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Building **Inclusive** Urban Communities

CASE STUDY

EXPLORING RELATIONS BETWEEN VULNERABILITY, TENURE AND PHYSICAL CONDITIONS IN SLUMS ALONG SEWERAGE CHANNELS OF VIJAYAWADA CITY

Ayon Kumar Tarafdar – 2018

Funded by the Erasmus+ Programme of the European Union

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Suggested Reference:
Tarafdar, A K (2018) Exploring Relations between Vulnerability, Tenure and Physical Conditions in Slums along Sewerage Channels of Vijayawada City. A report prepared for the Building Inclusive Urban Communities (BInUCom) project, funded by the Erasmus+ Programme of the European Union: http://moodle.donau-uni.ac.at/binucom/

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ABSTRACT

The study challenges the basic presumption amongst most Indian urban local bodies that regularizing or notifying slums leads to eventual improvement the living conditions. This has been re-looked at, through the prism of vulnerability as a tool of analysis, as vulnerability is a wider and integrated concept encompassing various components of capabilities and entitlements. The study quantifies three dimensions of vulnerability ie., social, economic and physical, based on nineteen parameters and relates the findings from slums that are located next to the sewer channels in the city of Vijayawada with aspects of tenure within the slums. The study demonstrates a need for comprehensive multi-dimensional assessment of vulnerability in slums to comprehend the actual conditions before embarking upon improvement strategies. It also attempts to show that development interventions in slums need to be multi-dimensional and not only of physical nature. ◆

“ This study demonstrates a need for comprehensive multi-dimensional assessment of vulnerability in slums to comprehend the actual conditions before embarking upon improvement strategies.”

CONTENTS

PART 1
UNLEARNING INFORMAL SETTLEMENTS

It is a generally accepted rhetoric that the informal sector is a constant and growing factor in present context of developing economies. 'Informality' is a term that is often used to describe a collection of firms, workers, and activities that operate outside the legal and regulatory frameworks of an economy. On an average, in a typical developing economy, the informal sector produces about 35% of the GDP and engages about 70% of the labour force. In South Asia, these figures are higher, i.e., about 85% of labour force performs outside the regulatory frameworks on daily wages and unaccounted cash dealings (World Bank, 2017). Significant analysis at the national level data shows that a substantial proportion of the daily wage workers are either landless or 'land-poor'. Added to this is the factor of very low years of education and training which limits the chances of informal sector workers to access higher quality work or better bargaining power (Govt of India, 2008). Characteristically, this large segment of informal sector lives under stressful living conditions in the urban context owing to their socio-economic background, migratory tendencies, lack of assets and low affordability. Attuned to exploitation and being constantly adjusting to adversaries, most informal sector workers and their families settle in colonies that are unauthorised and makeshift. Such colonies are often known to be deprived of basic amenities with relatively sub-standard spaces. However, due to the large quantum settlers residing in the informal settlements and the relatively long period of time for which these settlements exist, they have become an accepted and integral part of most Southern cities, commonly known as 'slums' (Chaudhari and Banerjee, 2007).

There is enough body of work explaining how to improve slum conditions that focusses mainly on in-situ development of basic infrastructure, participatory frameworks, and giving permissions to stay and function in these settlements (Chaudhari and Banerjee, 2007; ILO, 2002; Mahadevia, 2011; Jain, 2015). In lieu of similar logic, a large volume of public funding has been devolved in the last decade, particularly in India through schemes like Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Pradhan Mantri Awas Yojana (PMAY), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), and Smart Cities Programme that attempt to invest into components of physical infrastructure, housing, and ordain improved sense of tenure security. However, conditions of public health, probability to contract diseases due to unhygienic conditions, risk of accidents, threat of eviction and limited ability to cope with conditions of shock, continue to cast a shadow on a large proportion of urban citizens of India. For example, about 20 to 50% percent of Indian urban population continue to live in slums; one third of urban Indian families still live in houses that do not have kitchen, toilet, and treated water supply; only 44 percent of urban houses and 12 percent of slum houses in India have concrete roofs (Jain, 2015). Maternal and child health indicators among slum people show that their health is two-three times worse than other urban areas. It is estimated that public agencies are only reaching to about 30% of the urban poor and those being served belong to the comparatively 'better off' slums (Rao, 2007).

The word 'vulnerability' literally means 'propensity to be easily hurt'. Vulnerability itself implies the extent to which individuals are incapable of making and implementing free and informed decisions about their life (Rao, 2007). Slum residents, already grossly affected by chronic poverty, are highly vulnerable to different forms of shocks. The ability/inability to cope to conditions of shock and be able/unable to revert back to normalcy in short durations of time is what broadly encompasses vulnerability. Dimensions and methods of gauging vulnerability are well backed by theoretical rhetoric. Assessment of vulnerability in marginalised sections and in slums indicates dimensions of health, social, physical and economic aspects (Agarwal, 2005). However, the methodologies categorize places by creating a dichotomous division of 'slum' versus 'not slum'. This may be a problematic dichotomy as it hides the physical and social diversity within the slums (Marta, 2011). Also, there remains lack of clarity of whether by addressing mostly physical infrastructure and security of tenure, which has been the cornerstone of most of public funding in slum improvement, are the informal settlers becoming less vulnerable (Rao, 1984). Studies that attempt to bring out variations within slums in terms of particular vulnerabilities are limited.

In this backdrop, this report attempts to probe into the relations between vulnerability of slum dwellers and their actual physical conditions along with security of tenure, to arrive a framework of slum assessment that may look into varying vulnerabilities within slums in order to derive necessary strategies. The dominant structuralist approach that informal settlements need to be universally upgraded with specific planned interventions related to physical infrastructure and tenure, is attempted to be altered.

This report takes up the case of slums in Vijayawada, the new capital of the federal state of Andhra Pradesh. The aspect of slum improvement and upgrading is known to be progressive and dynamic in Vijayawada, with several slums being 'notified' and then upgraded in-situ over decades and several slums being redeveloped into resettlement colonies successfully (Baken, 2008). The city of Vijayawada has 111 notified slums, sheltering more than 3,00,000 population out of 11,00,000 total population living in the city, covering about 14.5 percentage of the city's area. There are about 22 slums out of these notified slums that lie in hazardous zones of the city putting life and property to short and long term risks. In addition, there are about 56 slums that are not notified. The notified slums have undergone slum improvement measures and the residents have some form of security of tenure. The paper attempts to pick one slums out of these notified ones which lies adjacent to the hazardous sewerage channels of the city and attempts to explore the relation of differential vulnerabilities of the dwellers and their security of tenure. Detailed study objectives and questions are discussed in subsequent sections. ◆

PART 2
INFORMAL SETTLEMENTS IN VIJAYAWADA

Vijayawada, the second largest metropolitan city in the federal state of Andhra Pradesh (A.P.), India by population, lies on the banks of river Krishna. The city is strategically situated within the Andhra Pradesh Capital Region, where the proposed green-field capital is getting designed, within a proximity of 5 kilometres. Due to the formation of the new State of Andhra Pradesh and the declaration of the new capital in its vicinity, the city is undergoing massive transformation in every respect. The city holds special significance being known as the 'the business capital of Andhra Pradesh' (Rao, 1984). The million-plus city of Vijayawada is well-connected to major Indian cities by national and state highways, the railways and airways, and thereby serving as a major transit point for many in the state of Andhra Pradesh. The railway junction at Vijayawada connecting north & south India is one of the most important railway junction of southern India. Known to be the knowledge city, a higher educational node for engineering and medical education, a hub for medical services, a centre for performing arts and due to the presence of the largest automobile servicing and repair cluster in South India, Vijayawada is perceived to be the commercial and cultural centre in the State of Andhra Pradesh. All these factors draw a large number of migrants and floating population to the city of Vijayawada every day. Additionally, due to the declaration of the new capital in the region, the city is undergoing a high spurt of construction and retrofitting activities to match up with the sudden relocation of many Andhra Pradesh government, corporate and administrative offices in the region from Hyderabad in the last two years. There are many residential and commercial projects emerging in the city and its suburbs due to the sudden increase in demand.

Figure 1

Location of Vijayawada and its Urban Spread

Geographically, Vijayawada is surrounded by Budameru River in the North, by the low range Indrakeeladri hills of Eastern Ghats along north-west, and southwest and by the river Krishna in its west. The south-western and north-western parts of Vijayawada is covered by rich and fertile agriculture lands yielding over 15 different crops in different stretches annually and three major irrigation canals – Eluru (~7.5km), Bandar (~8km) and Ryves (~7km) – run through the city.

In 1855, the British constructed the Prakasam Barrage on the river Krishna and the three canals for irrigation and navigation purpose. Since then, the city grew along the canals, the river and the transport linkages over the years. The canals are currently non-navigable and used only for the purpose of irrigation and drainage. Bandar, Eluru, and Ryve's canal, that serve drinking needs also down the stream, stand testimony to rampant pollution. The present scenario is such that the canal berms instead of giving benefits to the city, became major cause for degrading the city environment as the canals are polluted due to the solid waste & sewage coming from city households as well as slums located on canal berms. Due to the lack of enforcement of law, poor people has encroached open land which is the major cause of forming hazardous slums along the canal berms. The three canals cutting through the city will speak volumes of lethargy of administration.

The rate of growth of the slum population has been very high over the last two decades (Census, 2001, 2011). Out of the 59 city wards (which is a sub-city municipal administrative division), it is found that 36 wards have vulnerability due to spatial location and inefficiency of internal systems providing basic amenities to the marginal population. And a significant share of this vulnerable population resides in 22 notified slums situated along the canal berms and flood plains of river Krishna. These slums together form over 1,20,000 population or over 30,000 households staying about 24,000 houses. These slum dwellers have different types of tenureship of the property and limited facilities of accommodation, sanitation, waste disposal etc. making the living conditions grave. There is loss of property and precious lives in these slums every year during rains and floods due to the hazardous conditions. Deaths and water borne diseases are frequent consequences in these regions which submerge every year. As per media reports, the local government and other agencies come together during such times to provide aid.

In this context, the research would like to derive a focus on issues of vulnerability and tenure related to the slums that are located next to the sewerage canals and get submerged every year. In a milieu of mounting population growth in the city due to the upcoming capital city, its slum population are likely to continue to concentrate in the unauthorised and hazardous pockets of existing slums areas and hence require relevant, significant and critical attention. ◆

Figure 2

Location of Slums in Vijayawada

PART 3
VULNERABILITY, HAZARDOUS ZONES AND INFORMALITY

3.1 Defining Vulnerability

By vulnerability we mean '*the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard*'. It involves a combination of factors that determine the degree to which someone's life, livelihood, property and other assets are put at risk by a discrete and identifiable event in nature and in society. Some groups are more prone to damage, loss and suffering in the context of differing hazards. Vulnerability is defined as "the degree to which a system is likely to experience damage from exposure to a hazard or stressor, where a hazard is a single event and a stressor continues over time" (Turner, et al., 2003). Vulnerability is commonly associated with poor economic and nutritional status, but many other overlapping social vectors such as quality of housing and public services, occupation, gender, disability, marital status, age, debilitating ailments and many other aspects. (Ministry of Health and Family Welfare, 2017).

Key variables explaining variations of impact include class (which includes differences in wealth), occupation, caste, ethnicity, gender, disability and health status, age and immigration status (whether 'legal' or 'illegal'), and the nature and extent of social networks. The concept of vulnerability clearly involves varying magnitudes: some people experience higher levels than others. But we use the term to mean those who are more at risk: when we talk of vulnerable people, it is clear that we mean those who are at the 'worse' end of the spectrum. When used in this sense, the implied opposite of being vulnerable is sometimes indicated by our use of the term 'secure'. Other authors complement the discussions of vulnerability with the notion of 'capacity' – the ability of a group or household to resist a hazard's harmful effects and to recover easily.

The definition for vulnerability is illustrated by their wide appeal across disciplines and problem areas, and also by their context dependent nature. Policy communities have also yet to reach a common definition of this term. Even in disaster risk management and climate change, two increasingly allied fields of policy, existing definitions of vulnerability differ in their emphasis. According to UNISDR, vulnerability is defined as "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard". The Intergovernmental Panel on Climate Change (IPCC) has shifted from understanding vulnerability to climate change as "the degree to which systems are susceptible to, and unable to cope with, adverse impacts of climate change including climate variability and extremes" (IPCC, 2007) to "the propensity or predisposition to be adversely affected" (IPCC, 2012). The significant difference between these definitions is the relationship between vulnerability and physical events. While in the former, vulnerability is dependent on exposure, in the latter, vulnerability is considered independently of the physical event. It allows for a different understanding of vulnerability and lends itself to an alternative set of policy interventions. It reflects a departure from how the concept is usually portrayed in climate change circles and can be seen as an effort to align more closely with the disaster tradition.

The different dimensions for vulnerability assessment as followed for this project are as follows:

I. Physical vulnerability
This dimension covers aspects, which include persons/households who are vulnerable because of their residential location and type of housing. These include persons who are homeless, mobile (migrants), living in temporary houses, shanties, facing insecurity of tenure, unnerved or underserved with basic public services like sanitation, clean drinking water and drainage.

II. Social vulnerability
This dimension covers issues faced by people who tend to get discriminated or challenged based on their social status, i.e., their religion, gender, age, literacy levels, health based disability or illness etc. Such vulnerabilities are faced by women, transgender, senior citizens, child-headed households, disabled persons, persons suffering from debilitating illnesses like HIV/AIDS, Leprosy, Tuberculosis, mental illness, persons belonging to scheduled castes and scheduled tribes, migrant workers, religious minorities etc.

III. Economic vulnerability
This dimension is faced by persons/households who are without access to regular employment, susceptible to significant periods of unemployment, as well as those who face occupational hazards due to unsafe working environments.

The project goes on to detail the different dimensions of vulnerability in the form of measurable parameters under each and quantifies the levels of vulnerability as discussed in subsequent sections.

3.2 Defining Informality and Slums
"Informality" is a term used to describe the collection of firms, workers, and activities that operate outside the legal and regulatory frameworks or outside the modern economy. The term informality means different things to different people, but almost always bad things: unprotected workers, excessive regulation, low productivity, unfair competition, evasion of the rule of law, underpayment or non-payment of taxes, and work "underground" or in the shadows.

Slums can be defined as an area of the city that is very poor and where the houses are very poor and in bad condition. The word "slum" is often used to describe informal settlements within cities that have inadequate housing and squalid, miserable living conditions. They are often overcrowded, with many people crammed into very small living spaces.

In India, the Slum Area (Improvement & Clearance) Act, 1956 (under section 3) provides the legal basis for defining or declaring any area as "slum". The Act uses the following criteria for defining slum:

- Area in any respect unfit for human habitation
- Area by reason of dilapidation, overcrowding, faulty arrangement and design of such buildings, narrowness or faulty arrangement of streets, lack of ventilation, light, sanitation facilities or any combination of these factors which are detrimental to safety, health and morals.

The Registrar General of India has adopted the following definition for the purpose of Census of India, 2001:

- All specified areas in a town or city notified as 'Slum' by State/Local Government and Urban Territory Administration under any Act including 'Slum Act'.
- All areas recognized as 'Slum' by State/Local Government and UT Administration, Housing and Slum Boards, which may have not been formally notified as slum under any Act.
- A compact area of at least 300 populations or about 60-70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities.

The National Sample Survey Office (NSSO), for the purpose of survey in 1976-77 defined slum as declared and undeclared slums. The declared slums were areas which have been formally declared as slum by the respective municipalities, corporations, local bodies or the development authorities. The undeclared slums were defined as "an aerial unit having twenty-five or more kutcha structures mostly of temporary nature, or inhabited by persons with practically no private latrine and inadequate public latrine and water." For the purpose of the survey in 1993 and 2002, National Sample Survey Office (NSSO) adopted the definition of slums as "A slum is a compact settlement with a collection of poorly built tenements, mostly of temporary nature, crowded together usually with inadequate sanitary and drinking water facilities in unhygienic conditions. Such an area, for the purpose of this survey, was considered as "non-notified slum" if at least 20 households lived in that area. Areas notified as slums by the respective municipalities, corporations, local bodies or development authorities are treated as "notified slums". United Nations (UN-HABITAT) defines "A slum is a contiguous settlement where the inhabitants are characterized as having inadequate housing and basic services. A slum is often not recognized and addressed by the public authorities as an integral or equal part of the city." Slum households as a group of individuals living under the same roof that lack one or more of the conditions listed below:

- Insecure residential status;
- Inadequate access to safe water;
- Inadequate access to sanitation and other infrastructure;
- Poor structural quality of housing;
- Overcrowding.

The definition of Notified Slum Area as provided in "Andhra Pradesh Slum Improvement (Acquisition of Land) Act, 1956" is "where the government are satisfied that any area is or may be a source of danger to the public health, safety or convenience of its neighbourhood by reason of the area being low lying, insanitary, squalid, or otherwise, they may by notification in the Andhra Pradesh gazette declare such area to be a slum area." The Slum areas recognized by Urban Local Bodies (ULBs) but not notified by the State Government as above are "Non-notified Slum areas".

3.2.2 Slums in India

A total of 65.49 million population living in 13.9 million households have been enumerated in slums of 2613 cities/towns spread across 31 States and Union Territories in the 2011 Census of India. The non-slum population was 311.61 million. The slum population enumerated constitutes 5.4 per cent of the total population of the country. The slum population constitutes 17.4 percent of the total urban population of all the States and Union Territories; 82.6 percent of the urban population was non-slum population in 2011. The slum population enumerated was 22.4 per cent of the total population of the 2613 statutory towns (including 19 Census Towns in National Capital Territory of Delhi) reporting slums (Ministry of Housing and Urban Poverty Alleviation, 2015).

Slums in the 189 towns of Maharashtra accounts for 11.85 million population, which is 18.1 percent of the total slum population of the country. This is followed by Andhra Pradesh (10.2 million), West Bengal (6.4 million), Uttar Pradesh (6.2 million) and Tamil Nadu (5.8 million). In fact, these 5 states namely Maharashtra, Andhra Pradesh, Uttar Pradesh, West Bengal, Tamil Nadu account for about two-thirds (61.9 per cent) of the total slum population of the country. Other ten States/Union Territories namely Punjab, Haryana, Delhi, Rajasthan, Gujarat, Karnataka, Chhattisgarh, Orissa, Madhya Pradesh and Bihar have reported each more than 1 million slum dwellers in its cities/towns in 2011. Besides Jammu and Kashmir, all North-Eastern states including hilly states reported less than half a million slum population. ◆

PART 4
RESEARCH CONTEXT AND METHOD

Based on the backdrop as presented in preceding sections, the paper derives its goal to explore and critically examine the relation between vulnerability of the slum and tenure and physical conditions, in slums along canals/sewerage lines of Vijayawada. It is often seen that urban local bodies (ULBs) tread upon the path of regularising or relocating slums and unauthorised colonies. By regularising, the security of tenure of slum dwellers increase manifold, which in turn increase their chances of investing in their living space. However, regularising is an option, which is often taken when there is no other alternative left for the ULBs to manage an area. Slums which delve on hazardous stretches, where no other use may be permissible are often areas where ULBs face severe problems in managing and controlling urban dwellers and hence opt for regularising or providing tenure certificates in order to bring in certain levels of monitoring. It is intriguing to understand whether such steps lead to changes in levels of vulnerability amongst the slum dwellers. In essence, the paper builds itself to address the following research question: *"How can understanding of the linkages between living conditions, security of tenure and vulnerability of slums address strategic frameworks that deal with slum improvements?"*

Since there is limited literature on how vulnerability assessment plays any role in decision related to tenure or authorisation of hazardous slum settlements, the paper aims at analysing vulnerability dimensions in depth, to bring out aspects where the ability to cope with shocks and adversity is extremely challenged and limited. In this backdrop, the first research objective entails the following.

a) To estimate degrees of composite vulnerability involving social, economic, and physical factors in the slums of Vijayawada that lie in submergible hazardous stretches.

Due to limits in financial and human skill resources, they are often disabled to deal with health or financial risk. In addition, there is serious exposure to contamination, unhygienic conditions and vectors of diseases due to living conditions and locations. In this context, the second research objective is derived to understand the context in depth:

b) To characterise the living conditions in the slums that lie in submergible hazardous stretches of Vijayawada, in terms of space, function and structures.

Security of tenure in slums are an important factor that influences the manner in which dwellers engage themselves within the slum spaces. Upkeep of the common spaces, arrangement of amenities, maintenance of basic levels of hygiene, distribution of spaces, etc. are some of the tenets, which undergo massive changes as we see betterment in security of tenure. While perpetual security of tenure is often difficult to provide in slums, perceived and varying degrees of security of tenure are often meted out which has the capability of transforming spaces into better living spaces.

The two research objectives shall culminate in a framework of understanding slums where living condition, administrative response and actual vulnerability can be linked in order to form a decision support system for slum dwellers. The research shall have its central purpose of challenging the

basic presumption amongst most Indian ULBs that regularising or notifying slums, leads to improvement of the living conditions over time. The paper undertakes this through the perspective of vulnerability as a tool of analysis, since vulnerability is an integrated concept which encompasses various components of capabilities and entitlements of the subjects. In this premise, the paper shall attempt to first elaborate on the characteristics of Indian slums, particularly the ones that lie on hazardous floodable sites and derive assumptions of what conditions can positively influence the living conditions of the slums. It shall then delve into the assumed planning approaches can technically resolve issues of health and structural risks to the settlers. Finally, it shall derive its observations on why the assumed planned approaches and/or local solutions do not manage to resolve issues of vulnerability over time. The above Research Question read in conjugation with the two Research Objectives in the previous section helps in understanding the operational trajectories required to answer the questions.

4.1 Method

Demographia, a US-based international urban agency, in its 12th edition of Demographia World Urban Areas: 2016, revealed that Vijayawada had a projected population of 17.7 lakh living in 57 square kilometres of land area – 31,200 people in every square km. The city ranks third after Dhaka, Bangladesh, and Hyderabad, Pakistan, out of the 1,022 urban areas across the world that were considered for the study. Vijayawada ranked 278 among the world's most built up areas. In addition to that the growth rate of slum population in the city between 2001 and 2011 has been 39%, which is higher than the national average of growth rate of slum dwellers. It is important to have a mixed method of research when we deal with the marginalised, as every individual case become important than focussing on the cases representing majority. At the same time, there is a need to have quantification of a core strategy of analysis to inculcate scientific temper. The paper adopts a methodology that is a judicious mix of quantitative and qualitative techniques of analysis. The paper initially analyses all wards of Vijayawada to evolve a logic of identifying the most critical wards having critical slums. Subsequent to the preliminary analysis, one particular slum which lies adjacent to hazardous submergible stretches of sewer canals has been selected detailed data collection and analysis of vulnerability and tenure conditions. The preliminary city-level analysis is based on nine main indicators of criticality of slums. These nine indicators were overlaid in GIS platform to arrive at wards which have maximum incidences of criticality.

The identified slum, which is coded as slum number 31 (as per Vijayawada Municipal Corporation records) was observed and studied in terms of its layout, demography, built form and infrastructure provision through site reconnaissance visits, focussed group discussions, key informant discussions and physical survey. A detailed GIS based map of the slum 31 was evolved with plot level details of built form, access of infrastructure and basic demography. Subsequently, a detailed discussion-based survey of approximately one hundred households was conducted representing two typologies of tenure status – 'with *patta*' and 'tenant to a *patta* holder'. *Patta* refers to a time-bound local tenure arrangement, authorised by the urban local body that gives permission to certain households to reside and function in the given site for basic activities of residential nature without giving right to sell or use the site for production or commercial use. Data corresponding to indicators of social, economic and physical vulnerability were obtained through discussions with the sample households. In total, 19 variables for the three categories of vulnerabilities were addressed through primary discussions and secondary data collection at site. Details about these variables are discussed in section 5, in subsequent parts of this paper. Most of these variables were mapped at the plot level in a GIS platform to arrive at

understanding of spatial correlations and patterns, discussed in subsequent sections. These quantitative records were overlaid with different types of tenure security prevalent amongst the pockets within slum identified. Sampling of the slum dwellers were envisaged to represent different occupation groups, different age groups and different literacy groups. It enabled to evaluate and assess levels of correlation and dependency of the factors on each other.

The 19 variables were aggregated to understand patterns of composite social, economic and physical vulnerabilities separately and then at the comprehensive aggregate level. Vulnerabilities differed for different zones and backgrounds of the people within the slum

4.2 Preliminary evaluation of slums in Vijayawada

Since there are a large number of slums in Vijayawada, the paper portrays an initial analysis of all wards of Vijayawada on nine different parameters to find the wards which have likely criticality in dealing with slums. Datasets regarding the following nine city-level parameters were collated from different secondary sources and overlaid in Geographic Information Systems (GIS) computing platform to identify the wards which are most critical in handling slums.

a) *Slum Population Percentage:* The absolute slum population in each ward of the city (derived from municipal and electoral records 2016) and the percentage of slum population to the total ward population (derived from Census of India records) has been considered as an indicator of concentration of slum dwellers. GIS output represented in Fig 3.

b) *Percentage of slum area with respect to ward area:* The total area under slum limits (derived from municipal records) as a ratio of the total area of the ward (derived from satellite imageries processed in GIS) has been considered as an indicator of spatial concentration of slum built form. GIS output represented in Fig 4.

c) *Population Density within Slums*: Slum population in each ward as a ratio of the area under slum limits was derived as an indicator to understand levels of crowdedness in the slums of each wards. GIS output represented in Fig 5.

d) *Gross Population Density:* The gross population density of each ward as a whole was calculated from Census of India data to understand whether slums are located in already dense wards or sparsely populated wards. GIS output represented in Fig 6.

e) *Literacy:* The literacy figures, as derived from Census of India was considered for each wards slum population to understand their social strength. Wards having low literacy were considered more critical. GIS output represented in Fig 7.

f) *Marginal workers share in wards*: Marginal workers represent the workers who are not in the formal sector and dependent on unskilled daily wage arrangements. Share of marginal workers in each ward was estimated from Census of India data and taken as an indicator to gauge the concentration of lower-skill sets in each wards in terms of occupation. GIS output represented in Fig 8.

g) *Distance from Central Business District (CBD)*: Distance from the key business zones of the city was also analysed spatially in the GIS, and wards that are close to the CBD, were considered to be more critical if having slums. GIS output represented in Fig 9.

h) *Presence of Household Industries*: Household industries are often found to be existing in slums and unauthorised colonies, as slum dwellers tend to maximise the utility of space and initiate production of goods and services informally. The concentration of household industries in different wards of the city (as derived from Municipal records) was taken as an indicator. GIS output represented in Fig 10.

i) *Residential Use Concentration*: Concentration of overall residential use within each ward was also taken as an indicator as areas having high concentration of residential use and having slums are assumed to be situations of criticality. GIS output represented in Fig 11.

Each indicator data was rationalised to create categories of most critical, semi-critical and least critical ranges to derive the wards that are challenged. All the indicators were overlayed and aggregated in GIS with Boolean logic of union and the most critical wards were arrived at.

The most critical wards, as represented in Fig 12, indicates wards that have criticality in all or most of the nine indicators as discussed above. This preliminary analysis indicates that there are seven wards that are most challenged to have and address issues of slums. The wards are 78, 4, 6, 69, 53, 1, and 3 (as represented in Fig 12) are likely to be more challenged compared to the other wards and need special attention. Out of the most critical seven wards, the wards having sewer canals were shortlisted and slum number 31 (in ward 68), adjacent to the sewer canal was identified for detailed analysis. ◆

Figure 3

Wards with respect to % of Slum Population

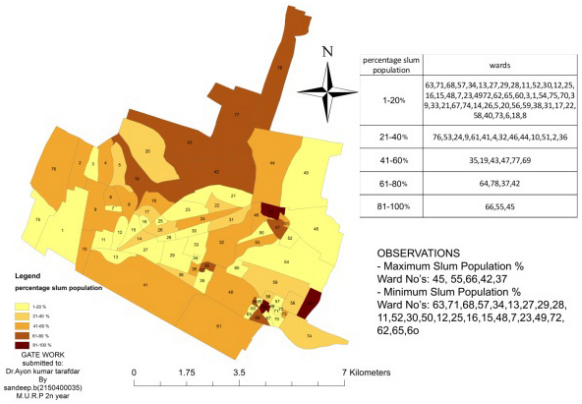


Figure 4

Wards with respect to Area under Slums

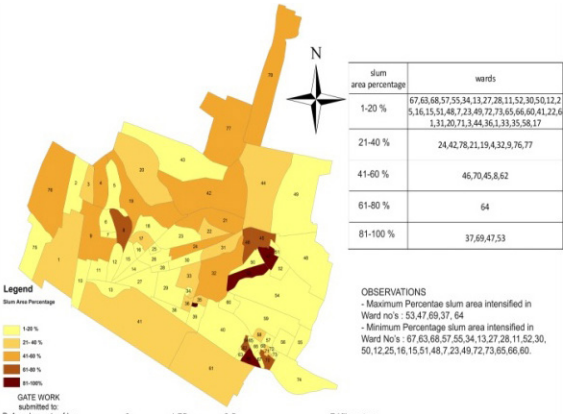


Figure 5

Wards with respect to Density of Slum Population

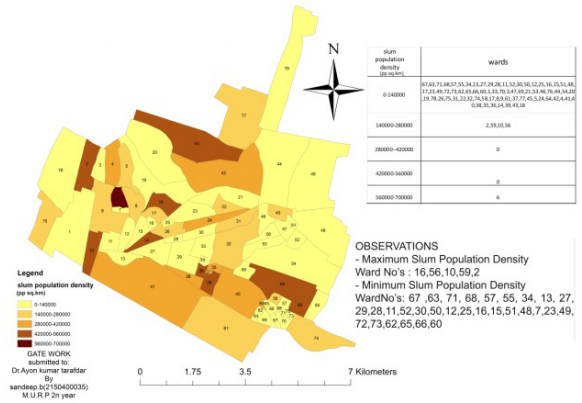


Figure 6

Wards with respect to Gross Population Density

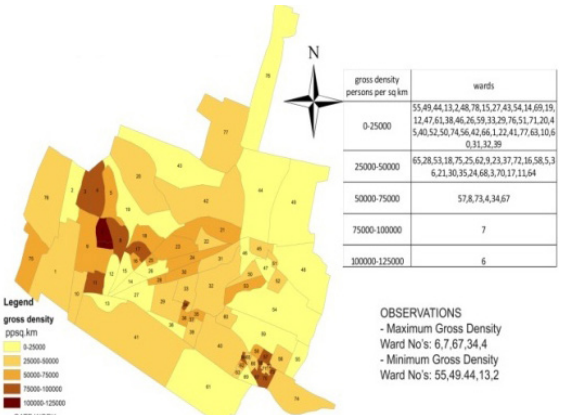


Figure 7

Wards with respect to Literacy Rate

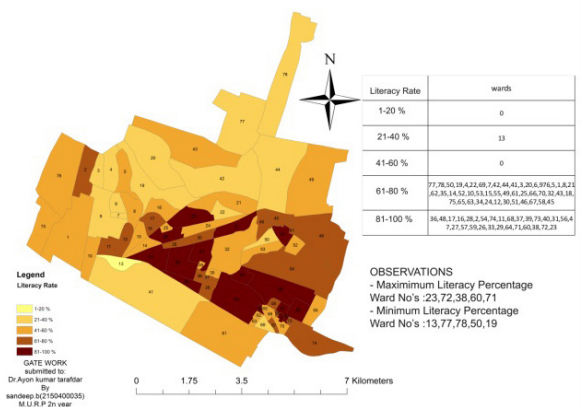


Figure 8

Wards with respect to % of Marginal Workers

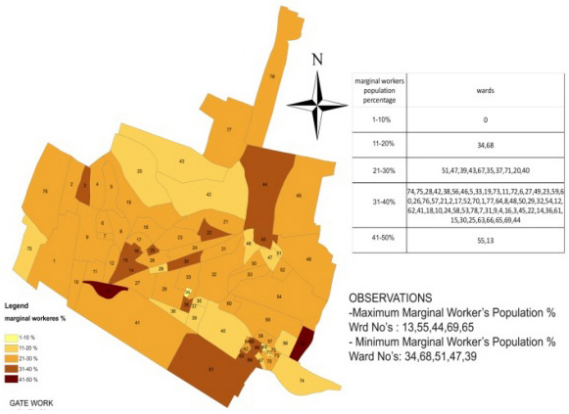


Figure 9

Wards with respect to Distance from CBD

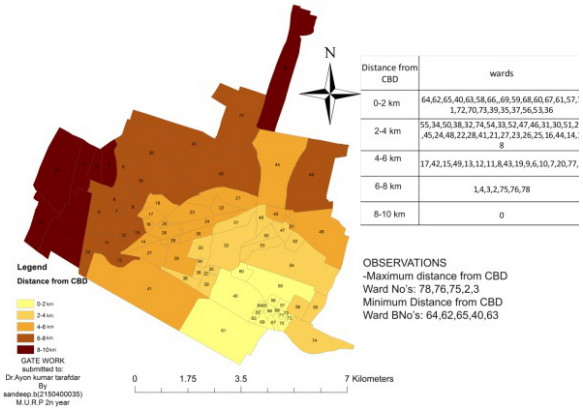


Figure 10

Wards with respect to Area under Residential Use

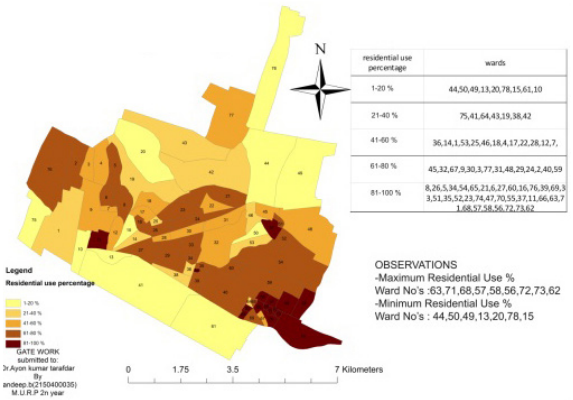


Figure 11

Wards with respect to Area under SluHousehold Industries

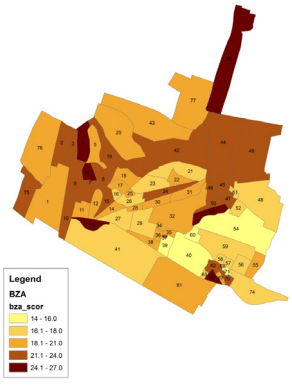
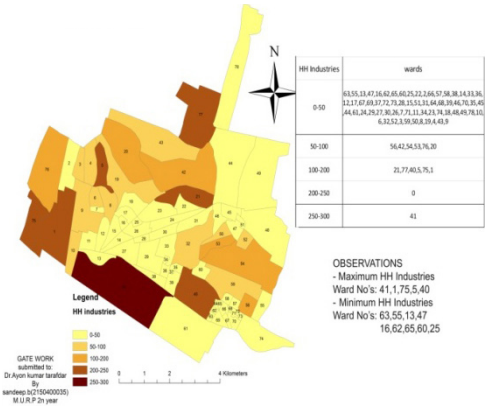


Figure 12

Critical Wards of Vijayawada (composite of 9 indicators)



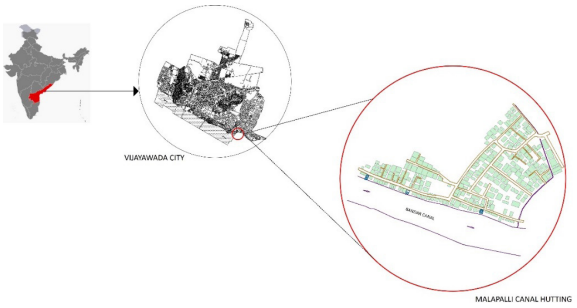
PART 5
THE CASE OF SLUM 31, VIJAYAWADA

5.1 Basic Slum Characteristics

For the purpose of Vulnerability Assessment of Slums in Vijayawada, a slum called the Malapalli Canal Hutting has been selected for the purpose of our study. It is located near Patamata and Ambedkar Nagar in the city of Vijayawada. Bearing the Slum Code of 231 according to the Vijayawada Municipal Corporation, the Malapalli Canal Hutting covers an area of 0.31 sq metres. The slum is located adjacent to the Bandar Canal. Currently it has a total of 285 households with an estimated population of 1600.

Figure 13

Location of Slum 31, Vijayawada

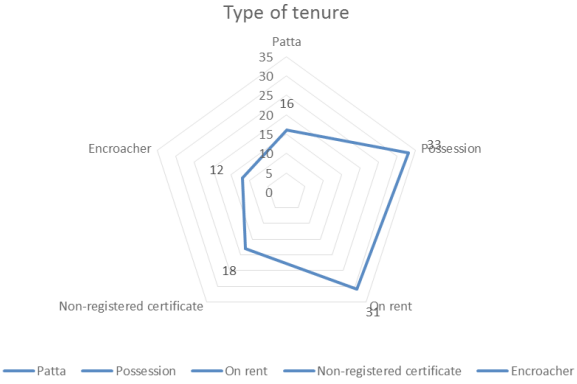


5.2 Tenure Characteristics

Based on the household survey undertaken of the people living in the slums, it was found that the people could be classified into 5 types based on their tenure characteristics – Possession, on-rent, patta, non-registered certificate holder and encroacher. The percentage distribution of people in the slum as per their tenure characteristics are given below.

Figure 14

% distribution of slum people as per tenure characteristics



5.3 Parameters of Analysis

In total, 19 parameters were analysed under the three dimensions of vulnerability. A total of 115 samples were taken from the three slums representing different occupation groups, different age groups and different literacy groups and locations of stay within the slums. The parameters under different dimensions of vulnerability taken for quantification are:

A Physical Vulnerability Dimensions:
- a. Type of Building
- b. No of Habitable Rooms per person
- c. Roof Conditions
- d. Water Connection
- e. Water Quality
- f. Toilet type
- g. Sewerage type
- h. Drainage type
- i. Distance to solid waste disposal site

B Social Vulnerability Dimensions:
- a. Dependency Ratio
- b. Level of Education
- c. Overcrowding Factor
- d. % of School Going Children
- e. Access / distance to medical facilities
- f. Health Condition (past one year)

C Economic Vulnerability Dimensions:
- a. Occupation type
- b. Rent to Income Ratio
- c. Income Expenditure Ratio
- d. Distance to Work

Each of the above parameters were quantified from the 115 sample households from the three slums and enumerated on a scoring logic as depicted in Table 1. The scoring is done based on feedback derived from the 115 samples on the 19 parameters as above and is normalised to compare and aggregate the varied dimensions of vulnerability.

Table 1

Logic of Normalisation of Quantified Variables of Data

Indicator	Parameters	Weightages	Highly Vulnerable (Score of 3)	Moderately Vulnerable (Score of 2)	Least Vulnerable (Score of 1)
Physical Vulnerability (40)	Type of building	6	Mud wall, Huts, No bricks, Dilapidate	Semi-dilapidate, Either roof or wall made of pakka material	Entire structure including floor, roof and exterior walls are made of pucca material
	No. Of habitable rooms (persons per room)	5	> 3	3 to 2	< 2
	Roof Condition	5	Thatched roof	Tiled/ Asbestos Roof	Cement Concrete Slab
	Water Connection	4	No Water Source	Community Taps	Individual conncetion
	Water Quality	5	Worst	Good	Best
	Toilet	4	No toilet	Public Toilet	Personal Toilet
	Sewerage	4	No provision for sewer disposal	Septic Tank	Sewer Lines
	Drainage	4	No drainage line	Open Drains	Closed Drain/ Drainage Pipes
	Distance to solid waste disposal site	3	No Garbage Bins are provided	Provision of Garbage bins Nearby	Door to door Collection
Social Vulnerability (30)	Dependency Ratio	6	> 5	3 to 5	< 3
	Education	5	Upto Class 5	Class 5 to Class 10	Above Class 10
	Overcrowding Factor	6	High (>5 persons per room)	Medium (3-5 persons per room)	Low (< 3 persons per room)
	School Going %	3	< 30%	30% - 70%	> 70%
	Access/Distance to medical facilities	5	> 2km	500m to 2km	< 500m
	Health Condition (past 1 year)	5	Major Illness with bed rest/hospitalization	Minor illness without bed rest/hospitalization	No health issues
Economic Vulnerability (30)	Occupation	8	Unemployed/daily wage labourer	Seasonal employment/contractual employment	Permanent employment
	Distance to Work	7	Unauthorized/no rent agreeement	Rent agreement	Owned
	Rent/ Income ratio	7	> 0.7	0.3 - 0.7	< 0.3
	Expenditure Income Ratio	8	> 0.8	0.79 - 0.5	< 0.5

5.4 Physical Vulnerability

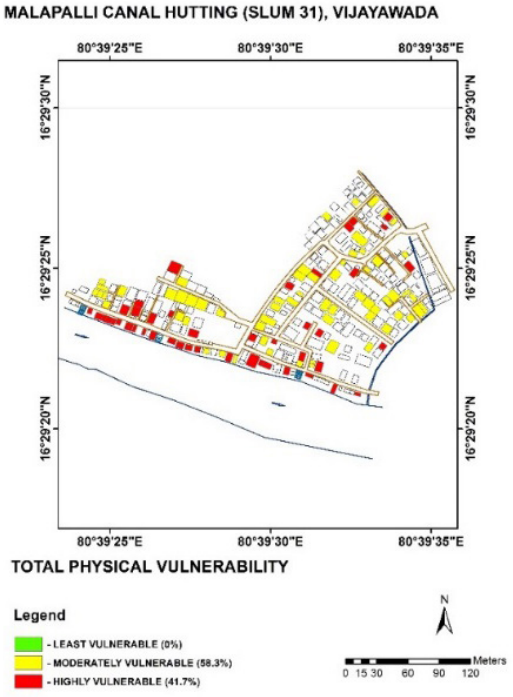
Based on the parameters for assessing the physical vulnerability of Slum 31, the project first observed the housing condition, roof condition and number of habitable rooms for the buildings in the slum. Majority of the highly vulnerable buildings are near the Bandar canal. Highly vulnerable houses are denoted as being in bad structural condition with most of them being using semi-permanent building materials houses or dilapidated in nature, also having thatched roofs and there is a high number of such buildings along the canal.

Next the project assessed the availability of infrastructure facilities in the slum. The buildings along the canal mostly have no private water connection and use community taps. The water quality in the slum has been seen to be moderately good throughout the area. There is no presence of areas having bad water quality in the slum. Most of the households have individual toilet facilities and the rest use communal toilets. Majority of the households along the canal use communal toilet facilities. However, the condition of the sewerage system is very severe. Most of the households use septic tanks, while the houses along the canal have no provision for sewage disposal. As such, the households along the canal are highly vulnerable. Also, there are only open drains in the entire area. Most of the households have door to door collection or have garbage bins provided nearby. However, the households along the canal are not provided with any garbage disposal facilities indicating their highly vulnerable status. This reflects the highly vulnerable status of the people living along the canal.

The map indicates the total physical vulnerability of the slum. As can be seen, there are no households having least vulnerability. Also, majority of the highly vulnerable house are located alongside the canal.

Figure 15

Total Physical Vulnerability

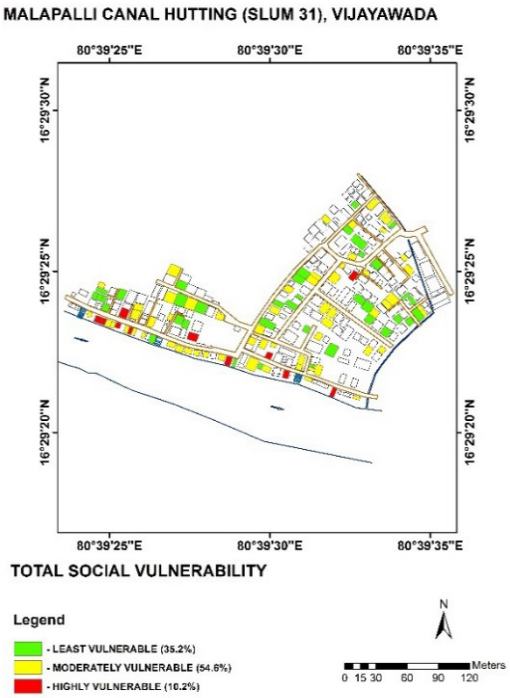


5.5 Social Vulnerability

In this section, the social vulnerability of the people living in Slum 31 are assessed based on the indicators identified earlier. The first indicator measured the social vulnerability with regards to the dependency ratio. Most of the households in the slum are in a moderately vulnerable status. Households having moderately and highly vulnerable status are scattered throughout the slum. However, it can be seen that along the canal, the households are mostly moderately or highly vulnerable with regards to their dependency ratio. Most of the residents have studied till Class 10 indicating a moderately vulnerable status. However, there are some who are uneducated or have only completed schooling till Class 5, indicating a highly vulnerable status. A majority of such households are along the canal.

Figure 16

Total Social Vulnerability



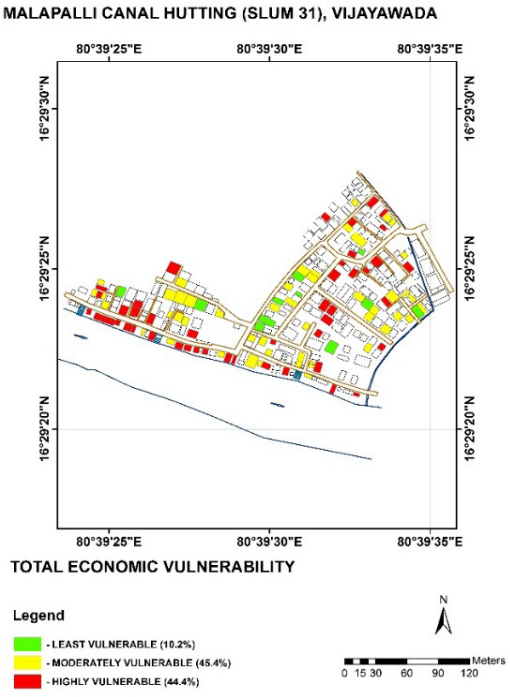
Most of the residents have no threat of eviction while a few of them have a moderate fear of eviction. Most of these residents who are moderately vulnerable are located alongside the canal. A high percentage of the residents are school-going indicating least vulnerability while a small percentage is in moderate vulnerability status. Considering the access of the residents to health facilities, it is seen that there is a primary clinic located in the slum which caters to the entire slum population. Also there are nearby hospitals. Hence with respect to access to health facilities, the residents of the slum are least vulnerable. The health condition of the residents for the past one year also indicates that the residents have faced no major illnesses with only some minor illnesses seen in residents (indicating moderate vulnerability). Hence majority of the residents are least vulnerable with respect to their health condition.

5.6 Economic Vulnerability

In this section, the economic vulnerability of the people living in Slum 31 are assessed based on the indicators identified earlier. The first indicator is about the occupation status of the residents in the slum. Highly vulnerable status is indicated by unemployment. A majority of the residents are moderately vulnerable, with most of the moderately and highly vulnerable households located along the canal. The tenure status of the residents indicates moderate vulnerability as indicated by their rental status while high vulnerability is indicated by unauthorized or illegal tenure. Most of such unauthorized households are located alongside the canal. The rent/income ratio of the households indicates that most of the residents are least vulnerable with respect to this aspect. Finally, the income status of the households indicates that most of the households are moderately vulnerable, and most of the highly vulnerable households located alongside the canal.

Figure 17

Total Economic Vulnerability

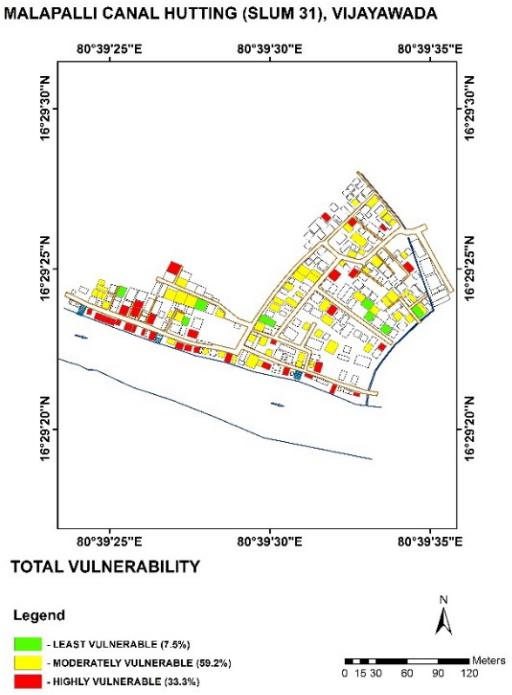


5.7 Total Vulnerability

The total vulnerability of the slum takes all above three factors into account and arrives at a total vulnerability map for the slum, aggregating the scores of each normalised parameter. It shows that majority of the households are moderately vulnerable. There are very few numbers of 'least vulnerable households' in the slum. Along the canal, majority of the households are highly vulnerable with the rest being moderately vulnerable. ◆

Figure 18

Total Aggregate Vulnerability



PART 6
ANALYTICAL DISCUSSIONS: COMPREHENDING THE MAZE OF COMPLEXITY

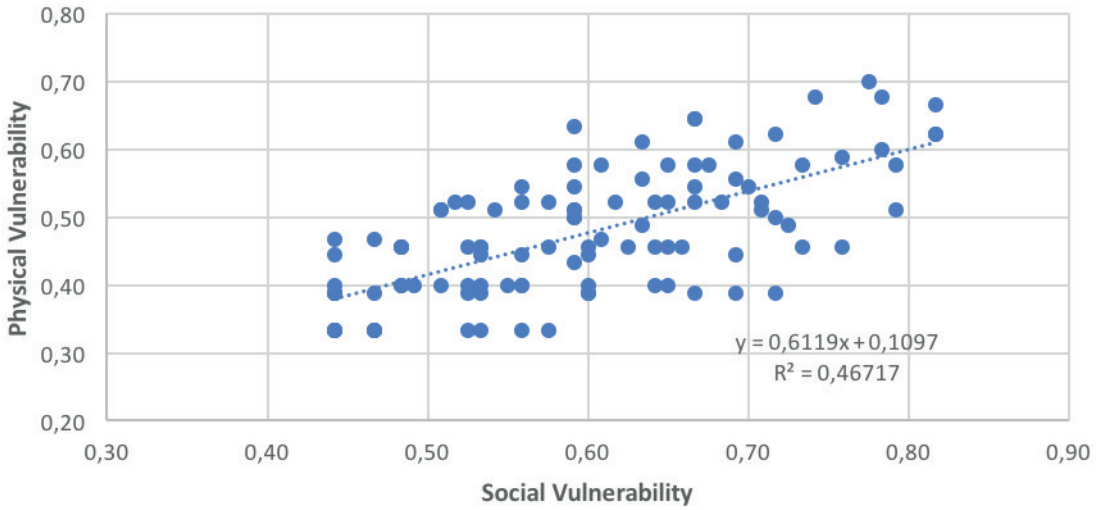
In this section the three dimensions of vulnerability are correlated in linear format amongst each other to understand the relationships between social economic and physical aspects and also to understand which aspect bears the maximum influence on the total vulnerability.

A. Interrelation between dimensions of vulnerability

It was found that there is a positive relationship between physical and social vulnerability. Also, the coefficient of determination comes out to be 0.4672 or 46.72% which indicates a moderate correlation between physical vulnerability and social vulnerability.

Figure 19

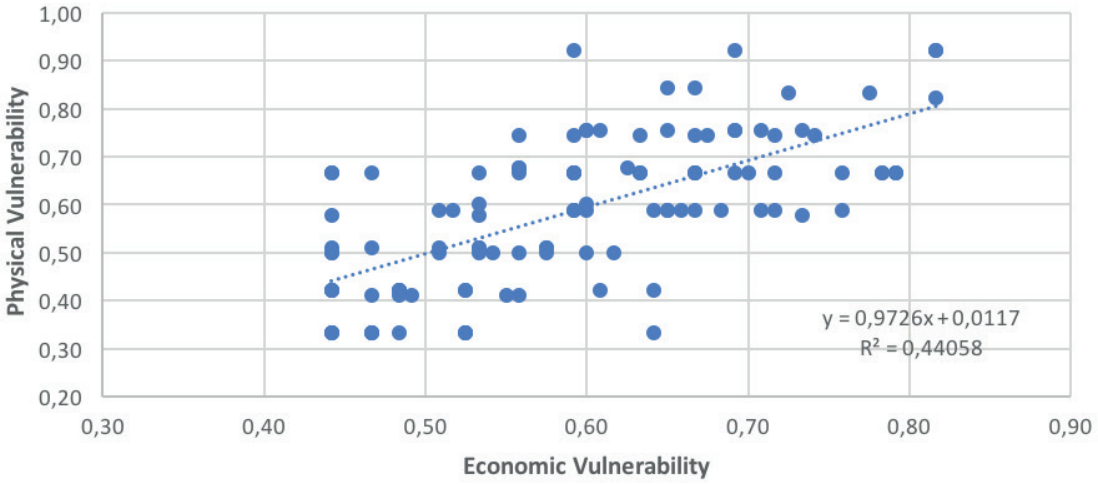
Physical Vulnerability vs Social Vulnerability



There is a positive relationship between physical and economic vulnerability. Also, the coefficient of determination comes out to be 0.4406 or 44.06% which indicates a moderate correlation between physical vulnerability and economic vulnerability.

Figure 20

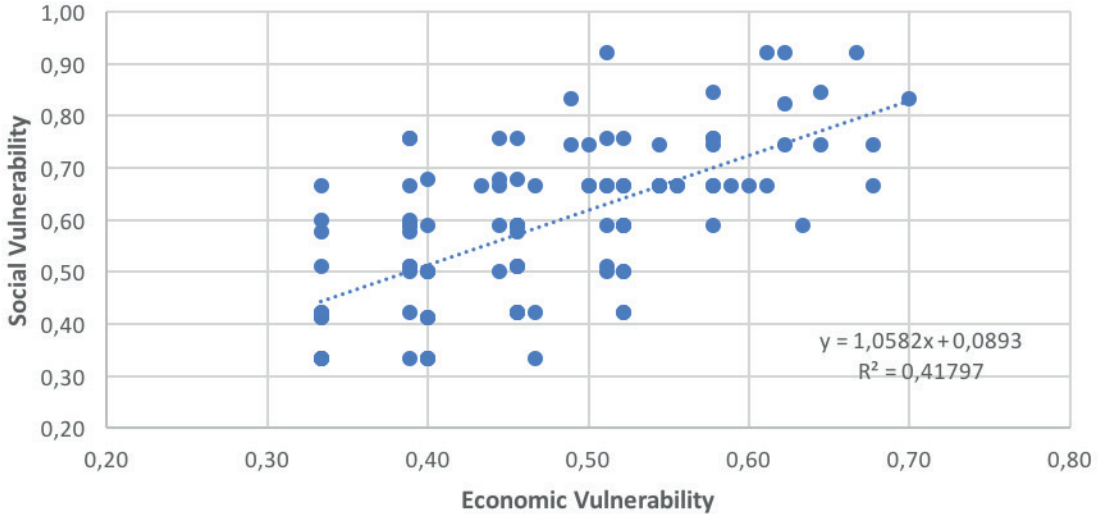
Physical Vulnerability vs Economic Vulnerability



There is a positive relationship between social and economic vulnerability. The coefficient of determination comes out to be 0.418 or 41.8% which indicates a moderate correlation between social vulnerability and economic vulnerability.

Figure 21

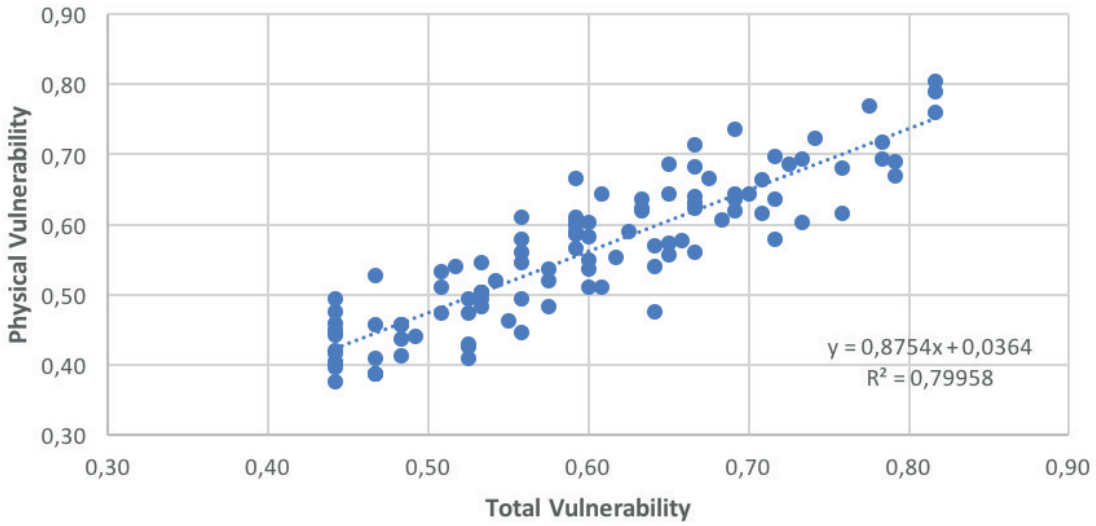
Social Vulnerability vs Economic Vulnerability



There is a positive relationship between physical and total vulnerability. However, the coefficient of determination comes out to be 0.7796 or 77.96% which indicates a high correlation between physical vulnerability and total vulnerability.

Figure 22

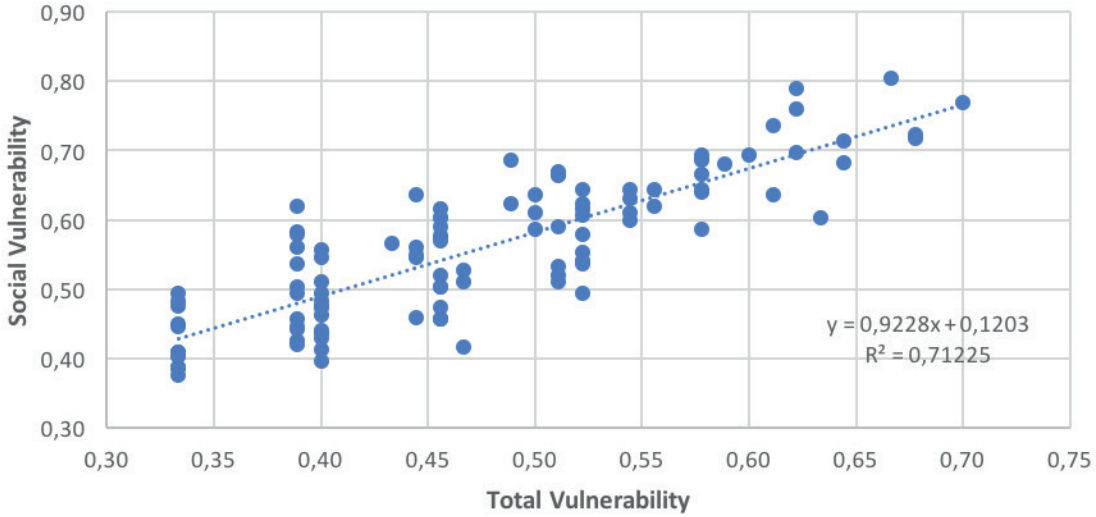
Physical Vulnerability vs Total Vulnerability



There is a positive relationship between social and total vulnerability. But, the coefficient of determination comes out to be 0.7123 or 71.23% which indicates a high correlation between social vulnerability and total vulnerability.

Figure 23

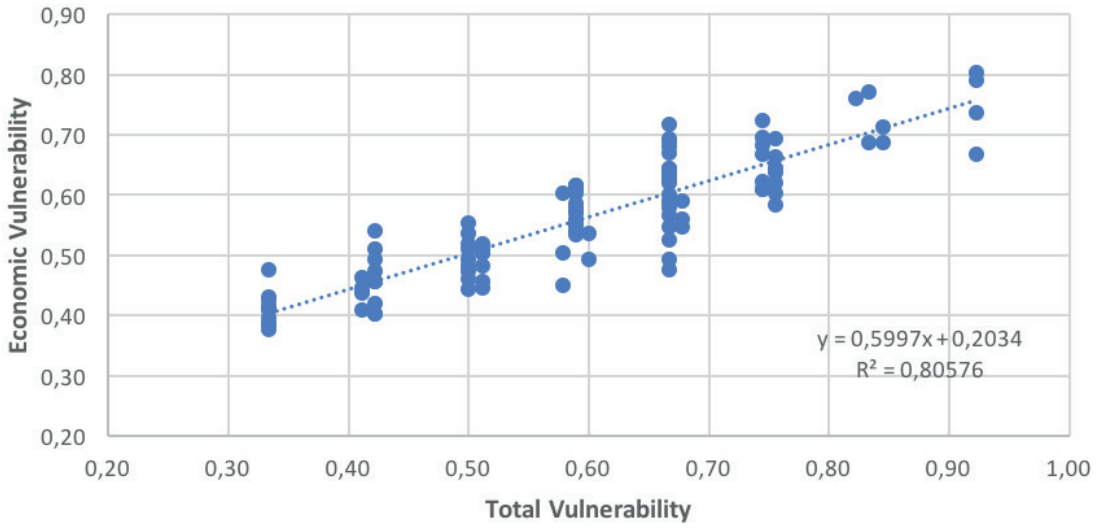
Social Vulnerability vs Total Vulnerability



There is a positive relationship between economic and total vulnerability. The coefficient of determination comes out to be 0.8058 or 80.58% which indicates a very high correlation between economic vulnerability and total vulnerability.

Figure 24

Economic Vulnerability vs Total Vulnerability



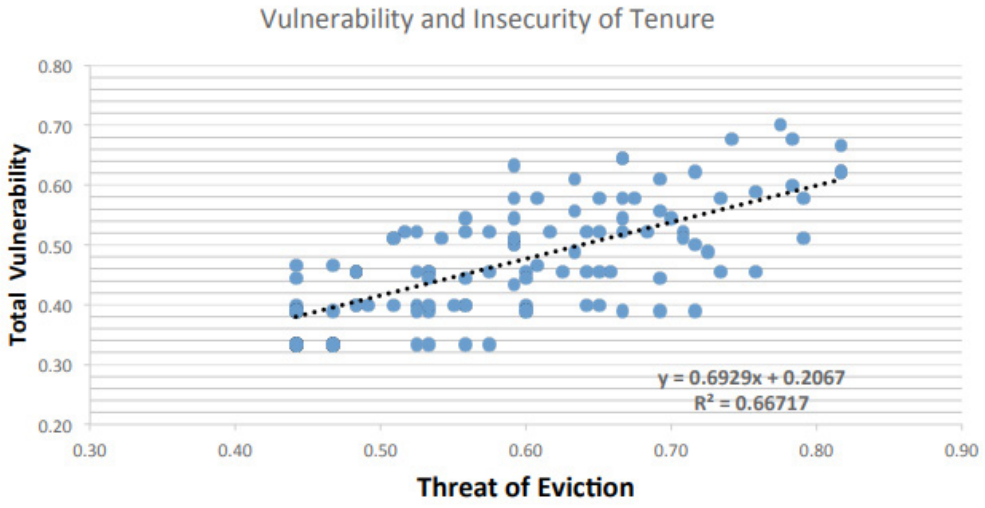
B. Interrelation between vulnerability and tenure types

The project then tried to delve into the relation between vulnerability and tenure status. As discussed earlier, there are 5 types of tenure in the slum. The most secure form of tenure is perceived when they have a 'patta', which is a right to stay in the slum (but not transact the space) given as document by the municipality. The next most secure form of tenure is when dwellers have a certificate of possession, which simply recognises the dwellers as possessors of government land and allows them that certificate so that they have a right to relocation and rehabilitation, if any. The third most secure tenure is when a dweller sub-lets and formally rents a space from a patta owner or a possession certified resident or a slumlord. The other tenures are residents who simply stay based on oral arrangements with other slum dwellers without any tenure status. As the security of tenure goes down, there is a rising threat of eviction. The 115 samples were adjudged in terms of their perception of threat of eviction on a likert scale, which was linked, to their type of tenure.

Comparing the total vulnerability with the threat of eviction, we see that there is a considerable positive relation between the two. As threat of eviction rises in a household, they are more prone to total composite vulnerability as shown below.

Figure 25

Total Vulnerability vs Threat of Eviction



Another dimension that was studied was the duration of stay of the dwellers irrespective of the type of tenure. An interesting thing that was observed is that for higher duration of stay, there is lesser composite vulnerability. If duration of stay is enhanced, there is chance in reduction in vulnerability as shown below. However, since the duration of stay is closely related to the nature of tenure and titles held by the dwellers, it gives an indication that when duration of stay is enhanced there is chance of reducing the vulnerability levels.

Figure 26

Total Vulnerability vs Threat of Eviction

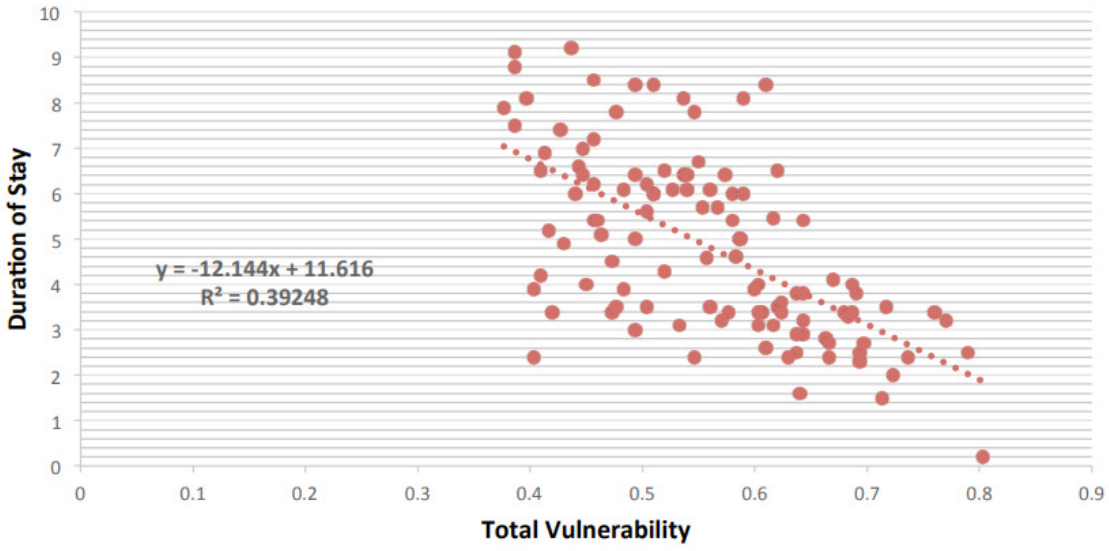
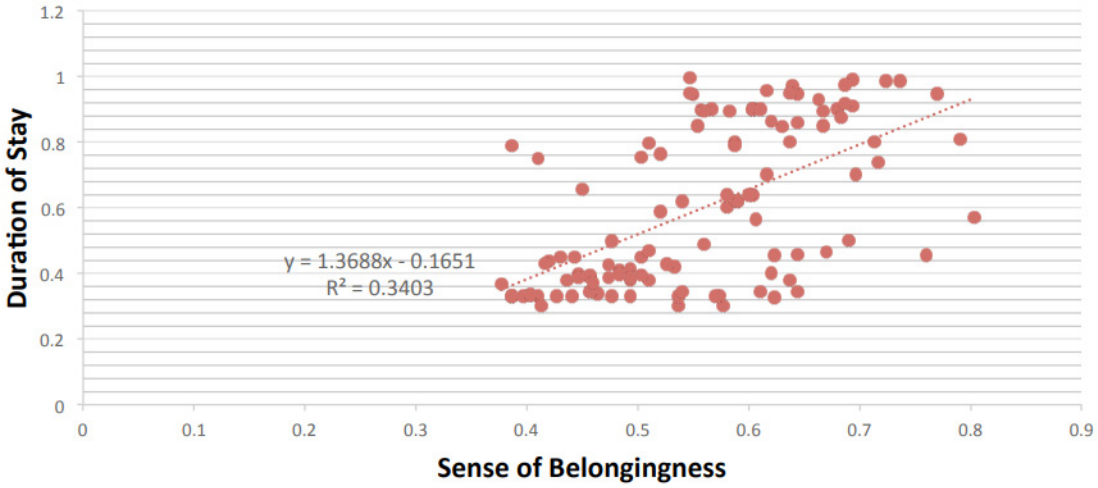


Figure 27

Duration of Stay vs Sense of Belongingness



The Sense of Belongingness (SoB) of the slum dwellers was assessed based on investment in immediate habitable space. It was observed that Sense of Belongingness was higher when duration of stay was high as shown below. Ability to own and be responsible for the habitable space is hence linked with the vulnerability by ensuring longer stay duration and better land titles. ◆

PART 7
INFERENTIAL DISCUSSIONS: UNRAVELLING COMPLEXITY

This case leads us to three different and significant realms of inferences.

A) First is a revised understanding of slums which can be based on vulnerabilities that do not limit itself to natural calamities and disasters but vulnerabilities that exist in way of living. In this realm, it is important to understand that our comprehension of slums should be merely physical in dimension derived from site visits and reconnaissance of physical shortcomings. It is important to comprehend that vulnerability of citizens living in slums, who should ideally have similar rights to the cities to reside, are of different dimensions that are interrelated to each other. Hence, a thorough understanding of the dimensions of vulnerability that includes social, physical and economic vulnerability based on quantifiable parameters that are derived from the settlers and residers, is an essential tenet for the actual comprehension and analysis of any informal settlement like a slum. In this case study, it was observed that the different plots and households have different degrees of social, economic and physical vulnerability. If we spatially characterize, we may observe concentrations of certain types of vulnerabilities in different sections within the slums. Proximity to the sewer channels and roads play a role in enhancing or reducing levels of vulnerability. This showcases the need to have differential treatment for different spatial pockets areas. Addressing economic and social vulnerability is equally important than focusing only on physical development of the slums. One solution cannot fit all slums.

B) An important aspect in slums or informal settlements in India is the security of tenure. The nature of the right to stay in the informal settlement is varying and has implications in the levels of sense of belongingness, duration of stay and threat of eviction. This study brings out statistical and spatial relations between these aspects and levels of vulnerability based on the responses derived from the residents and hence, implies that it is important to look at security of tenure and vulnerability in tandem when we aim at upgrading informal settlements or improving the conditions. There is a considerable positive relation between threat of eviction and total composite vulnerability. As the threat of eviction rises in a household, they are more prone to total composite vulnerability. Similarly, as duration of stay increases, levels of vulnerability reduces. Ability to invest and have a sense of belongingness also rises with better forms of tenure. Hence, tenure strategies can be evolved with close understanding of the typology of vulnerabilities so that slum upgradation is not limited to mere physical development. Therefore, understanding of relations of sub-dimensions of tenure and vulnerability through unstructured interviews and statistical analysis are required for informal settlements to bring out the need for non-spatial (tenure based) strategies.

C) Since impacts of Social, Economic and Physical vulnerabilities are significant tenets to the overall challenges of a slum dweller and together forms an atmosphere of vulnerability, it is prudent to set benchmarks and evolve acceptable standards of vulnerability for informal settlements. Even though this case does not derive such benchmarks, it clearly establishes that there are possible ways of measuring and interrelating aspects of vulnerability from the grassroots and hence, leave a possibility to extend such studies to arrive at benchmarks which can aid objective and multi-dimensional assessment of slum conditions.

Summarily, it may be suggested that a series of such research studies on varying typologies of slums can eventually lead to devising of a framework of computational vulnerability assessment that can replicated for assessment of slum conditions anywhere, before slums is regularized or upgraded by public authorities. ◆

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Disclaimer

The content of this article is solely the views of the author and not of the organisation for which he works.

Acknowledgements

The report is an outcome of the ERASMUS (EU) funded research project titled 'Building Inclusive Urban Communities (BInUCOM)' coordinated by Krems University, Austria, which partners 4 Indian universities and 3 European universities. The article herewith is one of the 16 case studies executed by the Indian partners of the project. The data gathered and processed is by the author along with the SPAV Binucom team members in SPA Vijayawada. The author wishes to deeply acknowledge the other team members - Prof. Dr. S. Ramesh, Prof. Dr Abdul Razak Md., Asst. Prof. Nagaraju K., and Asst Professor D Srinivas for their academic inputs. The author wishes to sincerely acknowledge Masters GATE scholarship students at SPAV for assisting in the production of the work and accompanying in site visits, namely, Sohan M., Sandeep K., Alisha C., Priyanka D. and Priya P.

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