town Planning, 2021)[8].

2. METHODOLOGY

2.1 Nature of the study

This study is descriptive and analytical. It is based solely on secondary data. There is no primary survey, interview, field observation, questionnaire or direct measurement conducted. Secondary data are used in the study where appropriate because the study is based on documented patterns of urban growth, land-use information, planning provisions, context and infrastructure issues already reported by public agencies and institutional sources[9]. The analysis is conducted on the urbanising fringe of the city of Sri Ganganagar and the city itself. District-level data used to give context to the overall agricultural and economic landscape to which the city belongs. The study is not designed to estimate land conversion on the parcel level or socio-economic impacts on the household level. Instead, it sifts through the official planning evidence and published data to create a sustainable planning framework[10].

2.2 Sources of secondary data

The primary data source for this study is Sri Ganganagar Master Plan 2017-2035 prepared as per the Rajasthan urban-planning system. This document provides a description of the city's history, population change, current land use, future urban population, city planning boundaries, proposed land-use structure, circulation network, public facilities, environmental conservation and development-control provisions (DIC, Shri Ganganagar, 2017-2018)[11].

2.3 Other secondary sources are the following:

- District level data on population and urbanisation context from Census of India.
- The government of Rajasthan surveys for industrial potential and export potential of Sri Ganganagar district, which includes details on land use, cultivated area, irrigation, major crops and agriculture-based economy.
- Rajasthan agricultural statistics are used to get information related to irrigated land and agricultural importance of the district.
- Asian development bank and Rajasthan urban infrastructure development project documents related to water supply, sewerage and urban service improvement of Sri Ganganagar.
- Government reports and policy documents related to urban planning, environmental management and sustainable development.

2.4 Method of analysis

This study adopts document review and comparative interpretation techniques. Current land-use data from the Master Plan 2001 and Master Plan 2017 have been analysed to gain insight into the nature of urban growth. Changes in the use of residential, commercial, industrial, public and semi-public, recreational and circulation uses are analysed. It also reviews the references to peripheral development on agricultural land in the Master Plan. The study also provides an interpretation of urban form and infrastructure. This encompasses the consequences of expansion to the outside, related to water supplies, sewerage, drainage, transport, open space and environmental quality, solid waste management. With this interpretation, recommendations on sustainable land use strategies for Sri Ganganagar are suggested.

2.5 Limitations of Study:

The study, however faced some limitation as secondary data was used. As detailed in the reviewed Master Plan, the existing land use comparison that is available is for the year 2001 and 2017. The paper thus refers to 2017 as the most recent detailed benchmark in the planning document, and the projections of the plan for 2035 are considered future planning estimates and not facts. On average, the study does not take into account satellite images or cadastre maps to estimate the total area of land used for agriculture that has been turned into another use each year. It also does not carry out surveys of the households to gauge the experience of farmers, tenants, agricultural workers, developers or residents. These zones may be investigated in the future with primary data, through GIS-based analysis of land use change.

2.6 Urban Growth Context of Sri Ganganagar

Sri Ganganagar is located in the north of Rajasthan and is an important regional urban centre. It is closely associated with the canal development as well as the agricultural development of the district. The Gang canal was followed by other irrigation systems and the region became one of the essential fields of the agriculture in Rajasthan. This base of agriculture was responsible for the development of mandi activities, agro-processing, transportation, warehousing and related service sector activities (DIC, Shri Ganganagar, 2020)[12]. The city is more than just about farming. It is the administrative centre of the district, having government offices, educational institutions, hospital, commercial establishments, transport services and other public services. People living in nearby rural areas rely on the city for administrative services, higher education, health services, shopping and access to markets. This is a role that is necessary for the city and the need for land is constant[13].

The overall climate of the region is hot and dry. Water management, shade, vegetation, and drainage and climate sensitive design are of significant importance, especially in the summer when temperatures are high and rainfall is limited. Water and environmental planning is interwoven with land-use planning in a dry-region city. Expansion and development in peripheral areas require appropriate water supply, sewerage and drainage provisions, and road access and public facilities[14]. Otherwise, there may be unserved colonies and high long term costs for the municipal system. The population of Sri Ganganagar (in the Municipal area, outer-growth areas and identified urbanising villages) was estimated at 273,784 in 2011 as per the Master Plan. The plan estimated that there would be approximately 545,000 people by 2035. The city will require more residences, businesses, schools, clinics, water, transportation, recreational areas, and public facilities if this projection is realized[1].

The Master Plan suggested a large Urbanisable area in order to cater to the future demand. The availability of land, however, should not only be taken quantitatively. The location, agricultural potential, water supply, drainage condition and the sensitivity and infrastructure cost of land must all be taken into account when urban development is planned. What may be convenient for speculative real-estate development is not necessarily appropriate for sustainable city building[2]. Peri-urban areas in Sri Ganganagar are emerging as critical locations of change. In such locations, agriculture, isolated dwellings, new settlements, businesses and transport routes can all be found. A landscape of transition can be a place for opportunities and some form of conflict. Higher prices will be offered to landowners and uncertainty to farmers and agricultural labourers and tenants. Meanwhile the city's limited

resources can be a constraint on offering roads, drainage, water, sewerage and solid-waste services to the fast-growing outer suburbs[3].

3. RESULTS AND DISCUSSION

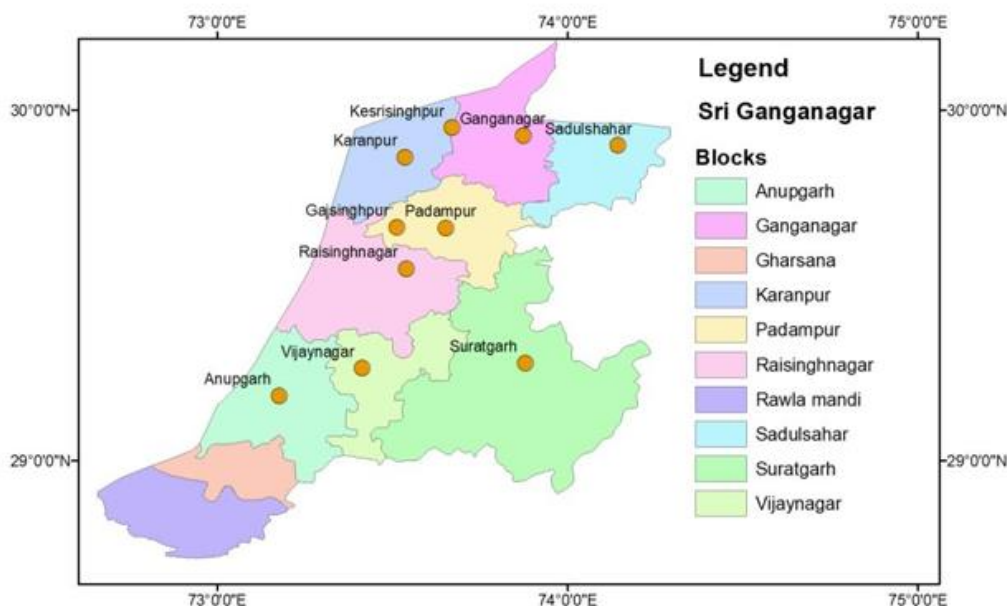
3.1 Pattern of Urban Expansion

The secondary data available reveal that Sri Ganganagar has experienced significant physical growth. According to the Master Plan, the urban area of the city has grown from approximately 1,501.81 hectares in 2001 to approximately 2,741 ha in 2017. The area of the urbanised area grew from about 2,388.32 ha to about 4,111 ha over the same period. The numbers suggest that the urbanised and built-up area of the city grew significantly over a fairly short timeframe[4]. This growth was not confined to the residential land. Commercial or industrial, public and semi-public, recreational and circulation uses also grew, while developed land was still the biggest use for residential. It means that Sri Ganganagar is becoming more and more functional diversified. It is growing as a settlement and also as a hub of trade, service, institutions, transport and economic activity[5]. The city is a market and service centre for the surrounding rural area, as evidenced by the growth of commerce. Small Scale industries, Argo based activity, Storage, processing & allied activities are associated with industrial growth. The rise in public and semi-public uses reflects a rising demand for education, public health services, administration, community facilities and public utilities. Roads and movement networks need to link new and existing urban areas, which is reflected in the expansion of circulation land (Government of Rajasthan, 2019)[6].

This is an indicator of urban development; however, it also poses a planning problem. Land uses may be expanded without coordination, leading to a spatial fragmentation of the city. New colonies can form before infrastructure, commercial strips might grow along key roads, and agricultural land can be transformed and fragmented. This situation hampers efficient delivery of public service at high cost[7]. The Master Plan acknowledges that urban development had gone beyond the initial intentions of the plan. It states that in some directions the urbanisation boundary was reached in the city while in the southern parts towards the Hanumangarh Padampur bypass development had occurred on agricultural land. This indicates that planning provisions are not the only factors affecting urban expansion; land availability, road access and private development and market demand have also played a role[8].

3.2 Urbain farming land in pressure

Sri Ganganagar district is important for agriculture due to the large amount of canal irrigation. According to government reports cultivated area is big, double cropped area is big and the level of irrigation is high. Crops grown are wheat, cotton, mustard, guar, gram, rice, sugarcane, horticultural crops such as kinnow and others. Agriculture is not only a livelihood of the agriculturist family, but also the agricultural labourers, mandi activities, transport workers, traders, storage facilities, and agro processing enterprises[9].



District map of Sri Ganganagar

Urbanization on agricultural land has broader impacts than merely the change of one land use to another. A productive farm is a constant source of food, income and employment. The land is usually permanently lost for cultivation after being developed into residential plots, commercial buildings, roads or institutions. For some landowners, the immediate sale price for the land might have a substantial impact, but the earning potential of agriculture might be diminished over time (Government of Rajasthan, 2020). As per the planning record, there has been some pressure for agricultural land in the southern peripheral zone[10]. The conversion is likely to take place near big roads, bypasses, market corridors and adjacent to existing urban development as these are attractive to developers and buyers. Predictive and speculative conversion can lead to leapfrog development. Isolated colonies are constructed in leapfrog development beyond the continuous edge of towns, with gaps in between or agricultural land. The pattern of land use is rapid, and roads, water, sewer, electricity, public transport and emergency service infrastructure becomes more expensive[11].

This is a problem especially in canal irrigated areas. Land that's irrigated via canals may carry a value other than agricultural and that can't be readily recognized in a standard real-estate evaluation. Canals, distributaries, field channels and drains are components of a larger production system. Construction projects that are not planned close to such systems may disrupt natural drainage, limit access to services and maintenance, raise pollution potential, and generate conflicts between agricultural and urban water uses[12]. Urban growth needs to then differentiate between the various agricultural land types. The most productive and contiguous agricultural land should be more protected than the less productive land, and the better connected to existing urban infrastructure. This doesn't imply there is no land that can ever be used for agricultural purposes. It implies that the process of conversion should be selective, based on long term public interest and not on short term speculation (MoHUA, 2015)[13].

3.3 Environmental impacts of land use and land cover change

The process of urbanisation alters the local environment by replacing soil and vegetation with buildings, roads, paved surfaces and other built structures. Sri Ganganagar is also experiencing a decrease in open spaces and vegetation cover, which can intensify heat stress, especially during the summer months. Urban development absorbs and holds heat while less tree cover will provide less shade and cooling. This urban heat discomfort can impact health, energy consumption and outdoor activities[14]. Loss of agricultural land also diminishes the ecological roles of open land. Agricultural areas could contribute to groundwater recharge, native wildlife, wind flow, and seasonal water uptake. While farming practices can also place stress on the environment through the use of chemicals or water demands, the conversion of land to impervious urban surfaces can have a different type of stress including increased run-off, duration and/or congestion of drainage and heat accumulation[1].

Another worry is disposal of waste. The collection, transportation and processing of solid waste become more difficult as the residential and commercial growth radiates outwards. Irregular collection of colonies, roadside dumping or disposal in vacant colonies or drains may occur in peripheral areas. These practices impact on the health of the public, visual quality and drainage efficiency (RUIDP, 2017)[2].



Figure 1: Field view of solid waste site of Suratgarh, Sri Ganganagar

The expansion of urban development away from the central area and public services can also lead to an increase in traffic and air pollution. Long distance of travel promotes private car use. When commercial development is

allowed to take place as unchecked ribbon development along roads it can cause congestion, slow traffic and reduce safety[3]. Hence, there is a need for land-use planning to be aligned with mobility planning (UN-Habitat, 2015). Green and open spaces are important responses to these environmental pressures. Canalside green corridors, roadsides plantations, community gardens and protected open spaces, as well as parks, urban forests all can contribute to heat reduction, air quality improvement and more liveable cities by providing recreation[4]. The allocation of recreational and plantation spaces and environmental conservation in the Master Plan should be enhanced by providing clear implementation targets, maintenance responsibilities and neighbourhood-level levels of access[5].

3.4 Socio-economic implications

Urban growth has mixed socio-economic impacts. On the other hand, it can lead to employment opportunities in construction, retail, transport, education, health services, real estate, and hospitality and small-scale industry. Can enhance land value and provide opportunities to landowners around growing urban areas. It can also enhance access to schools, hospitals, markets and public services[6]. However, inequality can be caused by land conversion, too. While landowners might be paid large lump sums for the selling of their agricultural land, agricultural workers, tenants, sharecroppers and others who rely on agriculture do not necessarily benefit in a similar way[7]. There are households that do not have the skills or resources to move out of rural to urban livelihoods. Small farmers might not be able to afford to sell all their land but might be left with reduced viability even when land is fragmented[8].

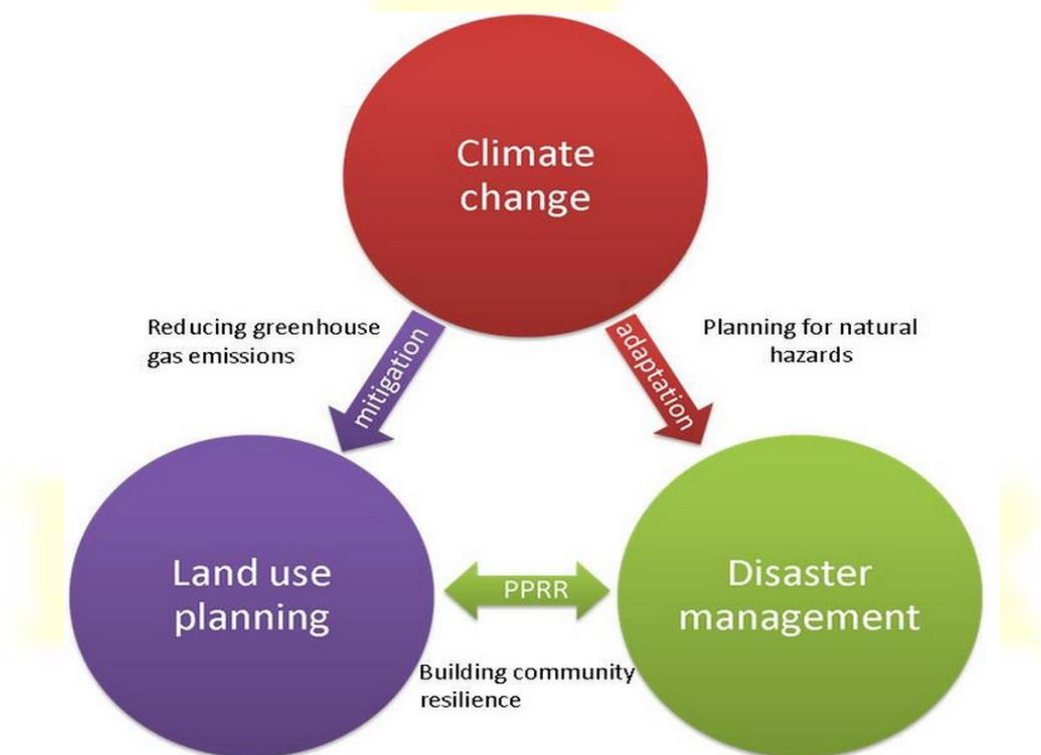


Figure 2: Framework for linking climate change with land use planning and disaster management

Escalation in land prices is another worry. If peri-urban land is becoming more desirable for real-estate development, housing prices may increase. Poorly serviced or informal settlements may be forced on the lower income households. Hence, sustainable land use planning must take into account the provision of affordable housing, rental housing, serviced plots and inclusive infrastructure[9]. High income housing or speculation should not be the only influences on urban development (Kumar, 2025). The agriculture identity of the city must also be regarded as regional economy asset. Sri Ganganagar's agricultural economy is able to cater to agricultural markets, storage, transport, processing, repair and input suppliers, trade networks[10]. Conservation of productive farmland close to the city, can be a way of sustaining this economic link. Thus, the goal of land-use planning should be to create urban-rural complementarity and not to regard agriculture and urbanisation as two distinct systems[11].

3.5 Evaluation of the Master Plan 2017-20235

Sri Ganganagar Master Plan 2017-2035 is a significant formal plan for urban development. It defines planning zones, future provision of land uses, road networks, public facilities, recreation areas, mixed uses and environmental considerations. It also acknowledges population growth and attempts to ensure adequate area is available for future urbanization[12]. One of the key advantages of the plan is that it recognises the city's outward expansion and the need to manage this. It includes provisions related to perimeter control, development along major roads, public and semi-public facilities, plantation, water conservation and environmental protection. These factors are vital to sustainable urban planning. ut a master plan can only be considered successful if implemented[13]. A plan might designate land but if development happens in places other than where it is planned, if infrastructure does not keep up, if there is poor enforcement, or for reasons of agriculture and environmental protection, if such protections are only general statements, then the plan can become unsustainable (Lavasa, 2025)[14].

Phase development is the first requirement for implementation. It is not advisable to urbanise all future potential development areas simultaneously. It needs to focus on land areas near already served neighbourhoods and open land up incrementally. This will promote a compact structure and minimise the risk of speculating[1]. The second one is more robust development regulation. The following approvals should be tracked digitally: layout approval, building permissions, land conversion, road access, drainage and utility connections. The decisions of the Urban Improvement Trust, the municipal council, the revenue authorities, the water and electricity agencies should be coordinated. Early detection of an unauthorised colony and/or construction in an area where it is not allowed is preferable to regularisation once infrastructure issues have arisen[2]. Thirdly, there is explicit protection of environmental and agricultural sources. The detailed maps included on the Master Plan should include identification of high-value agricultural land, buffers around canals and drains, inundation areas, open space networks, recharge areas and ecological corridors. There should be obvious limitations on development in these areas[3].

3.6 Sustainable land-use for Sri Ganganagar

Areas of vacant or under use or partially developed land within and near the existing serviced areas should be the first choice for new development. Water supply, sewerage, drainage, roads, public transport and public facilities

availability should be taken into consideration when planning peripheral expansion. This will help in minimizing the scattered development and enhance the efficiency of infrastructure investment[4]. Irrigated and/or highly productive urban agriculture should be identified and conserved with an agricultural-land overlay. Conversions of this type must be kept to a minimum and be adequately justified[5]. Strategies should focus on conserving large contiguous areas with viable farming operations and canal irrigation schemes (Sreelekha, 2026). An urban growth boundary should be clearly delineated and differentiate areas for short-term urban development from agricultural and rural areas. Plotting and ribbon growth outside this boundary should be limited. It is important to revisit the boundary periodically due to changes in population, infrastructure and environmental assessments[6].

The city should promote the use of unused serviced plots, unused land and unmaintained buildings instead of new peripheral land opening[7]. Some incentives might be streamlined approvals, infrastructure support, redevelopment guidelines and appropriate floor-space. This can allow for growth without the need to change the land use for agriculture[8]. The approval of any large residential, commercial or institutional project must be accompanied by verified provision of water supply, sewerage or wastewater treatment, storm-water drainage, roadways, solid-waste management, electrical and emergency access[9]. If there is added demand in the off-site infrastructure, then developers should be responsible for a fair share of the cost of that infrastructure[10].

Low areas, drains and distributaries and canals should be considered as critical urban infrastructure. Buffer zones need to be used for controlling construction. As far as possible these corridors may be natured as green-blue infrastructure plantation, walking paths, recharge and flood-management spaces. No encroachment and dumping should be allowed. Sri Ganganagar is in need of more than just individual parks[11]. It needs a network of greened neighbourhoods, road-side plantations, canal-side green belts, school grounds, public open spaces and urban forests as an interconnected green network. This infrastructure can help minimize heat stress, increase recreation, help to support biodiversity and enhance the visual environment of the city (Urban Flooding: Case study of Shri Ganganagar, 2025)[12].

Every new layout should have rainwater harvesting and stormwater management, a tree plantation, water saving landscaping and in the event of possible treated wastewater re-use. Water distribution needs should be metered and leakages should be prioritized. It is particularly important to implement these measures in a dry climatic region. We need to encourage pedestrian-friendly zones and facilities for cycling, as well as public transport links, to support residential expansion[13]. Travel distances can be minimised in a mixed-use neighbourhood. There should be access-control measures to prevent uncontrolled ribbon development and road-safety issues on major roads and bypasses. The city should keep an up-to-date GIS database of land use, approved layouts and building permissions, utilities, drainage, green spaces and agricultural areas. Early detection of unauthorised conversion can be achieved using satellite imagery and digital land records. Planning review needs to incorporate the perspectives of farmers, residents, civil-society organisations, developers, traders, experts and local elected representatives, with a focus on incorporating both growth and resource protection considerations[14].

4. CONCLUSION

Sri Ganganagar is undergoing a significant process of urbanization. It has become a district headquarters, an agricultural-market centre, a service hub and a regional commercial centre and this is what is fuelling its growth.

The second data sources analysed during this study reveal significant growth in the city's built-up and urbanised areas from 2001 to 2017. All land uses grew, including residential, commercial, industrial and institutional and circulation. This growth is attributable to the growth and functions of the city, but it also puts pressure on the productive agricultural land around the city. The challenge is particularly important because Sri Ganganagar is located in an agricultural area irrigated through canals. The urban area is surrounded by land that is able to be cultivated, and areas for farming, agricultural markets, transportation, storage and agricultural-based economic activities. Converting fertile land to the urban fabric can provide short-term economic benefits, but, if uncontrolled, this can have negative medium- to long-term implications for the agricultural base of the region and for environmental and infrastructure demand loads in the city. It reveals that unplanned peripheral growth can bring about fragmented land use, leapfrog colonies, high costs of extending infrastructure, drainage issues, water stress, reduction in green cover, dependency on traffic, and social inequality. As can be seen from the planning record, such pressures are already observed in some fringe areas such as the southern direction towards Hanumangarh Padampur bypass.

Plans for sustainable land-use provide a means of addressing these issues. Future development in/around Sri Ganganagar should be focussed on the contiguous and serviced areas, infill and redevelopment, protection of high value irrigated farmland, setting up an urban growth boundary, linking approvals with infrastructure capacity, conserving canals and drains, developing green-blue infrastructure and enhancing GIS monitoring. These measures are based on the Master Plan 2017 2035, but will require an approach of sequential implementation, institutional coordination, clear enforcement, and public engagement to achieve effective results. While urbanization is a key to Sri Ganganagar's future growth, it should be carried out in a way that maintains the agricultural productivity, water resources and environmental quality of the area. A planning process that prioritizes infrastructure, agricultural land use, and is compact can assist the city to develop in a more equitable, resilient and sustainable direction.

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