1. SCOPE OF RESEARCH

1.1 Introduction

Housing embodies many concepts such as comfort, safety, identity and above all, it has central importance to everyone's quality of life and health, with considerable economic, social, cultural and personal significance. Access to safe, healthy shelter and basic services is essential to the overall (physical, psychological, social and economic) well-being of a person. It is also a critical component in the social and economic fabric of all nations. No country is yet satisfied that adequate housing has been delivered to the various economic groups that make up its populace. It persists globally as a problem irrespective of the economic status of the countries, but differs in its nature and gravity. Homelessness is the most visible and extreme form of this and often connected with lack of basic facilities like drinking water, drainage and sanitation. It is estimated that there are more than hundred million homeless, having absolutely nowhere to live, and about one billion people inadequately housed throughout the world. Overall, at least six hundred million people live in shelters that are life threatening or health threatening in developing world cities (Tipple et al., 2005, UN 2005, Erguden, 2001, UNCHS 1996,). These figures are rough estimates, as measuring global homelessness is extremely difficult. Most data are known to be undercounts, relying on service provider statistics that do not include the entire homeless population. In addition to the difficulties in counting mobile and hidden population; the data collection on global scale is impeded by inaccurate and limited or non existent data collection in many countries and variation in the definition of homelessness. Anyhow, it is clear that the current and worsening global shelter situation needs serious concern. The persistence and growth of poor shelter conditions, particularly in the developing countries, is a stumbling block to socio-political stability and economic development (UNCHS, 1990). It urges the need for scaling-up housing supply and has become a focus of policy debate. A holistic approach is imperative to assess the housing demands, analyse the issues and solve the problems of those people who are not able to afford their housing due to lower economic status and inaccessibility to common property resources.

Housing has widely been acknowledged as a human right rather than being a basic need. Since the adoption of Universal Declaration of Human Rights* in 1948, the human right

* "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing, medical care, necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control." (Article 25(1), Universal Declaration of Human Rights).
to adequate housing has been repeatedly reaffirmed (UNCHS, 2000). The Millennium Development Goals have identified improving housing conditions as an integral part of the global development agenda (UN, 2005). It is recognized that adequate shelter for all and sustainable human settlements development cannot be isolated from the broader social and economic development of countries. Also they cannot be set apart from the technological advancements and environmental protection. All these factors are indispensable and mutually reinforcing components of sustainable development. Inadequate and insecure shelter will lead to social and political instability and will hamper economic development. In this sense, global shelter conditions are closely linked to the achievement and maintenance of world peace and economic stability. The economic and political self-reliance, social justice, and an environmentally sound quality of life are factors, which lead to sustainable development.

1.2 Housing situation; issues and concerns

Human settlements problems are of a multidimensional nature. They vary even from individual to individual, rural to urban, and obviously from country to country both in terms of quantity and quality. The unmet demand for housing, along with poverty, has led to the emergence of slums in many poor countries as a solution to affordable housing for low-income people. This is particularly true in third world countries where the majority of the housing activities are being done by acquiring land through purchase or invasion. In such cases, poor people with limited income and know-how construct their own houses with available resources, and gradually improve the structure in due course of time. As a result in most cases, the quality of housing is miserable with insufficient basic services, unhygienic surroundings, lack of access to safe water and proper sanitation. Hence quantitative housing deficits in most countries (even very poor ones) are relatively small, suggesting that the housing problem is largely qualitative rather than quantitative (World Bank, 2005).

The housing problem of low-income countries differs greatly from that experienced in developed economies, and further rural and urban housing also exhibit their own peculiar characteristics. There is a number of constraints that slow down the housing development programmes and the development of a sustainable habitat. Lack of effective implementation strategies, inadequate supply of affordable land and infrastructure, inadequacy of housing finance systems are a few among such constraints. Inadequate access to affordable building materials is one of the major limitations of the poor in developing countries to provide adequate housing for them. Out of the total cost of house construction, building materials contribute more than fifty percent in developing countries like India. The gap between the rising demand and the stagnating, and in many cases declining, production levels is widening at an alarming rate, leading
to the spiralling of prices of building materials in many developing countries, seriously affecting the affordability of housing for the vast majority of the population (UNCHS, 1993). Along with these, the depleting resources and energy consumed during extraction, processing and transportation of raw materials is another serious concern questioning the sustainability of building process.

1.2.1 India

The housing situation in India was not so much aggravated in the beginning of the twentieth century. According to the census records there was a surplus of 1.8 million houses in 1901. This continued till 1941. The Second World War totally changed this situation. It became worse in 1947. About 7.5 million of displaced persons migrated to India, owing to the partition of the country into India and Pakistan (First Five Year Plan (1951-56) document, Government of India). Fig. 1.1 shows the variation in the housing gap over the last fifty years.

![Figure 1.1 Housing gap in India during the period 1951-2001](image)

The latest census reports of India shows a housing deficit of twenty-two million housing units. Nearly half of the existing housing stock (48.2%) is either made of non durable or temporary materials and the housing problem is even bigger in terms of quality than quantity (Government of India, 2001). Every two out of the five households in India live in extremely poor quality houses. The World Bank's recent human development report says that 32% of the total population in India has still no access to improved sanitation and 14% has no access to safe drinking water (World Bank, 2005). Also the slum population in India (42.6 million people) accounts for 15% of the total urban population. In such cases, people themselves with little or no assistance from public
agencies build shelters, which are even devoid of basic amenities. The situation in the rural areas is also not better.

Rapid population growth (Table 1, Appendix 1.2), increased urbanization, relatively low investments in housing and widespread poverty have created serious shelter problems in India. Population growth and urbanization trends have a profound impact on people’s access to shelter, contributing to the proliferation of slums, increased demand for infrastructure and services, and declining quality of life for the poor. Additional key factors that have aggravated India’s critical housing situation include institutional deficiencies, especially among state and local housing agencies, and regulatory constraints to new housing development and investment such as the Urban Land Ceiling (and Regulation) Act of 1976 and the state rent control acts (ADB, 2000).

The strategy for rural housing in India is based on the observation that housing activity in rural areas is based on land rights and access to resources, and not on the cash economy (Government of India, 199X). The shelter problem, having a multidimensional nature with its main roots in poverty, seems to be aggravated by the scarcity and inaccessibility to common property resources, inadequate institutional capacities and legal and financial frameworks.

1.2.2 Kerala

Kerala, situated on the south-west coast of Indian sub continent (see Appendix 1.1 and 1.2 for general and topographic details), is well ahead in the field of social development and better living conditions compared to other parts of India. Over the past couple of decades, Kerala has drawn both international and national attention for its achievements in demographic transition, with fertility reaching below the replacement level and mortality under five. In terms of per capita income and production, Kerala with an agrarian economy is lagging behind many of the Indian states. However, in terms of Human Development Index (HDI) and life standard of people, Kerala is much ahead of most of other states in India (Tables 3, 4, Appendix 1.2). It is also one of the densely populated states (819 persons/ sq.km) with 3.43% of the total Indian population. The high population density of the state may be mainly due to good climate, fertile land and good rainfall. Literacy as a qualitative attribute of the population is one of the most important indicators of socio-economic and political development of a society. The state’s achievements in literacy (90.9%), education, birth rate (0.94) etc. are even comparable to many of the developed countries. Table 5 (Appendix 1.2) shows a comparison of Kerala situation with few neighbouring countries.

The housing situation in the state is quite different from other parts of India. Kerala has got a unique settlement pattern with the dwellings made in individual plots and scattered
all over the habitable areas. This is in striking contrast with the nucleated village system prevalent throughout the rest of India. The public housing schemes implemented in Kerala showed greater performance in terms of the magnitude of investment and physical achievements and could considerably reduce the housing gap. The official estimates predicted that if the present trend in house construction continues, by the year 2006 all people in Kerala would have their own houses (Government of Kerala, 2003). However, a closer inspection of the current housing situation in Kerala reveals another side of this picture. Despite many positive advances, visible slum-like areas occur in human settlements in rural parts of the state, and many inhabitants are deprived of basic facilities like drinking water and sanitation (Gopikuttan, 2002).

![Figure 1.2 Housing gap in Kerala during the period 1961-2001](image)

Traditional residential buildings in Kerala show a reflection of the socio-economic inequalities in the society in the early days. Rich people, mostly belonging to the higher castes were living in palatial buildings, but the houses of the poor people were in miserable conditions. Only the people belonging to higher castes were able to utilize the services of artisans and craftsmen for the building process. However, the poor used to help each other in putting up their shelters by using locally available materials. No wages were paid other than food. But during the period from early 1970s, the situation started changing. Social reform movements and economic changes in the society wiped off the ill effects of caste systems from the society. This was also visible in the housing situation. People started building palatial houses using the readily available, energy intensive materials like concrete, cement, and bricks replacing the indigenous materials such as mud, laterite, thatch etc. This generated changes in the employment sector and the wage structures, especially in the rural areas. But this modern technology with its
undue stress on costly and energy-intensive materials like steel and cement was beyond the reach of the majority of the population. In order to overcome these problems for solving the urgent housing demand, the Government of Kerala promoted cost-effective construction techniques and innovative materials. However, the present housing situation in Kerala shows that the public housing schemes could not solve the housing problems of the poorest sections in the rural areas. Also, the “Cost Effective and Environmentally Friendly” (CEEF) technology, which was actually meant for helping the weaker section, seems to have failed to reach the expected beneficiaries (Gopikuttan, 2004). This may be due to the inability of the poor in getting the awareness, non-availability of skilled labour, technical assistance, etc., on this technology. It can also be due to the mismatch in the perceptions of the poor and the government. Further, it seems that government intervention has aggravated the dependence and diminished the self-reliance of the rural poor (Glaeser, 1995).

In addition to this, housing and other related development activities have created severe environmental problems in Kerala. Long stretches of paddy fields are now kept barren or used for clay mining or developed as house plots in the state. This has created serious environmental issues in the neighbourhoods such as water logging, inadequate drainage facilities, non-availability of drinking water, etc. This also resulted in the decline of more than half a million hectares of area under paddy cultivation during the last two decades (Government of Kerala, 2004). Conversion of paddy fields means abandoning a highly developed and complex wetland agro ecosystem and hence affecting the environmental balance.

Conservation and effective use of renewable and non-renewable resources is a prime concern in the building process. Building materials constitute more than half of the total construction cost for an average residential building in Kerala. A substantial part of this is the cost of cement. A sustainable alternative to cement could provide a significant contribution towards the provision of low-cost building materials, and consequently to affordable shelter. An approach to affordability along with addressing environmental concerns could be a better alternative. The potential of rice husk ash; an agricultural waste from paddy, as a cement replacement material has significance in this context as an affordable and environmentally friendly building alternative.

The problem of housing in Kerala can be characterised mainly as a problem of sustainable housing rather than quantitative deficit. Causes could be either due to:

Policy aspects
- Lack of proper housing policies or implementation,
- Lack of access to resources, lack of infrastructure and facilities,
- Lack of local government controlling and monitoring.
- Lack of networking among institutions engaged in housing,
- Non-accessibility for easy finance,
- Lack of proper housing guidance, standards and specifications or

Technology aspects
- Unavailability of affordable materials,
- High cost of materials and skilled labour,
- Unawareness of cost reduction techniques,
- Improper usage of available technology,
- Blind usage of conventional (modern) materials,
- Lack of trained and skilled labourers) or a combination of both.

This situation hence urges the need of a closer evaluation on the various factors preventing the poor households from satisfying their housing needs in the midst of increased public interventions and favourable environment.

1.3 Significance of housing in sustainable development

Housing activity is very closely linked to the macro-economy. Investments in this sector not only improve and add to the existing stock of housing units, but also improve the working and living conditions. It generates a significant share of employment-typically around 9% worldwide-and often helps lead national economies out of recession as it did in the United States in 2001 and 2002 (Ferguson et al., 2003). In India, the National Building Organization has estimated that an investment of Rs.10 million (about US$1 million) in building construction at the 1980-81 wage rate generated 624 work-years in on-site employment (420 unskilled and 204 skilled) and 1000 work-years in direct employment in the building material industry and other supporting sectors (Moavenzadeh, 1987). Like all other development activities, housing has also got a monetary and subsistence component. Even if it is a self-help or family activity in rural areas, it needs building materials, tools and skilled labour as input factors. Besides creating an individual product, the new or repaired shelter and the combined input factors also contribute to national product and thus increase the overall national wealth.

Housing has a crucial role in the development of human settlements. Protection and conservation of the environment need serious concern during and after the building process. Sustainable construction is a holistic process aiming to restore and maintain harmony between natural and built environments, and create settlements that affirm human dignity and encourage economic equity (CIB and UNEP, 2002). Hence
sustainable housing development also needs environmentally-friendly technological innovations.

Improving shelter requires a better understanding of the mechanisms governing housing availability. That requires better data and better policy-oriented analysis, so that housing policy can be formulated in a more global comparative perspective, and the accomplishments and lessons learned in one country can be drawn on by others. This comparative perspective can help countries chart their paths, formulate realistic development objectives, and measure their achievements over time and compare them with other countries in similar circumstances (World Bank, 2005). The efficient supply of housing is also closely associated with sustainable-affordable construction techniques and building materials; therefore these processes need to be studied in an integrated way.

1.4 Research objectives

In the context of the above discussions, the main goal of this thesis is to contribute to a more sustainable solution to the present housing problem in developing countries. In order to address this objective and to conceptualize the problem from the perspective of the households a thoughtful and holistic approach based on the concepts of sustainability is needed. The objectives of this research can therefore be listed as follows.

1. To develop a better understanding of the present housing situation and the problems relating to sustainable human settlements in developing countries, based on an integrated approach that combines both the perspective of the households (users), and as well as the concept of sustainable development.

2. To develop and test a methodology based on this new integrated perspective to evaluate the success and failure factors of public intervention in housing the poor, and to suggest appropriate recommendations to contribute to public policies for sustainable development.

3. To adapt and apply this integrated approach in the evaluation of the building process, to suggest modifications and to explore a few sustainable technologies appropriate for the local conditions, utilizing renewable or locally available waste materials.

In order to reach these objectives, research questions are formulated and presented in the succeeding section.
1.5 Research questions

The housing situation in Kerala has been selected as the main focus of this thesis. Since the prime objective of this research is to develop a holistic perspective for identifying the problems relating to shelter, the main question has been formulated to achieve this goal in the context of Kerala.

Main question
How to develop an integrated framework for analyzing (both for the evaluation of policy and building process) the housing problem of the poor (from their own perspectives), and what sustainable materials or technological options can be suggested along with policy recommendations for achieving sustainable-affordable housing in Kerala?

Sub questions
1. How can the housing problems be evaluated from the perspective of the users, in such a way as to contribute to sustainable development?

2. What are the various policy approaches in the previous years in India (Kerala) in addressing the shelter problems of the poor and how far have the different schemes been successful in achieving sustainable housing development?

3. What is the real housing situation of the poor households in Kerala and what policy recommendations can be proposed (particularly for the economically weaker sections) for sustainable-affordable housing so as to contribute to sustainable development?

4. Does the present building process in Kerala contribute to sustainable housing? If not what are the recommendations for modifying it?

5. How could rice husk ash pozzolana be developed locally as a sustainable alternative to replace cement for the primary building applications in Kerala?

1.6 Methodology and chapter scheme

This thesis has adopted both social science and technology approach in reaching different objectives. In total there are seven chapters. This is illustrated in the figure (Fig. 1.3). Literature review, personnel interviews and household surveys are conducted
in the first part and experimental technical research has been carried out in the second part. The succeeding text describes the methodology adopted for each chapter.

**Figure 1.3 Thesis structure**

**Chapter 2** - This chapter explores the concepts of sustainable-affordable housing and introduces a general conceptual framework to evaluate the housing situation from the perspective of the users. This framework helps in understanding the problem from the perspective of the households specifically in terms of their basic needs and suggests solutions that contribute to sustainable-affordable housing.

**Methodology** - A literature survey has been carried out for exploring the concept of sustainable-affordable housing. Value focused thinking proposed by Keeney (Keeney 1992; Keeney et al., 2005) has been used in this chapter for structuring objectives and developing the framework. Various findings from notable researchers were also utilized at this stage of research for structuring and defining the objectives of sustainable-affordable housing.

**Chapter 3** - This chapter presents an evaluation of the public housing policy for Economically Weaker Sections (EWS) in the state. Three schemes (One Lakh Housing Scheme, Indira Awaas Yojana and Total Housing Scheme) are identified from each phase reflecting similar approaches in international housing policies, their uniqueness in implementing agencies and other peculiar characteristics. The evaluation of these schemes was done in three stages. The first two stages of analysis (A I and A II) are presented in this chapter. Analysis I (A I) evaluate the goals of the government policies in the selected schemes. The second stage (A II) assesses the real situation in the field from the viewpoint of an observer (the researcher). An overview of the evolution of housing policy in the developing world, subsequent changes in the low-income housing

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1 Families with monthly household income less than Rs. 2500 ($65)
policy of India with specific attention to the case of Kerala are also discussed in this chapter.

Methodology - A methodology based on the conceptual framework from chapter 2 is employed in the analysis to understand the problem through a sustainability perspective and to investigate the success and failure factors of public intervention in housing the poor. The information collected from the official reports of government of India, Kerala, local or self governments, implementing agencies and other secondary sources are taken as the basis of Analysis I. Data for this chapter are also collected from reports of international agencies like the World Bank and UNCHS (on the evolution of present housing policy in developing countries).

Chapter 4 - This chapter presents the third stage (Analysis III - AlIII) of evaluation to assess the real situation in the field. An evaluation of the housing situation in Kerala based on household surveys and case studies from the selected housing schemes is presented in this chapter. A discussion on the present housing situation of Kerala with respect to different aspects of sustainability and a comparative analysis of the public initiatives in low income housing with examples from other parts of the world is also presented. Based on these evaluations and comparative study strategies are formulated for sustainable-affordable housing in Kerala.

Methodology - The information employed for this part of analysis is based on household surveys from Kerala. These surveys were conducted using a structured questionnaire prepared on the basis of the conceptual framework. A scheme of analysis is prepared for each aspect of sustainability based on the “objectives hierarchy model” of the conceptual framework and the questions are transformed into measurable criteria. The Statistical Package for Social Sciences (SPSS- Version XI) is employed for the analysis of household data. Some examples of enabling strategies from UNCHS, Global Best Practice database are discussed in this chapter to see how they have tackled the problems of low-income housing in similar contexts.

Chapter 5 - This chapter gives an evaluation of the prevailing building process in Kerala. It presents the guidelines for selecting environmentally-friendly and as well as affordable technological options. This chapter also discusses the potential an affordable alternatives (rice husk ash) suitable to the specificities of Kerala. Basic principles and examples from straw bale construction in The Netherlands and India are presented as the appendix of this chapter.

Methodology - The evaluation has been done using a methodology based on the conceptual framework from chapter 2. The information employed for the evaluation of the prevailing building process in Kerala is supported by the knowledge which has
learned from the researcher's experiences from practise, by field studies, data collected from household surveys and desk research.

**Chapter 6** - This chapter deals with the experimental study which has been conducted on the rice husk ash samples under controlled conditions in the lab and from different field ovens to compare the performance of the ovens and to identify the most feasible method to produce a reactive pozzolana as an alternative to cement for building applications requiring lower strengths.

**Methodology** - The first phase of the research discusses the parameters, which influence the reactivity of the pozzolana from rice husk under controlled conditions in the laboratory. Literature work has been carried out for collecting information on the previous researches. An in-depth characterization of rice husk ash samples produced from different temperature-duration-cooling regimes in the controlled laboratory condition had been conducted as a function of combustion conditions using X-ray diffraction (XRD), $^{29}$Si magic-angle spinning (MAS) nuclear magnetic resonance (NMR), chemical analyses, conductivity measurements and microscopic analysis.

For the second phase of this research, ash samples from three different types of field ovens (annular enclosure, brick oven and pit arrangement) are investigated for loss on ignition, soluble silica, pozzolanicity and X-ray diffraction. Malvern apparatus has used for the particle size analysis and Brunauer-Emmett-Teller analysis is employed for the investigation of specific surface area of rice husk ash samples. The long-term strength of these rice husk ash pozzolanas (from field ovens and optimized condition in the lab) with lime or cement is investigated through lime reactivity test and compressive strength test.

**Chapter 7** - This chapter gives the general conclusions and recommendations of this research together with an insight into the scope for further studies. Recommendations for the practical implementation of the policies to contribute to sustainable-affordable housing development in Kerala are also presented in this chapter.
APPENDIX 1.1

Figure 1  Map of India showing the position of Kerala
(Source: http://cs101.sewanee.edu/map.gif, last accessed on 22/08/2006)
APPENDIX 1.2

General physiographic and climatic features of Kerala

In terms of the topographical characteristics, Kerala may be divided into three regions such as Lowland, High land and mid land. **Low land** (10.2%) stretches along the Arabian Sea and population density is highest (Coastal area). This region is characterized by marine landforms consisting of beach ridges and beaches with swamps and lagoons. The low land region is well known for its backwaters with extensive rice fields and coconut trees. **High land** (48%) stretches along the Western Ghats and population density is lowest (Hilly area). It slopes down from the Western Ghats, which rise to an average height of 900m, with a number of peaks well over 1,800m in height. The soil varies widely in depth and texture. Plantation crops including tea, coffee, rubber and cardamom are grown in highlands. **Mid land** (41.8%) lies between low land and high land, with altitudes ranging from 7.5 to 75 meters above mean sea level, is made up primarily of valleys. The terrain is undulating, with numerous rivers, small hills and valleys. Laterite and lateritic soils cover around 60% of the total geographical area of Kerala.

Kerala is the land of Rivers and backwaters. 44 Rivers (41 west flowing and 3 east flowing) cut across Kerala with their innumerable tributaries and branches, but these rivers are comparatively small and being entirely monsoon-fed, practically turn into rivulets in summer, especially in the upper areas.

**Climate** - Kerala falls within the realm of tropical climate and dominant feature is monsoon. It has a warm and pleasant tropical monsoon climate. The climate is pleasant from September to February. The summer months are warm and humid with a mean max temperature of about 33°C. March to May is the hottest, with temperature reaching more than 32°C. Lowest temperatures are experienced during the month of December and January.

<table>
<thead>
<tr>
<th>Season</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>21°C</td>
<td>18°C</td>
</tr>
<tr>
<td>Summer</td>
<td>33°C</td>
<td>27°C</td>
</tr>
</tbody>
</table>

**Wind** - Wind over the state is seasonal and wind speed attains 40 to 50 km/hr during and before the monsoon rains.

**Rainfall** - Kerala receives a good annual rainfall, varying from 1250 to 5000 mm. The normal annual rainfall of Kerala is 3107 mm. (national average is 1197 mm). The State has the benefit of the Southwest and Northeast monsoon. Although, quantum wise the rainfall received is high, its distribution shows temporal and spatial variations. On an average, the number of rainy days is in the range of 120-140 in a year. The highest rainfall occurs in the high ranges of Idukki district, where it exceeds 5000 mm.
APPENDIX 1.3

Table 1  Population growths and the ‘Housing gap’ in India (in million)

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Population</th>
<th>Number of households</th>
<th>Number of housing units</th>
<th>Housing gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>360.9</td>
<td>73.4</td>
<td>64.4</td>
<td>9.0</td>
</tr>
<tr>
<td>1961</td>
<td>439.2</td>
<td>83.5</td>
<td>79.1</td>
<td>4.4</td>
</tr>
<tr>
<td>1971</td>
<td>547.2</td>
<td>97.1</td>
<td>90.8</td>
<td>6.3</td>
</tr>
<tr>
<td>1981</td>
<td>685.2</td>
<td>122.6</td>
<td>114.4</td>
<td>8.2</td>
</tr>
<tr>
<td>1991</td>
<td>846.3</td>
<td>160.6</td>
<td>129.6</td>
<td>31.0</td>
</tr>
<tr>
<td>2001</td>
<td>1025.3</td>
<td>209.2</td>
<td>187.1</td>
<td>22.1</td>
</tr>
</tbody>
</table>

Source: Census reports, Government of India

Table 2  Population growths and the ‘Housing gap’ in Kerala (in thousands)

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Population</th>
<th>Number of households</th>
<th>Number of housing units</th>
<th>Housing gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>16,904</td>
<td>2,808</td>
<td>2,754</td>
<td>54</td>
</tr>
<tr>
<td>1971</td>
<td>21,347</td>
<td>3,433</td>
<td>3,362</td>
<td>71</td>
</tr>
<tr>
<td>1981</td>
<td>23,454</td>
<td>4,423</td>
<td>4,195</td>
<td>228</td>
</tr>
<tr>
<td>1991</td>
<td>29,033</td>
<td>5,513</td>
<td>5,342</td>
<td>171</td>
</tr>
<tr>
<td>2001</td>
<td>31,839</td>
<td>6,595</td>
<td>6,540</td>
<td>55</td>
</tr>
</tbody>
</table>

Source: Census Reports, Government of India

Table 3  Comparative statistics with neighbouring Indian states

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerala</td>
<td>38863</td>
<td>819</td>
<td>90.92</td>
<td>0.64</td>
<td>19.9</td>
<td>12.7</td>
<td>8.6</td>
<td>2490</td>
</tr>
<tr>
<td>Tamilnadu</td>
<td>130058</td>
<td>478</td>
<td>73.47</td>
<td>0.53</td>
<td>29.3</td>
<td>21.2</td>
<td>2.6</td>
<td>3141</td>
</tr>
<tr>
<td>Karnataka</td>
<td>191791</td>
<td>275</td>
<td>67.04</td>
<td>0.48</td>
<td>32.7</td>
<td>20.0</td>
<td>1.4</td>
<td>2866</td>
</tr>
<tr>
<td>India</td>
<td>3287263</td>
<td>324</td>
<td>65.38</td>
<td>0.47</td>
<td>39.4</td>
<td>26.1</td>
<td>2.3</td>
<td>2840</td>
</tr>
</tbody>
</table>

Table 4  Comparative Statistics, Housing and amenities in Kerala with neighbouring Indian States

<table>
<thead>
<tr>
<th>State</th>
<th>Permanent houses (%)</th>
<th>Owned houses - Tenure status (%)</th>
<th>Toilet facility (%)</th>
<th>Electricity connection (%)</th>
<th>Availability of drinking water within the premises and near (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerala</td>
<td>68.1</td>
<td>92.6</td>
<td>62.1</td>
<td>70.2</td>
<td>88.1</td>
</tr>
<tr>
<td>Tamilnadu</td>
<td>58.5</td>
<td>77.7</td>
<td>39.9</td>
<td>78.2</td>
<td>87.9</td>
</tr>
<tr>
<td>Karnataka</td>
<td>54.9</td>
<td>78.5</td>
<td>58.9</td>
<td>78.5</td>
<td>78.1</td>
</tr>
</tbody>
</table>

Source: Census Reports, Government of India, 2001

Table 5  Comparison of Kerala with neighbouring countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Area in Sq.Km</th>
<th>Density of population</th>
<th>Population below poverty line 2002 (%)</th>
<th>Human Development Index (HDI) 2003</th>
<th>Human Poverty Index (HPI) 2003 (%)</th>
<th>Life expectancy at birth 2003</th>
<th>Literacy of total population (%)</th>
<th>GNP index</th>
<th>Population growth rate (%)</th>
<th>Population with sustainable access to an improved water source (%) 2002</th>
<th>Population with sustainable access to an improved sanitation (%) 2002</th>
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