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# Housing Deprivations in the Underserved Settlements of Jaffna Municipality and Its Urban Fringe Using Slum Severity Index

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**ABSTRACT**

*Underserved settlements pose challenges to urban planning and development in developing countries, while they provide affordable shelter and a livelihood to a large proportion of the urban poor. Most definitions consider an underserved settlement to be a community of several housing units, failing to recognize that housing conditions vary by housing unit within the area. This study employed the criteria of structural quality, living area, land tenure, improved drinking water, and water for other purposes, improved sanitation, electricity, kitchen, and clean fuel to identify the underserved settlements and assess their housing deprivations. A housing unit-level field survey, field observation, focus group discussions with representatives of community-based organizations and ground-level officers, and interviews with administrative officers of government institutions, local authorities, academics, and social activists were employed to gather primary data for this study, while secondary data was gathered from government departments. The Slum Severity Index adopted in the study measured the degree of deprivation on a continuous scale. Arc GIS 10.4 was used to create maps that depict the spatial distribution and housing deprivation of underserved settlements. According to the findings, 100% of settlements lacked access to drinking water, 81.23% lacked adequate living space, 58.99% lacked land tenure, 42.35% lacked housing structure, 23.45% lacked water for other purposes, 15.70% lacked sanitation, and 0.76% lacked electricity. Overall, 42.35% of settlements lacked more than three of the aforementioned criteria, and 0.76% of settlements lacked all of them. The study's conclusion emphasized the importance of assessing multiple housing deprivations via the Slum Severity Index to attain sustainable development goals and establish cities free of underserved settlements.*

## 1. Introduction

Various researchers and institutions use a variety of terms—informal settlements, slums, shanty towns, spontaneous settlements, squatter settlements, unplanned settlements, and low-income settlements—to describe deprived settlements in the global context. In Sri Lanka, underserved settlements (USSs) refer to housing units that lack essential services, sufficient living space, adequate housing structure, and tenure security (Ekanayake, 2001; Gunetilleke, Cader & Fernando, 2004; United Nations Human Settlements Programme [UN-HABITAT], Centre for Poverty Analysis [CEPA] & Sevanatha, 2013). By South Asian standards, urban areas in Sri Lanka rank highly for their livability. In general, living conditions and housing stock in Sri Lanka are better than those in slums in South Asian megacities (Ministry of Housing & Construction [MHC], 2016). However, much literature denotes that poor living conditions in USSs have evolved into a major concern in the capital city of Colombo, Sri Lanka (Ekanayake, 2001; Gunetilleke, Cader & Fernando, 2004; Niriella, 2012; & UN-HABITAT, CEPA & Sevanatha, 2013; Subasinghe, 2015; ChandraKumara, 2015; Rasnayake, 2019; Lakshman, Alikhan & Azam, 2019). More than half of Colombo's inhabitants reside in USSs that take up 9% of the city's entire land area. According to the Urban Development Authority [UDA] (2010), there are a total of 68,812 families living in 1,499 USSs that lack basic infrastructure amenities such as access to clean water, sanitary facilities, and electricity, as well as a healthier environment for human habitation. On the other hand, cities outside of the Western Province are not exempt from the dilemma of USSs. The United Nations Development Programme [UNDP] et al (2006) reported that the entire underserved area of Jaffna city has developed into an imminent threat to the environment, health, and sanitation of not only that area but the entire city as well. Therefore, the USSs in this area should be developed sustainably. To do that, it is necessary to identify the spatial distribution of USSs and assess the housing deprivation of those settlements.

USSs have been identified at the neighbourhood and household levels. USSs are defined at the neighbourhood level as an amalgamated representation of numerous households (Patel, Koizumi & Crooks, 2014; Patel et al., 2019; Patel, Shah & Beauregard, 2020). The neighbourhood-level approach makes USSs neighbourhoods more distinguishable compared to others, either due to the notably deteriorating physical conditions of those neighbourhoods' general housing stock or due to a distinctive set of economic, socio-cultural, and demographic traits exhibited by the vast majority of their inhabitants, such as severe poverty (Montgomery, 2009). Regardless of their specific housing circumstances, all people residing in predefined underserved neighbourhoods are included in the aerial identification of underserved dwellers. According to a household-based approach, the inhabitants of USSs are those whose households do not have sufficient living conditions, which disaggregates the population (Patel, Koizumi & Crooks, 2014; Patel et al., 2019; Patel, Shah & Beauregard, 2020). Living conditions are naturally a characteristic of an individual household. There are benefits to classifying underserved status at the household level due to the variability of living conditions, socio-economic and demographic characteristics of households (Seeley, 1959; Stokes, 1962; Vliet, 1987; Sandhu, 1989; Patel, Koizumi & Crooks, 2014; Patel et al., 2019; Patel, Shah & Beauregard, 2020).

A similar strategy would enable urban planners and policymakers to target and customize USS's development initiatives and policies to the requirements of specific households. This is crucial because modern underserved development programs strive to identify and target beneficiaries more effectively (Patel, Koizumi & Crooks, 2014).

Deprivation is defined as being excluded from the minimum acceptable way of life in one's society due to a lack of resources (Castriotta et al., 2020; Callan et al., 1993). Several deprivation indexes have been developed based on various criteria to assess the deprivational condition of USSs in various spatial and temporal contexts, such as the Slum Severity Index (Patel, Koizumi & Crooks, 2014); Housing Deprivation Index (Patel et al., 2019); Multiple Housing Deprivation Index (Patel, Shah & Beauregard,2020); Multi-dimensional Slum Severity Index and Exploratory Factor Analysis (Roy, Bernal & Lees, 2019); Slum Deprivation Index (Akoteyon, Aliu & Soladoye, 2020); Basic Services Deprivation Score (Nolan, Bloom & Subbaraman, 2017); Slum Condition Index (Sajjad,2014); Severity Index and Relative Importance Index (Okoye, Ezeokonkwo & Mbakwe, 2017); Socio Economic Opportunity Index (Ahmed & Mustafa 2016); Single Index of Deprivation (Fukuda, Nakamura & Takano, 2007); Standardized Neighbourhood Deprivation Index (Messer et al., 2006); New Zealand's Deprivation Index (Salmond et al., 2012); Quality of Life (Mawkhlieng & Debbarma, 2018); Vulnerability Assessment (Rao & Thakur, 2007); Living conditions (Mandleni et al., 2021; Ecological Footprint (Devi, Lowry & Weber, 2017). Most of these researchers focused on assessing the USSs at the neighbourhood level rather than the household level. A limited number of studies moved beyond the neighbourhood level and assessed the underserved conditions at the household level (Patel, Koizumi & Crooks, 2014; Patel et al., 2019; Patel, Shah & Beauregard, 2020; Akoteyon et al., 2021).

Even though many scholars have assessed the housing deprivation of USSs by employing different indexes, the literature on this topic in the context of Sri Lanka has not been sufficiently developed. Furthermore, as addressed by UN-HABITAT (2004, 2018, & 2021), there is a fundamental lack of knowledge and literature that integrates all dimensions of housing deprivation. Despite the fact that many studies can be cited, such studies only cover one or a few aspects of housing deprivation. Furthermore, previous studies did not conceptualize housing deprivation to the level addressed in UN-HABITAT (2004, 2018, & 2021), which provides a comprehensive framework for understanding housing deprivation, particularly among the poor. The purpose of this research is to fill a knowledge gap in the multiple housing deprivations of USSs in Sri Lanka. This is the first study that reports the extent and nature of multiple housing deprivations using housing units as the unit of analysis in the Jaffna context. This paper attempts to achieve the specific objectives of identifying the spatial distribution of USSs and assessing the multiple housing deprivations of USSs.

## 2. Materials and Methods

The Jaffna Municipality and its urban fringe were chosen as the study area. It is located in the Jaffna Peninsula's southern part, between $9^0$ 36' 30'' N – $9^0$ 42' 90'' N and $79^0$ 88' 10'' E – $80^0$ 08' 20'' E. It is 44.539 $km^2$ in size and is naturally bounded in the south by the Jaffna Lagoon. It includes 68 GND, with a total population of 121,762 (Jaffna District Secretariat (JDS), 2021). Figure 01 depicts the study area's location.

Preparatory work for data collection is an important aspect of research (Weeratunga & Hugo, 2014). From April 2020 to August 2020, preparatory work was carried out in this study, which included conducting a preliminary survey to familiarize the study area; observing the existing condition of settlements and deciding the nature of samples; meeting USS dwellers, community leaders, and ground-level officers; preparing site maps; finding available secondary information, and identifying the data to be collected.

*This study relies mainly on primary data, which was collected by direct field observation (DFO); transect walks, field surveys, focus group discussions (FGDs), and key informant*

*interviews (KIIs). A housing unit-level field survey was carried out from August 2020 to April 2021 to detect USSs due to the lack of a public data source for underserved housing units in the study area. In order to determine a settlement's underserved housing condition, this study has chosen the following criteria based on the literature review: adequate structure, sufficient living space, access to improved drinking water, access to water for other purposes, access to improved sanitation, access to electricity, access to a kitchen, access to clean fuel, and security of tenure. The housing units that lack one or more of the abovementioned housing conditions are considered USSs. Table 1 lists the criteria used to identify USSs, which were developed from previous literature.*

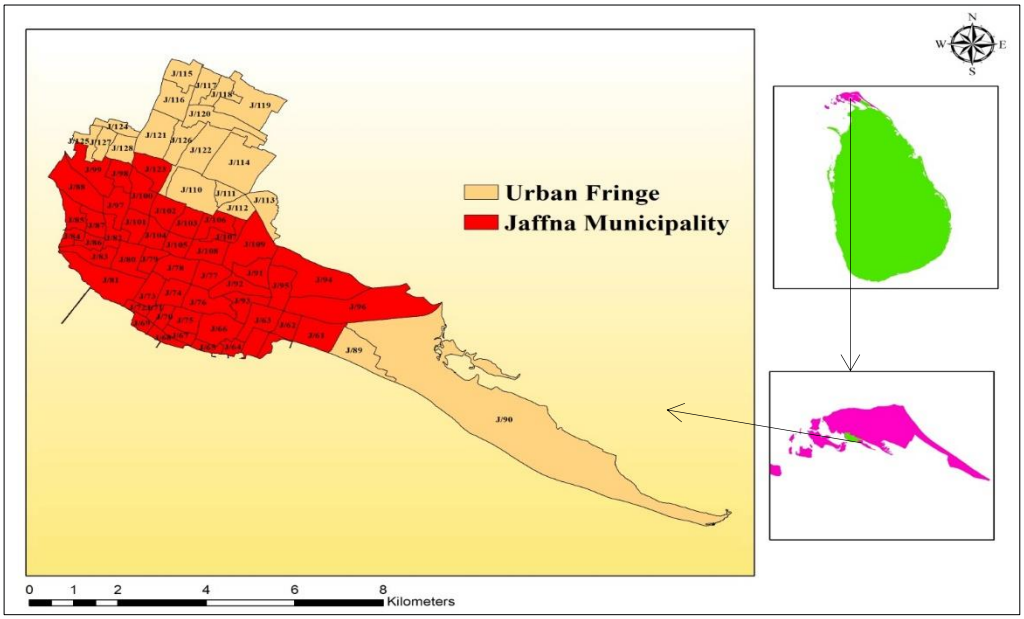


**Figure 1.** Study area's location
(Source: Developed by the researcher based on the database of Survey Department, 2021)

**Table 1.** Criteria to identify the Underserved Settlements

| Criteria | Description |
|---|---|
| Adequate structure | *Temporary, semi-permanent, and permanent settlements in dilapidated housing conditions were considered settlements with a lack of adequate structure (UN-HABITAT, 2021, 2018 & 2004). |
| Adequate living space | * The same habitable room cannot be shared by more than a family.<br>* The same habitable room cannot be shared by more than three people (UN-HABITAT, 2021, 2018 & 2004).<br>*The average floor space required per person must be at least 85 square feet [ft2] (UN-HABITAT, CEPA & Sevanatha, 2013). |

| | |
|---|---|
| | The settlement that fulfills the abovementioned criteria was indicated as a settlement with sufficient living area, and the contrast situation was equivalent to a lack thereof. |
| Security of tenure | *Settlements that were situated on land belonging to government institutions, municipal land, state land, temple land, and private land without legal evidence were considered to be settlements without the security of tenure (UN-HABITAT, 2021, 2018 & 2004). |
| Access to improved drinking water | *Municipal/Pradeshiya Sabah drinking water supply was considered improved water sources, such as piped water into a house, plot, or yard; public stand post serving no more than 5 households; whereas other water sources were considered unimproved water sources in the study area context (UN-HABITAT, 2021, 2018 & 2004).<br>*A settlement was considered to have access to safe drinking water; availability of at least 20 litres (L) per person per day from a improved source within 1km of the user's residence at a reasonable cost (less than 10% of total household income); whereas a contrast situation refers to a lack thereof (UN-HABITAT, 2021, 2018 & 2004). |
| Access to water for other purposes | * The availability of an individual well/bathroom/stand post with a water connection was referred to as access to water for other domestic consumption and the unavailability was referred to as a lack thereof (Patel, Shah & Beauregard, 2020). |
| Access to improved sanitation | * Availability of individual toilet facilities was regarded as access to sanitation facilities and unavailability was regarded as a lack thereof (UN-HABITAT, 2021, 2018 & 2004; Patel, Koizumi & Crooks, 2014; Patel et al., 2019; Patel, Shah & Beauregard, 2020). |
| Access to electricity | *Settlements without access to electricity were considered equivalent to a lack thereof (Patel, Shah & Beauregard, 2020). |
| Access to kitchen | * Settlements without access to a kitchen (inside or outside) were considered equivalent to a lack thereof (Patel, Shah & Beauregard, 2020). |

Source: Created by the researcher based on literature review, 2020.

The Grama Niladhari Divisions [GND], which have clusters of USSs, have been taken into consideration for this study, whereas the divisions that have isolated USSs were excluded from the population frame. The USS list that was generated was given to the GND and the list was vetted by Grama Niladhari and Economic Development Officers, who serve as the link between the underserved communities and the administrative bodies. Following that, the CT Droid app was used to collect the coordinates of every USSs in the study area to generate a spatial distribution map of USSs.

From August 2020 to December 2021, DFO was conducted in the Jaffna Municipality and its urban fringe for sixteen months. This data was collected primarily to comprehend housing deprivations in USSs. FGDs with community leaders and ground-level officers, as well as KIIs with administrative officers of government institutions, local authorities, academics, and social activists, were conducted to obtain additional information about the issues and challenges related to the housing deprivation of USSs and measures to mitigate the deprivation. The FGDs were arranged from January to February 2022. The

size of the focus group was between six and twelve participants, and each discussion was scheduled for 60–90 minutes. The FGD participants were chosen by adopting the purposive sampling method based on the severity of the USS problem in their divisions. Moreover, the KIIs were conducted from January to March 2022. Each interview took 15 to 30 minutes. The identified relevant stakeholders for the FGDs and KIIs are tabulated in Tables 2 and 3 respectively.

**Table 2.** Stakeholders for the Focus Group Discussion

| **Focus Group 01 : Community leaders** |
|---|
| a) Members of Community Based Organizations- Fishermen's Co-operative Society, National Youth Service Co-operative Society, Agricultural Society, Community Center, Rural Development Society, and Women's Rural Development Society,<br>b) Members of Jaffna Municipal Council (JMC) and Nallur Pradeshiya Sabah (NPS) |
| Focus Group 02: Ground-level officers |
| Grama Niladhari, Economic Development Officers, and Samurthi Officers |

**Table 3.** Stakeholders for the Key Informant Interviews

| **Stakeholders** | |
|---|---|
| Jaffna Municipal Council (JMC) | Sri Lanka Railway Department [SLR] |
| Nallur Pradeshiya Sabah (NPS) | Excise Department [ED] |
| UDA | Landlords of temple lands |
| National Housing Development Authority (NHDA) | Academics/Retired academics |
| JDS | Retired professionals/social activists |
| Jaffna & Nallur Divisional Secretariat | |
| Coastal Conservation and Coastal Resources Management [CCD] | |

Source: Created by the researcher, 2021

**Table 4.** Secondary Data Collection Methods

| Type of Data | Year of Acquisition | Data format | Source |
|---|---|---|---|
| GND boundary | 2020 | Shape file | Survey Department |
| Details of land | 2020 | Hard copy | Jaffna & Nallur Divisional Secretariat |
| Statistical handbook | 2020 | Hard copy | Jaffna District Secretariat, Jaffna & Nallur Divisional Secretariat |
| Settlement address | 2020 | Hard copy | GND office |

Source: Created by researcher, 2021

Required secondary data was gathered from the official documents of relevant departments, national and international journals; published and unpublished theses of academics; books; maps; electronic

devices; and websites. Collected secondary data is depicted in Table 4.
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The primary data collected to identify the spatial distribution of USSs was analyzed using ArcGIS 10.4. First, the collected GPS points/coordinates of the USSs were exported as a CSV file to MS Excel and the spatial data attributes were entered there. After completion, the excel file was imported into ArcGIS and created as a shape file. Following that, the USS shape file was added along with the GND boundary shape file, and the spatial distribution map of USSs was created.

In this analysis, each housing unit was allotted a binary score for each criterion, with 1 indicating deprivation and 0 indicating no deprivation.
The decomposed score on each of these nine elements enabled the categorization of housing units as per their deprivation level. The binary scores were aggregated to create a deprivation score known as the Slum Severity Index (SSI). The index scale ranges from 0 to 9, with 0 representing non-underserved status and 9 indicating a lack of all nine basic housing elements, denoting the most deplorable living conditions. The housing deprivation was calculated in MS Excel, and the results of the quantifiable derivatives were summarized in text and table formats. Moreover, ArcGIS was used to create thematic maps that depict the condition of housing deprivation. This methodological framework is based on previous studies (Patel, Koizumi & Crooks, 2014; Patel et al., 2019; Patel, Shah & Beauregard, 2020). Figure 2 depicts a flowchart diagram of the methodology for determining the spatial distribution and housing deprivation of USSs.

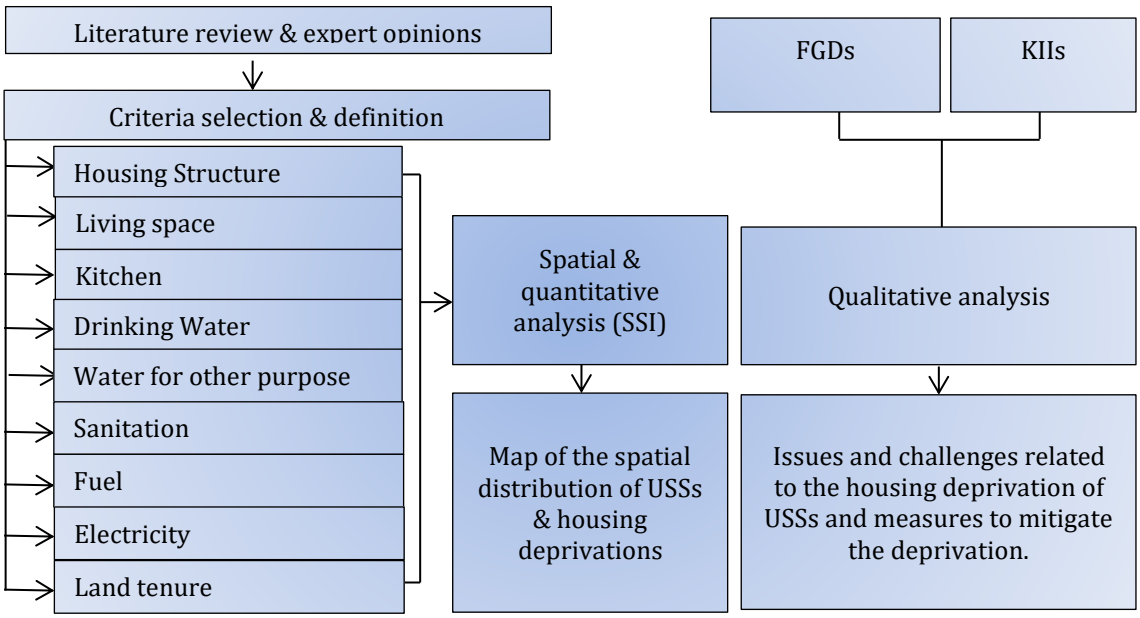


**Figure 2.** Methodology for determining Spatial Distribution and Housing Deprivation of USSs (Source: Created by the researcher, 2021)

## 3. Results and Discussion

### 3.1 Underserved Population

The total population of the USSs is 12971, accounting for 10.65% of the total population of the study area. Figure 3 represents the underserved population of the study area by age. The underserved communities have a relatively large working-age population, accounting for 67.35% of the working-age population, which includes 8.25% of the adolescent population aged 15-19. However, the communities have a lower proportion of the aging population (over 65) than the national average, accounting for only 11.93% of the total population.

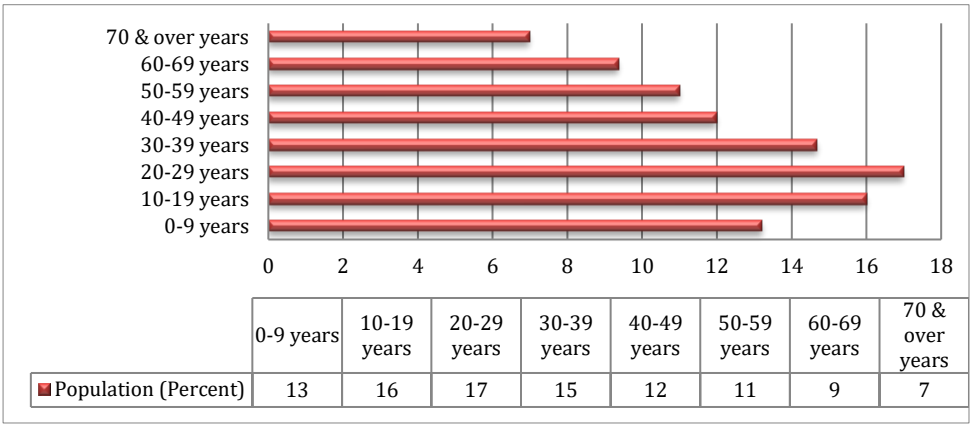


**Figure 3.** Underserved Population by Age (Source: Field survey, 2020 & 2021)

### 3.2 Spatial Distribution of Underserved Settlements

UN-HABITAT and other studies have utilized the aforementioned criteria (Table 1) to identify USSs. Accordingly, settlements that suffer from one or more of the aforementioned housing deprivations are indicated as USSs. The number of identified USSs in each division is tabulated in Table 5.

**Table 5.** Distribution of Underserved Settlements by GND

| GND | USSs | GND | USSs | GND | USSs | GND | USSs |
|---|---|---|---|---|---|---|---|
| J/61 *Nedunkulam* | 69 | J/72 *Small Bazzer* | 25 | J/83 *Koddady* | 17 | J/99 *Vannarpannai North West* | 24 |
| J/62 *Columbuthurai East* | 48 | J/73 *Jaffna Town East* | 39 | J/84 *Navanthurai South* | 45 | J/109 *Sangiliyan Thoppu* | 44 |
| J/64 *Passaiyoor East* | 11 | J/74 *Jaffna Town West* | 45 | J/85 *Navanthurai North* | 177 | J/89 *Thirunelvely West* | 105 |
| J/65 *Passaiyoor West* | 48 | J/75 *Chundikuli South* | 17 | J/86 *Moor Street South* | 80 | J/90 *Thirunelvely Center North* | 57 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| J/67 *Thirunagar* | 86 | J/77 *Maruthady* | 08 | J/87 *Moor Street North* | 54 | J/110 *Kokuvil East* | 17 |
| J/68 *Reclamation East* | 930 | J/78 *Athiyady* | 09 | J/88 *New Moor Street* | 61 | J/114 *Vannarpannai North West* | 95 |
| J/69 *Reclamation West* | 683 | J/79 *Sirampiady* | 04 | J/94 *Ariyalai South East* | 07 | J/122 *Sangiliyan Thoppu* | 44 |
| J/70 *Gurunagar East* | 19 | J/80 *Grand Bazaar* | 27 | J/96 *Ariyalai East* | 13 | | |
| J/71 *Gurunagar West* | 34 | J/81 *Fort* | 67 | J/98 *Ariyalai Center North* | 10 | | |

Source: Field survey, 2020 & 2021

According to the survey, there are 31841 settlements in the study area, with USSs accounting for 9.48% of them (3019). JMC's administrative boundary encompasses 89.46% of the USSs, while the remaining settlements are within NPS's administrative boundary. According to their location, 80.19% of the USSs are located along Jaffna's coastal belt, with the rest located in the city center or on the northern urban fringe. *Reclamation East, Reclamation West, Navanthurai North*, and *Ariyalai South East* all have a huge number of USSs, accounting for 62.77% of the total number of USSs. Furthermore, the number of USSs *in Maruthady, Aththiyady, Sirampiady, Ariyalai Center North,* and *Vannarpannai North* is relatively low. Figure 4 depicts the spatial distribution of USSs.

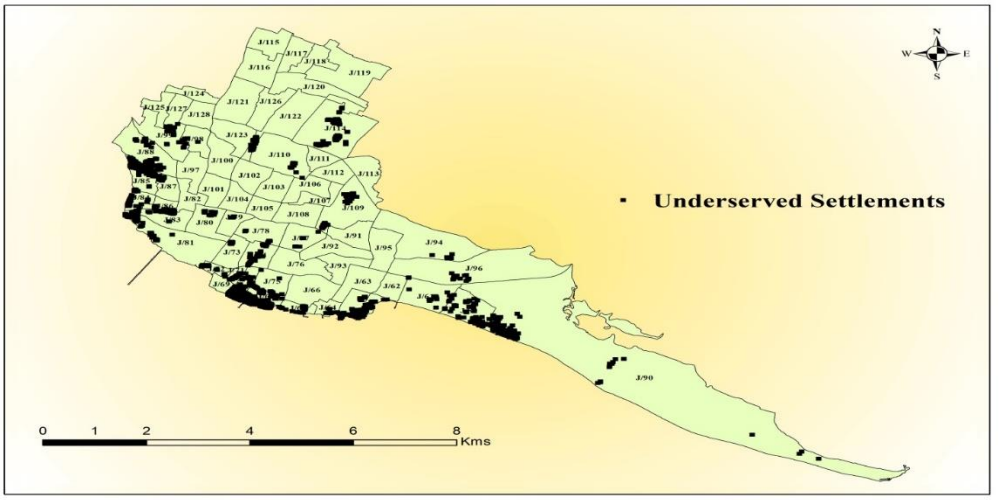


**Figure 4.** The Spatial Distribution of Underserved Settlements
(Source: Field survey, 2020 & 2021)

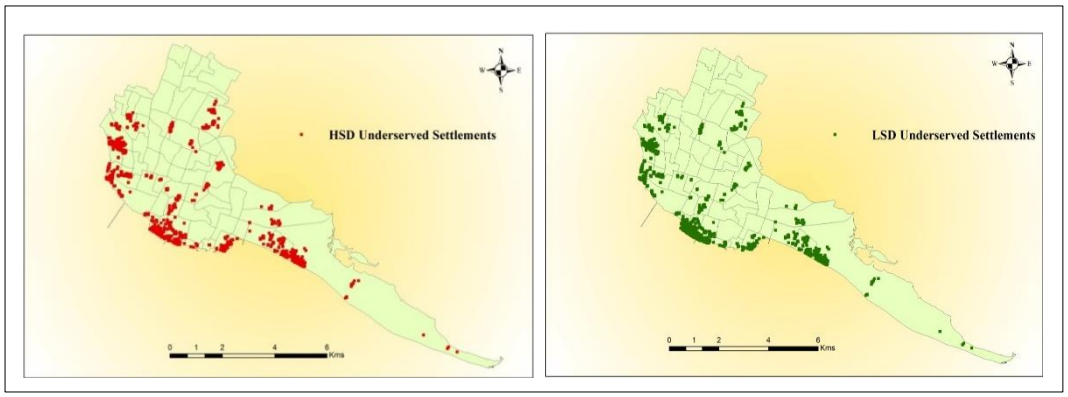


**Figure 5.** Underserved Settlements with Housing Structure Deprivation (HSD) & Living Space Deprivation (LSD) **(**Source: Field survey, 2020 & 2021)

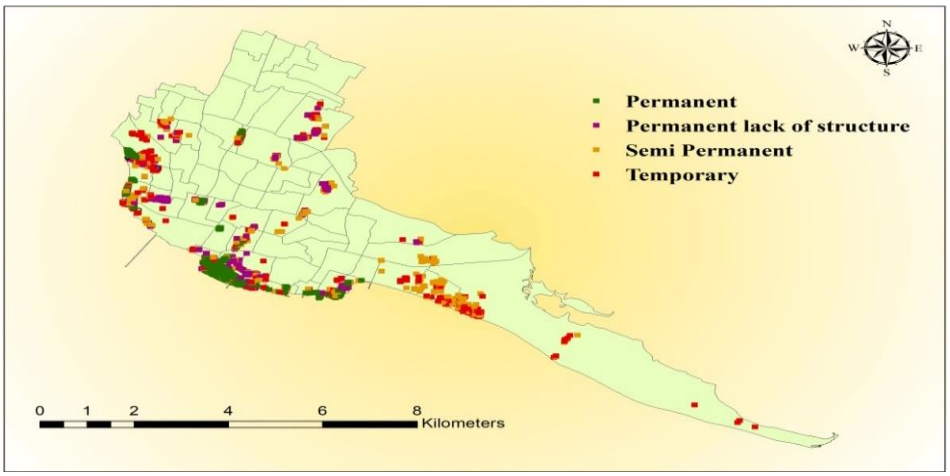


**Figure 6.** Housing Structure of Underserved Settlements (Source: Field survey, 2020 & 2021

### 3.3 Housing Deprivation in Underserved Settlements

USSs were categorized based on their deprivation conditions.

#### 3.3.1 Housing Structure and Living Space

The settlement's habitability is the most important aspect, which is determined by the structural quality and the availability of living space. Housing is inadequate if it does not provide physical safety, sufficient space, and protection from extreme weather conditions, health threats, and structural hazards [UN-HABITAT, 2021]. Figure 5 depicts the spatial distribution of USSs that lack housing structures and adequate living space.

In the study area, 42.35% of the USSs are deprived of housing structures. Within the settlements that lack housing durability, 37.39% are temporary settlements, 31.58% are semi-permanent settlements, and 31.03% are built with permanent materials but in

dilapidated housing conditions. In particular, the divisions of *Navanthurai North, Reclamation East, Ariyalai South West, Thirunelvely Center North, Thirunagar, Moor Street South, New Moor Street, Reclamation West, Fort, Ariyalai East,* and *Moor Street North* have covered 69.41% of settlements deficient in housing durability. The spatial distribution of USSs based on housing structures is depicted in Figure 6.

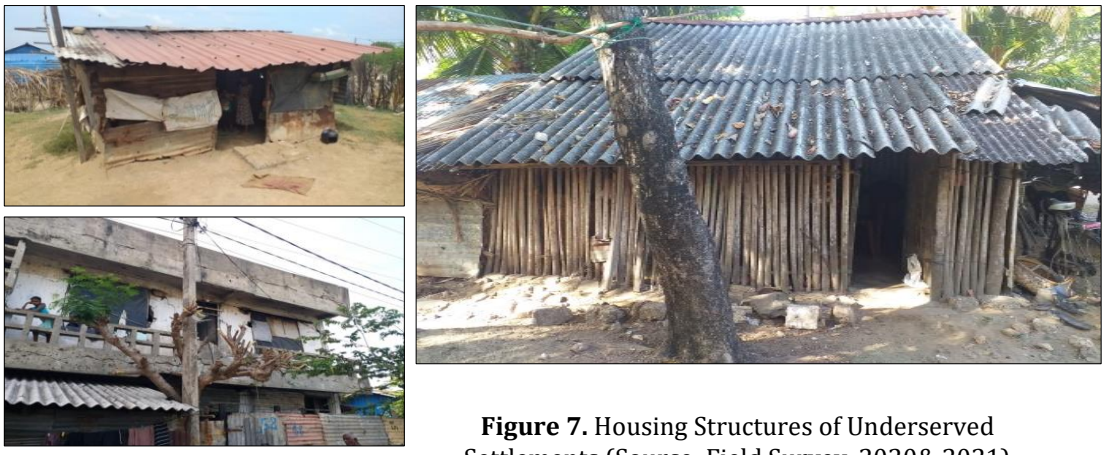

**Figure 7.** Housing Structures of Underserved Settlements (Source: Field Survey, 2020& 2021)

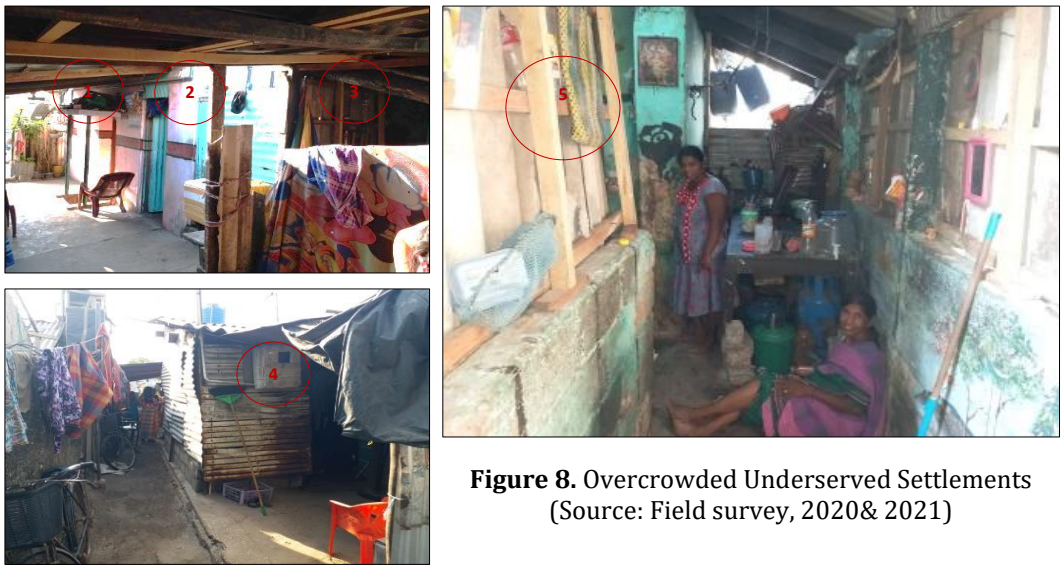


**Figure 8.** Overcrowded Underserved Settlements (Source: Field survey, 2020& 2021)

Overcrowding is defined by different institutions by adopting different criteria (Table 01). UN-HABITAT (2021, 2018 & 2004) defined the condition of more than three people sharing the same habitable room as overcrowding, and the survey finds that 76.83% of the settlements can be classified as overcrowded. According to the World Health Organization [WHO], an average in-house living area per person or floor space per person must be at least 85 square feet (UN-HABITAT, CEPA & Sevanatha, 2013), and 81.23% of settlements fall short of this standard. The divisions of

*Reclamation East* and *Reclamation West* have the highest number of USSs lacking sufficient living space, accounting for 60.87%. Figure 8 depicts the overcrowding in the USSs of *Reclamation East*. Here, the house is divided into five portions and used by five families.

Community leaders of *Reclamation East* and *West* said,

> *"Reclamation is the most populated division, where land plots are most fragmented by the inhabitants. It is common to see one settlement shared by a large number of households, and in many cases, the inner part of the dwelling unit is divided into numerous portions using permanent and temporary materials, with one family using one room or chunk. At the same time, those who could afford it added additional levels to their settlements within their plots. The fundamental reasons for agglomerating individuals in a limited area are occupational compulsions and emotional bonds. As a result, these settlements have become overcrowded. Many environmental and sociocultural negative repercussions are developing as a result of overcrowding".*

According to Grama Niladhari of the *Reclamation East and West*,

> *"Presently, 7948 members of 2453 families reside within 0.35 square kilometres of land, but there are only 1172 houses. Here, the average plot size is less than 2.5 perches. A single settlement has an average of two families, with some settlements having three to four households. People in this area are mostly fishermen, and they are hesitant to leave, despite the housing schemes available in other areas".*

One of the primary reasons for the USSs concentration in Jaffna's coastal divisions and pockets in other divisions is the importance of the site for the communities' livelihood, as highlighted in section 3.2. Fishermen predominate in *Nedunkulam, Columbuthurai East, Passaiyoor East* and *West, Gurunagar East* and *West, Reclamation East* and *West, Small Bazar, Navanthurai North* and *South, Ariyalai South East* and *East.* 82% of residents in the *Thirunagar* division work as sanitary laborers for the JMC. People on *New Moor Street, Moor Street North* and *South* primarily work as small vendors and antique iron collectors. Figure 9 depicts the economic activity of the working-age population in USSs by sector.

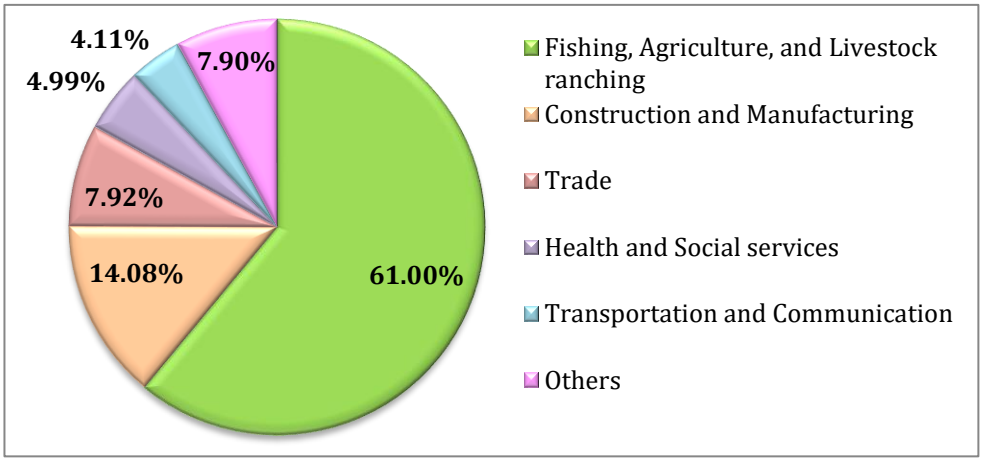


**Figure 9.** Economic Activity of Working Age Population in Underserved Settlements by Sector (Source: Field Survey, 2020 & 2021)

**Figure 10.** Issues Related to Getting Water for Drinking Purposes (Source: Field survey, 2020& 2021)

One of the primary issues in the research area is the lack of access to drinking water. Previous research has confirmed that the Valikamam region's groundwater is unfit for human consumption (Navaratnarajah, 1994; Rajasooriyar et al., 2002; Mageswaran, 2003; Hidayathulla et al., 2013; Mikunthan et al., 2013; Jeevaratnam, 2017; Prabagar, Prabagar & Thuraisingam, 2020). More than 80% of households rely on shared public water collection points, where water is available for one or two hours per day, while the remainder obtain water from a temple well or a common well (Balachandran & Thennakoon, 2021). Typically, ten or more households share a single stand post. In the Reclamation East and West settlements, which are overcrowded, more than fifteen households must share a single stand post (Balachandran & Thennakoon, 2021). At the same time, JMC and NPS have restricted their drinking water supply due to the low yield, and the residents struggle with severe drinking water shortages due to inadequate water allocation per person per day (Balachandran & Thennakoon, 2021). As a result, all of the settlements in the study area lack access to drinking water, as illustrated in Figure 10. *Vasanthapuram, Niththiyaolly, Sabinagar, Pommaivelly, Poompugar, Ariyalai Munanku, Navalady,* and *Uthayapuram,* in particular, are severely deprived of drinking water as indicated in Figure 11.

People from the divisions highlight that due to insufficient provision, they struggle to collect water for drinking where the well water is contaminated with high salt. During the field visit, it was noticed that one or two tanks had been installed on streets in the areas of *Ariyalai East, Poompukar, Uthayapuram,* and *Mulli,* where residents are having difficulty collecting drinking water due to the unavailability of drinking water.

*Navanthurai North* community leader mentioned,

> *"Due to the unsuitability of house well water, the JMC provides us with drinking water. However, they provide water for half an hour between 6.30 and 7.00 am. One stand post is shared with more than 10 households; therefore, the duration is insufficient to collect water for all households. At the same time, the water provision time is inconvenient for us as we have to send our children to school. If we come late to the stand post, we won't be able to acquire drinking water for the entire day. Then we either send our husbands to the temple well or common well to collect water, or have to purchase water from a mobile private tanker truck. We have complained regarding this matter to the respective institutions, but have not received any solution yet. Access to drinking water is a huge strain for us; purchasing drinking water daily is beyond our budget".*

*Ariyalai East* community leader mentioned,

> *"Due to the excessive salinity of our well water, we rely on NPS for drinking water. They placed one or two tanks on the side of the road and filled them three times a week. It is insufficient to meet our requirements. There are no other options for getting water here. "We've complained to several institutions, including ground level, divisional level, and district level, as well as political parties, about the issue, but it hasn't been resolved yet."*

The JMC administrative officers stated that,

*"Due to a lack of drinking water sources, JMC is unable to provide water for 24 hours with an adequate supply to all divisions".*

The NPS administrative officers stated that,

> *"NPS provides water to those in need three times a week via tanks, primarily in Ariyalai East, Poompukar, Udayapuram, and Mulli."*

Water for other domestic purposes is also necessary. Based on the selected criteria, the survey found that 23.45% of settlements lack water for other purposes. The divisions of Reclamation West, Navanthurai North, and Reclamation East have a significant number of settlements (46.32%) that lack water for other purposes. Figure 11 depicts the spatial distribution of USSs that lack drinking water and water for other purposes. Furthermore, Figure 12 depicts the condition of wells in underserved areas.

### 3.3.3 Access to Sanitation Facility

Improved sanitation is defined as having access to a facility with an excreta disposal system that safely separates human waste from human contact [UN-HABITAT, 2021]. Sanitation facilities are unavailable in 15.70% of the USSs in the study area. According to the survey, the divisions of *Reclamation West, Navanthurai North, Reclamation East, Moor Street North, Ariyalai East,* and *Nedunkulam* have a considerable number of settlements that are lacking in sanitation facilities, which accounts for 56.75%.

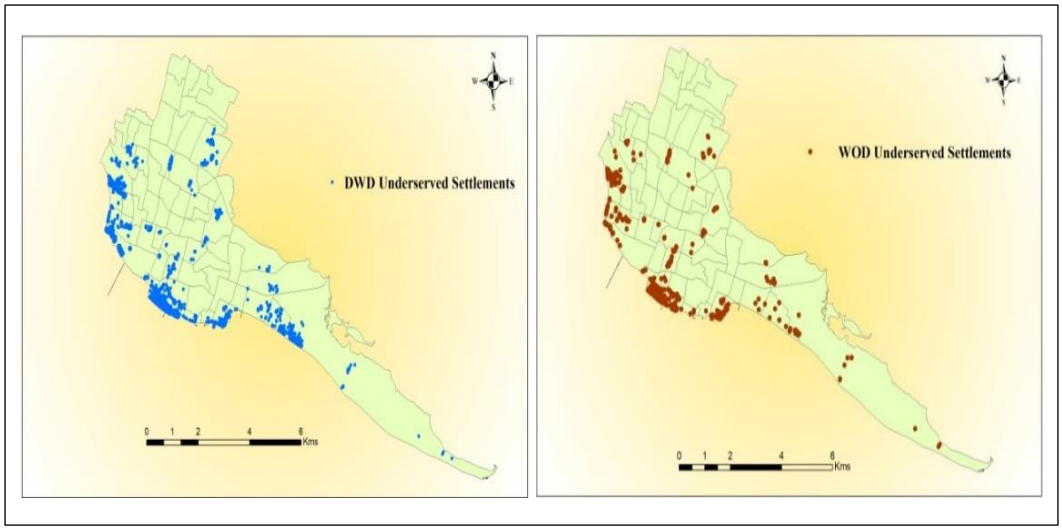


**Figure 11.** Underserved Settlements with Drinking Water Deprivation (DWD) & Water for Other Purposes Deprivation (WOD) (Source: Field survey, 2020 & 2021)

During the FGD, 81 % of respondents stated that in previous years, the majority of them utilized public toilets. The sharing of toilets by residents causes a slew of problems, like being forced to wake up early to get in line, and arriving late for work and school.

*Navanthurai North's* community leader explained that,

> *"In the past, everyone used the public toilet; however, recently, they built individual toilets with their own money because their female children are growing into teenagers, and they are concerned about their privacy and security. Furthermore, the government, non-governmental organizations, and charitable organizations have taken steps to provide residents with permanent toilet facilities. As a result, the number of settlements that do not have individual toilets has dropped considerably. Anyhow, presently, 27 households use the public toilet and 27 households use their neighbours' toilets".*

According to the community leader of *Moor Street North*,

> *"There are 26 families of 133 people living in 26 USSs on the 1st cross street. Only four houses have individual toilets provided by the Ministry of Resettlement. Others utilize a single public toilet provided by Jaffna police, while another public toilet is in deteriorated condition".*

The USSs of *Niththiyaolly* and *Pommaiveli* are still using communal toilets, where one toilet is shared by a large number of people. The public toilets at Niththiyaolly and Pommaiveli are shown in Figure 13.

During the field visit, it was noticed that some toilets were lacking essential components or were in a dilapidated state and that the pits were not adequately constructed. During the FGD, respondents stated that they experience several inconveniences as a result of the faulty design of some latrine pits; the toilet waste is contaminated with runoff, especially during the rainy season. Conditions of toilets in the USSs are depicted in Figure 14.

**Figure 12.** Condition of Wells in the Underserved Settlements
(Source: Field survey, 2020 & 2021)

**Figure 13.** Condition of Public Toilets in the Underserved Settlements
(Source: Field survey, 2020 & 2021)

### 3.3.4 Access to Electricity Facility

Electricity is required for lighting and the function of household appliances (Patel, Shah & Beauregard, 2020). In the study area, 0.76% of the USSs are deprived of access to electricity, which is in *Athiyady, Thirunagar, Reclamation East, Reclamation West, Small Bazzar, Fort, Ariyalai East*, and *Ariyalai Center South.* They rely on kerosene for lighting. The grid line is available in their neighbourhood, but due to financial constraints, they are unable to get the connection.

Figure 15 shows the USSs that lack access to sanitation facilities and without electricity.

**Figure 14.** Conditions of Toilets in the Underserved Settlements
(Source: Field survey, 2020& 2021)

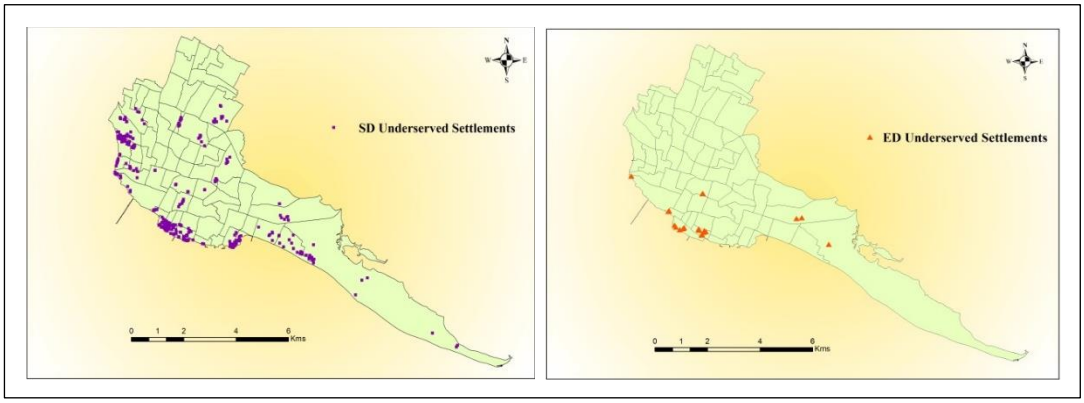


**Figure 15.** Underserved Settlements with Sanitation Deprivation (SD) and Electricity Deprivation (ED). Source: Field survey, 2020 & 2021

### 3.3.5 Access to the Kitchen and Clean Fuel

It's imperative to have access to a kitchen and clean fuel to reduce indoor air pollution and the resulting respiratory health problems (Sanbata, Asfaw & Kumie, 2014). In the study area, 36.95% have an inside kitchen, 24.05% have an outside kitchen, and 39% don't have a separate kitchen but have designated a portion of their living room for cooking needs. In terms of access to clean fuel, 43.11% of settlements have limited access to clean fuel (Liquid Petroleum Gas [LPG] /electricity/ kerosene/ biogas/ solar), while the rest rely on firewood/ charcoal/ coal/ agriculture residue/ dung. Settlements with a lack of kitchens and clean fuel are depicted in Figure 16.

### 3.3.6 Security of Tenure

People have secure tenure when there is documentation that can be used to prove their status. Secure tenure is defined as everyone's right to effective state protection against forced evictions (UN-HABITAT, 2021). In Figure 17, the lands of USSs and the settlements with a lack of security of tenure are represented.

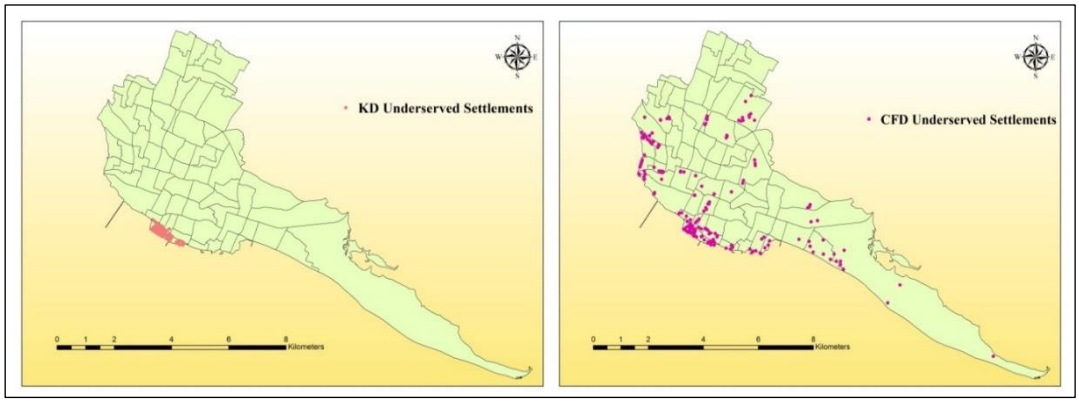


**Figure 15.** Underserved Settlements with Kitchen (KD) and Clean Fuel Deprivation (CFD) (Source: Field survey, 2020 & 2021)

Figure 17 shows that 58.99 % of the settlements in the study area lack security of tenure. Within the settlements that lack tenure security, 69.75% are on state-owned land, 12.74% are on religious institutions-owned land, and the remaining settlements are on private land. *Reclamation East, Navanthurai North,* and *Reclamation West,* in particular, have the highest number of settlements without the security of tenure, accounting for 47.27%. Figure 18 depicts the settlements that are on the land reservations along the road.


**Figure 17.** The Lands of Underserved Settlements and Underserved Settlements with Security of Tenure Deprivation (STD) Source: Field survey, 2020 & 2021

**Figure 18.** Underserved Settlements in the State Land Reservations (Source: Field survey, 2021)

*Passaiyoor East* community leader stated,

> *"We have lived in this place for more than 40 years. Due to the unaffordability of purchasing a land plot, we occupied this place where we don't need to pay land rent or land value, and the place is very close to the working place. However, we paid the property tax to JMC annually. Furthermore, we reported the land issue under the accelerated programme on solving post-conflict state land issues in the Northern and Eastern Provinces in 2013 and received a reply that action will be taken in the future to resolve our problems. However, no attempt has been made to provide us with land*

*ownership, and we still receive notifications from the Coastal Conservation Department [CCD] that we have to vacate this place".*

*Navanthurai North* community leader stated,

*"We bought the land from someone who falsely claimed to possess it. We then came to know that it was the property of another person who lives overseas. We have now been labelled as encroachers. "*

Following that, issues related to land tenure were discussed during the KIIs, and the findings are summarized below.

According to the CCD's administrative officer,

*"The CCD insisted on a 50-meter buffer zone along the coast from Ariyalai to Navanthurai. People, on the other hand, do not adhere to the setbacks, and massive coastal encroachment has occurred along the coastal zone between Nedunkulam and Navanthurai, causing adverse effects on the coastal ecology. The CCD has taken some legal actions against the coastal encroachments. However, due to political pressure, the CCD is having difficulty evicting and controlling unauthorized settlements. Anyhow, CCD is currently exerting maximum effort to control the emergence of new USSs in the coastal reservation. At the same time, when the coastal zone plan is revised in the future, CCD contemplates reducing the extent of coastal setbacks to reduce the number of unauthorized settlements".*

According to a social activist, *"One of the most significant aspects of settlement is land tenure. While the land is deemed to be the residents' property, it is legally valid for gaining authorization to build homes and receive bank loans and mortgages. A significant number of underserved settlement inhabitants are experiencing challenges as a result of the lack of legal evidence. In addition to that, the land was reclaimed and provided to the fishing population in the 1950s. Following that, people occupied the conquered lands and set up their residences. They don't have proper legal evidence, but they produce forged documents and get invalid deeds".*

This study identified and delineated USSs geographically and underserved populations numerically by following Patel, Koizumi & Crooks (2014); Patel et al., (2019); and Patel, Shah & Beauregard, (2020). Moreover, previous studies employed the following approaches for USS identification: 1) participatory mapping and enumeration, which aims to change the relationship between USS residents and city governments by empowering residents, identifying community resources, and holding city governments accountable (Macura, 2012; Makau, Dobson & Samia, 2012); 2) longitudinal survey research to pinpoint heterogeneity within USSs and monitor changes over time (Rains, Krishna & Wibbels, 2019); 3) Remote Sensing in conjunction with household surveys to uncover hidden USSs and define USS boundaries (Krishna et al., 2014).

Several researchers focused on assessing USSs in terms of deprivation, vulnerability, and severity using various indexes specified in section 1 and constructed using the criteria specified in Table 06. The criteria of adequate structure, adequate living space, access to improved drinking water, access to water for other purposes, access to improved sanitation, access to electricity, access to kitchen, access to clean fuel, and security of tenure were employed in this study to assess multiple housing deprivations in USSs via SSI. The proportion of settlements deprived of the abovementioned housing condition is tabulated in Table 07.

**Table 6.** Criteria Used to Assess the Condition of Underserved Settlements

| Researcher | Household characteristic | Housing characteristic | Employment & Income | Health | Education | Access to basic services | Security | Physical environment |
|---|---|---|---|---|---|---|---|---|
| Ahmed & Mustafa (2016) | | √ | | √ | | √ | | |
| Akoteyon, Aliu & Soladoye (2020) | | | | √ | | √ | | √ |
| Devi, Lowry & Weber (2017) | | | | | | | | √ |
| Fukuda, Nakamura & Takano (2007) | | | | √ | | | | |
| Khan, Kundu & Yeasmin (2021) | √ | √ | √ | √ | √ | √ | √ | |
| Mandleni et al. (2021) | √ | √ | √ | √ | √ | √ | √ | √ |
| Mawkhlieng & Debbarma (2018) | | √ | | √ | √ | √ | | √ |
| Messer et al. (2006) | | √ | √ | √ | √ | | | |
| Nolan, Bloom & Subbaraman (2017) | | | | √ | √ | √ | | |
| Okoye, Ezeokonkwo & Mbakwe (2017) | | √ | | | | √ | | √ |
| Patel et al. (2019) | | √ | | | | √ | √ | |
| Patel, Koizumi & Crooks (2014) | | √ | | | | √ | √ | |
| Patel, Shah & Beauregard (2020) | | √ | | | | √ | | |
| Rao &Thakur (2007) | | | √ | √ | | | √ | |
| Roy, Bernal & Lees (2020) | | √ | | | | √ | | |
| Sajjad et al. (2014) | √ | √ | √ | √ | √ | √ | | √ |
| Salmond et al. (2012) | | | | √ | | | | |
| Uddin (2018) | √ | √ | √ | √ | √ | √ | √ | |
| UN-Habitat, CEPA & Sevanatha (2013) | √ | √ | √ | √ | √ | √ | √ | |
| | 5 | 13 | 7 | 13 | 8 | 14 | 7 | 6 |

Source: Created by the researcher in accordance with a literature review, 2021

**Table 7.** Housing Deprivation in Underserved Settlements

| Criteria | Percent (%) |
|---|---|
| Clean fuel deprived USSs | 56.89 |
| Drinking water deprived USSs | 100 |
| Electricity deprived USSs | 0.76 |
| Housing structure deprived USSs | 42.35 |
| Kitchen deprived USSs | 39.00 |

| | |
|---|---|
| Living space deprived USSs | 81.23 |
| Sanitation deprived USSs | 15.70 |
| Security of tenure deprived USSs | 58.99 |
| Water for other purposes deprived USSs | 23.45 |

Source: Field Survey, 2020 &2021

Thus, according to the survey, 42.35% of USSs lack more than three housing conditions, with 0.76% lacking all housing conditions and the rest lacking three or less basic housing conditions. Except for having access to water for drinking, the GND output varied greatly in terms of their main housing deprivation. Patel, Shah & Beauregard (2020) conducted a similar type of study, and their findings indicated that access to a kitchen, clean fuel, sanitation, and water remained the leading causes of housing deprivation in urban India, with states differing greatly in their main housing deprivations. Roy, Bernal & Lees (2020) indicated high variety of housing conditions of USSs in Mexico. According to Akoteyon, Aliu & Soladoye (2020), the large number of Nigeria's underserved households are cramped, have poor access to sanitation, and live in an unfavourable environment.

Okoye, Ezeokonkwo & Mbakwe (2017) emphasized that the majority of buildings in the underserved area and the surrounding environment are in dilapidated condition, which has a substantial detrimental effect on the residents' general wellbeing. According to Mawkhlieng & Debbarma (2018), the USS problem is heterogeneous, and different regions respond differently to USS issues, therefore, assessing the living conditions and quality of life of urban USSs on a regional scale is crucial for sustainable urban development.

Accordingly, the research question of where underserved settlements are spatially distributed and for what housing conditions these dwellings are in deprived status—particularly in Jaffna Municipality and its urban fringe was illustrated using figures and tables.

## 4. Conclusion and Recommendation

Recognizing the full scope of the housing problem is regarded as crucial for planning and policymaking purposes. In other words, failing to comprehend the full extent of housing issues may result in inadequate governmental resource budget allocations for housing issues. Due to the heterogeneity of living conditions as well as the residents' socioeconomic and democratic characteristics, it is challenging to delineate USSs using the neighbourhood as the analytical unit (Patel, Shah & Beauregard, 2020; Patel, Koizumi & Crooks, 2014). Consequently, settlements must be recognized at the housing unit level. Previous research has also indicated that type of housing deprivation is a more accurate method for identifying deprivation by sectorial domains and can eventually aid in the development of sector-specific policies (Patel, Shah, & Beauregard, 2020; Patel et al., 2019; and Patel, Koizumi, & Crooks, 2014). As a result, the present study identified USSs at the housing unit level, assessed the multiple housing deprivations, and contributed significantly to accurately estimating housing problems, tailoring housing programs based on housing requirements, and prioritizing policy interventions based on the degree of housing deprivation. Furthermore, this approach helps reduce housing deprivation in USSs to attain sustainable development goals and establish cities without USSs.

Reorganizing the existing infrastructures and activating malfunctioned infrastructures in underserved areas, allotment of government lands to people in alternative places, acquisition of temples and private land from the landlords, taking measures for the construction of dwellings for low-income

households, creating sustainable infrastructure mechanisms for the entire Jaffna region and integrating the USSs with them, taking steps to build apartments for low-income households, taking measures to provide legal evidence for their land, increasing the human, economic, and social capital in USSs, developing housing policies for sustainable development of USSs, develop coordination between multiple stakeholders, preserving the land reservations, and raising awareness of environmental protection are some strategies used to reduce housing deprivation in USSs in various spatiotemporal contexts. For instance, Karunarathne & Lee (2022) asserted that urban reciprocal support network legacies are important in improving the resilience of urban informal livelihoods. According to Nolan et al. (2017), inequality in housing, quality of life, and health outcomes in urban areas is perpetuated by a lack of legal recognition; thus, providing legal recognition improves access to basic services, lowers the threat of eviction, and enables them to organize collectively to claim these entitlements, which will improve the quality of their homes. Not only they but also UN-Habitat, CEPA & Sevanatha (2013); Uddin (2018); and Khan, Kundu & Yeasmin (2021) have highlighted that establishing legal land rights for people can help to solve the problem of USSs. Uddin (2018) advocated for a holistic approach involving the cooperation and collaboration of various actors in order to address the various challenges of USSs. Okoye, Ezeokonkwo & Mbakwe (2017) emphasize the bottom-up approach in identifying the priorities and problems of USS dwellers and encouraging their participation in USS upgrading programs.

This study offered a descriptive analysis of multiple housing deprivations by taking into account criteria such as housing characteristics, service availability, and security. Future research can examine the role of location, health, education, employment, income, expenditure, asset, and relief assistance, participation in CBOs, social network, and security in housing deprivation, which can then be integrated with SSI.

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