# Examining Spatial and Temporal Patterns of Crimes Against Women: A District level Study in Karnataka

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## DECLARATION BY STUDENT

I hereby declare that data presented in this Dissertation report entitled, "Examining Spatial and Temporal Patterns of Crimes Against women: A District level Study in Karnataka" is based on the results of investigation carried out by me in Economic Discipline at the Goa Business School, Goa University under the Supervision of Ms. Heena Subrai Gaude and same has not been submitted elsewhere for the award of the degree or diploma by me. Further, I understand that Goa University or its authority will be not be responsible for the correctness of observations / experiment or other findings given the dissertation.

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Place: Goa University

## COMPLETION CERTIFICATE

This is to certify that the dissertation report "Examining Spatial and Temporal Patterns of Crimes Against women: A District level Study in Karnataka" is a bonafide work carried out by Pratibh Ganesh Gundenhalli under my supervision in partial fulfillment of the requirement for the award of degree of Masters in Economics in the Economic Discipline at the Goa Business School, Goa University.

Signature and Name of Supervising Teacher

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# PREFACE

The issue of crime against women in Karnataka, India, has garnered significant attention over the years, with alarming statistics revealing a concerning trend. From 2001 to 2022, reported incidents surged from 4061 to 10598, prompting a critical examination into the underlying factors driving this escalation.

In response, this study delves into the intricate landscape of crime against women at the district level within Karnataka, employing a comprehensive analytical approach by using geographic information systems (GIS) and spatial analysis techniques.At its core, the study aims to unravel the multifaceted dynamics of crime against women, extending beyond mere statistical trends to explore the spatial relationships and influences among the neighboring districts. By leveraging crime data spanning over two decades sourced from the National Crime Records Bureau (NCRB), the research endeavours to shed light on the spatial patterns, clustering phenomena, and hotspot identification pertaining to six distinct categories of crimes against women.

This study represents a crucial attempt to not only quantify the magnitude of the issue but also dissect its spatial nuances, acknowledging the interconnectedness of districts in propagating or mitigating crime against women. Through rigorous spatial autocorrelation analysis techniques such as Moran's I test, coupled with hotspot identification using Getis-Ord Gi*, the research unveils hidden patterns and localized concentrations of crime occurrence. Notably, districts like Bengaluru Urban, Chamrajnagara, Bengaluru Rural, Kolar, and Raichur emerge as recurrent hotspots across various crime categories, underscoring the need for targeted interventions and localized strategies.In essence, this study serves as a vital compass for policymakers, law enforcement agencies, and stakeholders, offering actionable insights to address the pressing issue of crime against women in Karnataka, Indi

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Pratibha Ganesh Gundenhalli

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# ABSTRACT

Crime against women in Karnataka state increased from 4061 in 2001 to 10598 in 2022, one of the important issues looked into this study analyzes the crime against women at the district level in Karnataka, India. The study uses crime data starting from 2001 to the latest available data till 2022 sourced from the National Crime Records Bureau (NCRB), by looking into 6 distinct categories of crime against women. The study aims to understand the influence of increasing crime in a district on neighboring districts using spatial autocorrelation and hotspot analysis. The data is examined by applying the GIS and spatial analysis, spatial autocorrelation analysis technique, including Moran's I test, which unveils clustering patterns, while Getis-Ord Gi* identifies Hotspots and Coldspots of crime against women occurrence. Findings show that crime like Dowry deaths show a positive autocorrelation, and the rise in crime in districts has a positive influence on neighboring districts. Additionally, the Study also identifies hotspots and coldspots for each crime. Districts like Bengaluru Urban, Chamrajnagara, Bengaluru Rural, Kolar, and Raichur have been hotspots in most of the crimes.

Keywords: Karnataka, Crime against women, Moran's Spatial Autocorrelation, hotspot analysis

# CHAPTER 1: INTRODUCTION

## 1.1 Background

Crime against women is one of the rising problems that affect both India and the entire world, taking the form of various offenses like domestic violence, sexual assault, harassment, trafficking, and gender-based discrimination Frontline News Desk. (n.d.). CRIME | Over 4.45 lakh crimes against women in 2022; one every 51 minutes: NCRB. Despite the progress made in promoting gender equality and empowering women, these crimes persist and pose a serious threat to the safety, dignity, and fundamental rights of women. In India, the problem of crime against women remains a major concern, as alarming statistics highlight its severity. According to data from the National Crime Records Bureau (NCRB), there has been a rise in crimes against women in recent years. In 2020, despite the challenges brought by the COVID-19 pandemic and subsequent lockdowns, there were 371,503 reported cases of crimes against women, showing a 9.6% increase from the previous year KumarB, S. (2023, January 15). These crimes involve a wide range of offenses such as rape, dowry harassment, abduction, cruelty by family members, and sexual harassment. Sexual violence is one of the most severe forms of crime against women in India Bangalore Mirror Bureau. (2024b, March 29). The NCRB data indicates a shockingly high number of rape cases, with an average of over 80 cases reported daily in 2020. Furthermore, the conviction rate for rape cases remains unacceptably low, worsening the issue of impunity and undermining trust in the justice system. Additionally, the prevalence of other forms of sexual harassment like eve-teasing and molestation creates a climate of fear and insecurity among women, restricting their freedom and participation in public

spaces. Apart from sexual violence, women in India also endure systemic discrimination and violence within their own homes. Domestic violence, driven by patriarchal norms and unequal power dynamics, continues to impact millions of women in the country PTI, & PTI. (2023, December 4). Despite legal measures like the Protection of Women from Domestic Violence Act, 2005, many women find themselves trapped in abusive relationships, unable to seek help due to social stigma, financial dependence, and lack of support services. Moreover, the issue of dowry-related violence persists in India, despite being outlawed. Dowry harassment, which often leads to dowry deaths, reflects deep-seated gender biases and the objectification of women within marriages. The prevalence of dowry-related crimes highlights the entrenched nature of patriarchal mindsets and the urgent necessity for comprehensive legal, social, and educational interventions to tackle this issue. On a global scale, crime against women transcends borders, affecting women of all backgrounds, ages, and socio-economic statuses. According to the United Nations Office on Drugs and Crime (UNODC), around 35% of women worldwide have encountered physical and/or sexual violence at some point in their lives, with intimate partner violence being the most prevalent form. Additionally, the existence of human trafficking, forced marriages, and female genital mutilation underscores the interconnectedness of gender-based violence and other exploitative practices. Prosenjit Murmu, (2023) Crimes against women have been on the rise in India for the past two decades. Dowry death and molestation feature a positive association with rape and torture. It is also notable that cybercrimes are also increasing day by day because of the increased accessibility of various web media platforms. Mangoli & Devarmani, (2014) Women in Indian society have been victims of humiliation, torture and exploitation. Today, in spite of women being gradually recognized as important powerful,

meaningful contributors to the life of men, but the violence against women is keep increasing. In spite of the legislative measures adopted in favor of women in our society after independence, the spread of education and women's gradual economic independence, countless women still continue to be victims of violence. Women are beaten, kidnapped, raped, burnt and murdered (Ahuja 2007).

1.1 objectives:

1) To evaluate the spatial and temporal variation exhibited by these crimes across different districts within Karnataka .
2) Hotspot and Coldspot analysis to identify those districts where similar forms of crimes against women tend to be concentrated.

1.2 Research Questions

1) What are the spatial and temporal patterns of crime against women across various districts within Karnataka?
2) Which are the hotspots and coldspots of similar forms of crime against women in the districts of Karnataka?

1.3 scope

Identifying hotspots where crimes against women occur, and also examining variations in the crime rates and patterns across different districts can help to uncover underlying socio-economic, cultural, and demographic factors that contribute to each crime.

# CHAPTER-2: LITERATURE REVIEW

According to NCRB report highlighted that 12 states and Union Territories recorded high crime rates than the national average, Crime against women in India is a pressing issue, with various forms of violence prevalent. The National Crime Records Bureau data highlights alarming statistics, such as high rates of intimate partner violence, child marriage, and crimes like rape, dowry deaths, human trafficking, and assault on women (Murmu, 2023). Spatial analysis reveals spatial clustering of different types of crimes against women, influenced by neighboring regions and socio- economic factors like female literacy and labor force participation rates (Kabiraj, 2023). Efforts are being made to analyze crime data, create heat maps, and predict crime hotspots to aid in preventing crimes against women in India (Dar & Nagrath, 2022).

Dhingra Neerja,(2020) tries to analyze the nature of crime against women in the states of Punjab and Hryana. Crime against women for both the states has been collected from NCRB for the year 2019 and tabulation has been done to calculate percentages. Finds that unlike other states in India, Punjab and Haryana have also shown crimes such as cruelty and violence by the husband and other family members, sexual assault, rape rates are rising. Bharali Arati,(2021) try to study status of women in Assam , for the period from 2013 to 2016 using NCRB data, a self constructed index has been used to measure the status of women in Assam, to calculate this index 12 indicators have been taken into consideration . Finds that only 5 districts have medium level of women status while other districts have low women status. Clustering analysis helps us to study spatial patterns and concentrations. Using cluster will helps to understand the areas where incidents are more

prevalent. This information will be useful for targeted interventions , proper resource allocations, and policy making.

Gera & Vohra,(2014) try to study used a clustering algorithm for a data mining approach to analyze the crimes pattern using K-means clustering technique to study crime data Delhi police first information report (FIR) records. Crimes like heinous crime, non-heinous crime and special and local laws violation have given importance, finding which area categories are more sensitive towards crime and also distributions of each crime type in every area and category of crime. Alkhaibari & Ping-Tsai Chung, (2017) cluster analysis is the process of classifying a large group of data items into smaller groups that share the same or similar properties. Study used different clustering algorithms such as, K-Means clustering, agglomerative clustering were applied to the Stop, Question and Frisk Report Database, City of New York, police Department, NYPD, FOR analyzing the location of the crime and stopped people using the reason of stopped in order to reduce city crime rates. Study revealed that the best clustering algorithm is K-Means algorithm to analyze crimes. Andresen, (2011) to investigate the importance of immediate spatial neighbors when investigating local crime patterns. Local indicators of spatial association are used to identify local crime clusters, the classification scheme of these local crime clusters is then modeled in a multinomial logistic regression. Finds that immediate spatial neighbors are important for understanding local crime patterns through spatial autocorrelation.

Prosenjit Murmu,(2023) the study investigating major types of crime against women I India, which include dowry death, human trafficking, rape, assault on women with intent to outrage her modesty, the main objective of author was to understand the spatio-temporal variation and trends of these crimes , author has used basic statistic tools to conduct the study, finding highlights that IPC crime against women have been increasing and SLL crimes are in a decreasing trend. Mangoli & Devarmani, (2014) in this paper author presents a serious assessment of the high trend of crimes against women in India. the prevalence of various forms of violence, including domestic violence, dowry-related deaths, rape, and molestation. Author finds there is should be action taken violence, as the trends in the violence against women are rising.Qadir, (2023) this study was conducted to see the violence against women in mega cities of India, study was conducted for the years 2014 to 2018, by using year by year percentage change method author found that, high records were found in Delhi, and low records were found in Surat in (Gujarat), followed by Kozhikode in (Kerala), Coimbatore in (Tamil Nadu) have noticed a low rates of violence against women. Bhargavi et al., (2023) conducted a study to understand the growth rates of the crime against women in various states and regions of India from 2011 to 2020, and also to compare the variations in crimes across states and regions of India, year-on-year growth rate and Compound Annual Growth Rate (CAGR) methods were used. The results showed that Sikkim had the highest crime rates, followed by Manipur, Andhra Pradesh. However, states like Telangana, Arunachal Pradesh, had very low rates. similarly,(Thapa,2021) analysed the impact of socio –economic factors and various crime types in India states from 2001 to 2019 , to study recession of 2008-09. By applying panel data analysis , conducting both fixed effect and two stage methods, the author finds that

there is an inverted U shaped relationship between certain crime categories and economic growth, indicating economic growth, poverty and unemployment primarily impact total crime. Prosenjit Murmu, (2023) try to analysis regional variations in crime against women over a period of 2013- 2019 in India, two types of crime against women (IPC and SLL) were used from NCRB for analysis, ArcGIS 10.8 was employed which gave results which showed low crime rates in North India and NorthEast India. A. Bhattacharyya et al., (2022) analysed crimes against women (rape, dowry death, molestation, and torture) using Spearmans Rank Correlation along with global and local Moran's I test to get insights into crimes over a period of 1995 to 2015 across 24 states in India. The results show that FEMALE WORK FORCE PARTICIPATION and police station significantly reduce incidences of dowry death. Chauhan & Baraik, (2016) conducted a study which explores the spatial and temporal aspects of crime against women in India with special reference to rape, the study indicates existence Of geographical associations visible spatial variations along with rising trend of crime rates is evident across the country over a period of time. Mondal et al., (2022) analysed crime (robbery, molestation, rape, and dacoity) using Kernal Density and Getis – Ord Gi* to get the insights of hotspots over a period of 2012 to 2015 , a case study of Pune. Spatio – Time permulation model was inbuilt in SatScan for crime hotspots detection in Pune. A L & Rose, (2016) try to explore the rates and spatial variations of crime in Thiruvananthapuram city for a period of 2010 to 2014 Moran's I and Getis-Ord Gi* were used to find the clustering pattern as well as the outline in the data, hotspots in crime like murder ,robbery, snatching and theft edi. Kedia, (2011) tried to analyze crime mapping and its analysis for effective law enforcement and crime management using QGIS to create heat maps based on temporal and spatial analysis.

Yar & Nasir,(2016)try to study the crime with special reference to its spatial and temporal distribution. To analyze the impact of weather on the prevalence of criminal activity in Mardan city. GIS tools were used to do the analysis, (kidnapping, murder, injury). Kaur et al., (2018) Ty to study factors contributing to crimes employs regression analysis using SPSS to examine the impact of individual factors on the overall crime rates in Delhi and also use K-means clustering to categorized cases based on the degree of crime rate. Andresen & Malleson, (2013) to investigate the impact of modified areal units of crime patterns, a new area based – spatial point pattern test was employed, also cross national was done , finds how much spatial heterogeneity is also present in the area. Yar & Nasir, (2016) try to study crime in Mardan city, its spatial –temporal distribution, as well as the potential impact of weather on criminal activity under taken using GIS for spatial and temporal analyses to provide valuable insight into crime patterns. Roy & Chowdhury, (2023) try to study crime against women in West Bengal ,for the span of 6 years from 2016 to 2022 ,for 6 different IPC crime against women, employing GIS and spatial techniques ,such as Moran's I and Getis-Ord Gi* were under taken to test spatial autocorrelation and spatial clustering of crimes against women in Districts of West Bengal. F. Mohammed & R. Baiee, (2020) try to study crime attributes using GIS techniques by providing spatial – temporal connections between different types of crime and land use to evaluate crime patterns. Pain et al., (2006) try to study the areas of new streetlight to improve community safety and reduce fear of crime in Northumberland, Northeast England, by employing GIS and crime hotspot maps and lighting coverage maps, finds the complexity of people's experiences of crime and fear, and their perceptions of steetlighting's role in looking these issue. Gartner & Macmillan, (1995) try to investigate

the impact of the victim offender relationship on the reporting of violence against women to the police, data from the 1993 Canadian violence against women survey, finds that the knowledge of violence being the least likely to be reported to the police.

## 2.1 Research gap

Collectively, these study shows that limited research has been conducted in Karnataka regarding the spatio- temporal patterns, clustering nature, hotspots of crime against women , some aspects have been studied to some extent , as crime rates being increasing in Karnataka which can be seen from the studies done earlier, but no special attention was given to specific crimes and their occurrence with in the districts of Karnataka , by using spatio- temporal analysis studying the occurrence of crimes against women with in the districts of Karnataka.

# CHAPTER 3: METHODOLOGY

## 3.1 Study Area

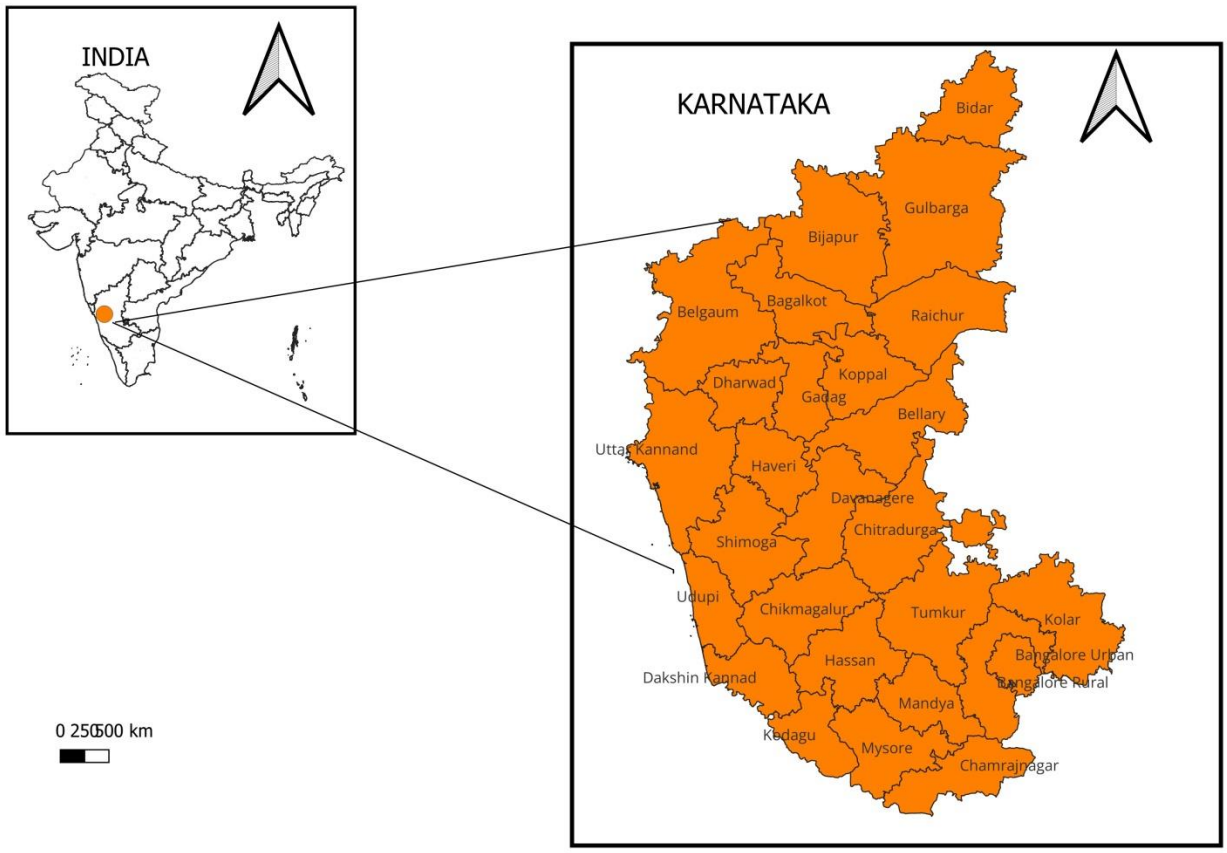



Fig 3.1.1 over view map of study area

Karnataka, state of India located on the western cost of the subcontinent. Karnataka is a diverse state in southern India with 31 districts, each with its own unique culture and economy. It shares borders with Maharashtra and Goa to the north, Andhra Pradesh and Telangana to the east, and Tamil Nadu and Kerala to the south, with the Arabian Sea forming its western boundary, Covering an area of 191791sq.kms, Karnataka covers 5.83 per cent of India's total geographical area. As of 2011, its population of 61095297 makes up 5.05 per cent of nation's population, ranking it as the 9$^{th}$ largest state among India's 28

major states and 8 union territories. The state is becoming steadily urbanized, in terms of urbanization, the state has witnessed an increase of 4.68 per cent in the proportion of urban population in the last decade. 61.33 per cent are rural residents and 38.67 per cent are urban residents. It has a larger proportion of its population living in urban areas, than the average for the country as a whole. (Economic Survey of Karnataka). For the administrative purpose, Karnataka is divided into 4 divisions, 31 districts, and 500 community development blocks (CDBs). The state has 5788 Panchayats and 327028revenue villages, out of 51533 habitations/hamlets, 9 urban agglomerations, and 130towns. Regarding religions, 83% of the population is Hindu, 11% is Muslim, 4% Christian, 0.78% is Jain, 0.73% is Buddhist, and remaining followed by other religions. Kannada is the official language spoken by about 67.75% of the population. The linguistic minorities include Urdu 9.72%, Telugu 8.34%, Tamil 5.46%, Marathi 3.95%, Tulu3.38%, Hindi 1.87%, Konkani 1.78%, Malayalam 1.69% and Kodava. 0.25 %. Karnataka has one of the largest state economies in India, contributing significantly to the county's GDP. Agriculture is major occupation for majority of the rural population, as per the 2011 census agricultural crops like rice, sugarcane, pulses, and oilseeds being important. The state is also a major producer of silk. Karnataka, is known as the "Silicon Valley of India" due to its thriving IT industry, especially in cities like Bengaluru, other industries include manufacturing, biotechnology, aerospace and automotive. The state has a strong services sector with IT, education, healthcare and tourism playing significant role.

Crime against women, have been on the rise in India over the years. Karnataka being a urban, semi-urban, and rural areas providing a diverse demographic landscape, the reason behind selecting Karnataka as a study area is due to its diverse socio-economic landscapes,

varying levels of urbanization and its unique cultural factors makes Karnataka. According to statistics from the National Family Health Survey, official reports from the, UN and other reports, Karnataka, has revealed a notable rise in the number of cases recorded in relation to crimes against women inside the state.

3.2 Data collection and its processing:

The study is based on the detailed analysis of secondary data sourced from the National Crime Records Bureau (NCRB). The set span of 22 years commencing from 2001 and extending up to the latest available data for 2022, which specifically highlighting on crimes related to women , Within the context of Indian law, crimes against women are classified into two distinct categories: cognizable and non-cognizable offences. Cognizable crimes denote those where law enforcement authorities are immediately obligated to undertake prompt action upon receipt of a complaint or credible information. These offences are further subsumed under (1) the Indian Penal Code (IPC) or (2) Special and Local Laws (SLL). Conversely, non-cognizable offences pertain to situations wherein police intervention cannot be immediately initiated based solely on a complainant's report; instead, it falls upon affected parties, such as victims or complainants themselves, to pursue legal recourse against alleged perpetrators. Unlike cognizable crimes that warrant police investigation and subsequent arrests, non-cognizable offences necessitate impacted individuals to approach courts and formally file complaints to instigate legal proceedings (Kabiraj, 2023; NCRB, 2021). In this study I manly focused on this 6 types of crimes committed against women, using district wise IPC crimes data collected from NCRB . Table 1 below shows the 6 major crimes which are selected for the study along with its IPC sections and meanings of each crimes related to crime against women.

### 3.1.2 Table selected crime related to women, IPC section and its meaning

| Crime related to women | IPC Section | Remarks |
|---|---|---|
| Dowry deaths | 304-A | When a married woman passes away from burns or other physical harm or under unusual circumstances, and it is proven that her husband or any of his relatives mistreated or harassed her in the days before she passed away because of or in connection with any demand for dowry |
| Cruelty by husband or his relatives | 498-A | Any intentional action of such a kind as to push the woman to commit suicide or to in significant harm or risk to the woman's life, health, or well-being (whether mental or physical) |
| Kidnapping and abduction | 363 | The illegal act of removing or seducing a person away without their permission constitutes the crime of kidnapping. The act may entail the use of physical force, trickery, persuasion, or any other technique that results in the eviction of a subject from their legal residence or from their legal guardianship |
| Rape | 376 | Non-consensual sexual activity with a |

| | | |
|---|---|---|
| | | woman that is done either against her will or without her permission |
| Assault on women with intent to outrage her modesty | 354 | This entails assaulting or employing criminal force against a woman. Physical acts or gestures that violate a woman's bodily integrity or privacy are included. Furthermore, the act is conducted with the aim to offend the woman's modesty, including harassment, intention to disrobe, and stalking. It refers to activities that are sexually inappropriate, indecent, or breach social modesty standards |
| Insult to the modesty of women | 509 | Whoever, with the intent of insulting a woman's modesty, delivers any words, makes any gesture or sound, or shows anything with the intent that such phrase or sound be heard, or such motion or object be seen, by such lady, or intrudes upon her solitude |

SOURCE: NCRB website

The main reason behind selecting these specifically 6 crimes as they are important to look into and their frequency ad reasons for happening vary across different areas of Karnataka,

by closely examining crimes defined by the Indian Penal Code (IPC), aiming to fully understand the consequences of crime against women in Karnataka. Along with the data of crime against women, the Karnataka district shapefile data was downloaded from the survey of India , which is used for spatial analysis in the study. The initial stage of this study with collection of data from the official website of National Crime Records Bureau (NCRB). However the data set included data for all the districts throughout India, as my primary focus of the study was the crime against women with in the all districts of Karnataka, a process was undertaken to sort and organize the data to include all 31 districts with the state of Karnataka .after collecting the data of 6 crimes against women for all the districts of Karnataka for the 22years starting from 2001 to 2022. Further evaluated the status of crime against women by looking into the trends of different types crimes of the years from 2001 to 2022. After looking into trends, spatial statistical methods such as Moran's I and Getis-Ord Gi*are under taken conduct the further analysis.

Exploratory spatial data analysis for spatial pattern of Crime Against Women:

Exploratory spatial data analysis (ESDA) is a set of techniques used to analyse and understand spatial patterns and relationships within geographic data. It helps in identifying hotspots , detecting spatial clusters, mapping trend over time assessing factors resources allocations, policy developments, community engagements, comparative analysis. various statistical methods can effectively quantify spatial autocorrelation, including Moran's I , Geary's C, LISA and Getis-Ord Gi*. These methods are useful for assessing both the strength and statistical significance of spatial relationship between observations. These

methods also helps in detecting spatial patterns or trends, allowing the evaluation of spatial dependence or structure within a geographic dataset.

3.3Moran's I analysis

Moran's I is a statistical test used in spatial statics to determine if spatial autocorrelation exits. The first basic measurement of spatial autocorrelation is Moran's index, which came about as a result of Pearson's correlation coefficient in general statistics. Generalizing Pearson's cross-correlation coefficient of two samples to the autocorrelation coefficient of one sample, and then generalizing the 1-dimensional autocorrelation coefficient from time series to the 2-dimensional autocorrelation coefficient about spatial distribution by substituting the weighting function for the lag parameter, we can obtain the formula of Moran's index (Chen, 2013). Moran's I is a method used to measure correlation between observations at different locations in space. This is the Moran's I formula to calculate Moan's I value .

$$\textbf{Moran's I} = \frac{n}{S_o} \times \frac{\sum_i \sum_i W_{ij}(x_i)[x_j - \bar{X}]}{\sum_i [x_i - \bar{X}]^2}$$

where, x represent the interest variable, X denote the mean of x, n signify the count of spatial units, Wij stand for the matrix connecting observation i and j, which features zeroes on the diagonal, and SO represents the aggregate sum of all spatial weights., i.e., SO = ∑ i ∑ j Wij.

In this study Moan's I statistic was calculated using RStudio, the 'spdep' package in Rstudio was employed to compute Moan's I, a measure of spatial autocorrelation. The

code utilized for importing the spatial data, merging the crime data with Karnataka, shapefile, defining the spatial weights matrix, and executing the Moran's I function to obtain the spatial autocorrelation coefficient .the results were presented using scatter plots .

Moran's I helps us to understand if there is a pattern in the spatial distribution of the variable. It tells us whether nearby observations are similar od dissimilar. The value of Moran's I range from (-1 to 1).

A value close to ( 1) indicates strong positive spatial autocorrelation ,these means nearby values are similar .A value close to(-1)indicates strong negative spatial autocorrelation ,these means are values are dissimilar. A value around (0) suggests no spatial autocorrelation, these means nearby values are not related.

Moran's I scatter plots

Scatter plots involves understanding the spatial pattern of the study points. If data points cluster together in the scatter plot, forming groups or cluster, it indicates positive spatial autocorrelation .

Positive Moran's I value s (close to +1)- suggests that similar values are close to each other geographically. Suggesting a spatial pattern where areas with high or low values are surrounded by areas with similarly high or low values.

Negative Moran's I values (close to -1) - suggests that dissimilar values are close to each other geographically .suggesting a spatial pattern where areas with high or low values are surrounded by areas with dissimilarly high or low values.

If data points are randomly distributed across the scatter plot, it indicates no spatial autocorrelation. If data points cluster towards the upper right and lower left corners, it suggests positive spatial autocorrelation. If points cluster towards randomly across all four quadrants, it suggests no spatial autocorrelation. If point cluster towards the upper left and over right corners, it suggests negative spatial autocorrelation.

The primary objective of this study is to analysis the spatial autocorrelation present with in a specific set of crime against women across various districts in Karnataka. The aim involves employing the Moran index to evaluate and identify any discernible spatial patterns that may emerge, thereby enabling an assessment regarding whether the occurrences of these crimes exhibit random dispersion or demonstrate notable geographic clustering throughout the districts of Karnataka. Through this analytical study, it is possible to understand underlying factors or spatial processes that contribute to the observed patterns, thus enhancing our understanding of the phenomenon.

3.4 Getis-Ord Gi*: hotspot and coldspot:

It is a spatical statistical method used for analysing hotspots The Getis-Ord Gi* method is used to determine the trend (clustering) in the attributes of spatial data (points or polygons) in a particular location and coldspot. (Roy & Chowdhury,) Gi* calculates a z-score for each location in the dataset, representing the degree to which a specifc feature (e.g., a high or low variable value) is clustered relative to its neighbouring locations. Positive z-scores indicate hotspots (high-value clusters), while negative z-scores indicate coldspots (low-value clusters).

$$G_j^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S * \sqrt{\frac{\left[\sum_{j=1}^{n} w^2{}_{i,j}x_j - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}}$$

where, xj represents the feature value attribute for j, wi,j signifies the spatial Matrix between i and j, and n denotes the total features count.

Getis-Ord Gi*: hotspot and coldspots analysis was performed usig RStudio, Getis-Ord Gi* values were calculated to assess spatial autocorrelation. The ‘spatialststs’ along with this other required packages from Rstudio was used for calculating the Getis-Ord Gi* statistics. Firstly the Karnataka district shape file was imported in R and along with crime data was also imported. Followed by merging the two dates to link the data with districts and by using the G* function from ‘spatialstats’, package was applied to calculate the Getis-Ord Gi*: hotspot and coldspot:.The final output was presented with maps for this ‘ggplot2’ and ‘tmap’ packages were used.

If the Gi statistic is positive, it indicates clustering of high or low values are surrounded by low values and low values are surrounded by high values. A higher positive gi value indicates a strong clustering of high values (hotspots), while a low negative value indicates a strong clustering of low values(cold spots). Gi results are presented with maps to visualize hot cold spots, which helps in understanding spatial pattern in the data.

- If Gi value is positive :
- High positive values indicate clustering of high values (hotspots).

- Low positive values indicate clustering of low values (coldspots).

If Gi value is negative :

- High negative values indicates dispersion of high values (coldspots).
- Low negative values indicate dispersion of low values (hotspots).

In this study I have used Moran's I and Getis-ord Gi* as both the methods help me to understand the spatial patterns, Moran's I will help me in identifying if there is a clustering pattern in crime rates within districts ,which will help me know districts with high crime against women are clustered together. Getis-ord Gi* will help in pinpointing specific districts of significant clustering, indicating where hotspots (high crime clusters) and coldspots(low crime clusters) are located. These methods will provide a comprehensive view of spatial autocorrelation in the data.

# CHAPTER 4: ANALYSIS

Fig. 4.1 District wise 6 different crime against women rates 2001

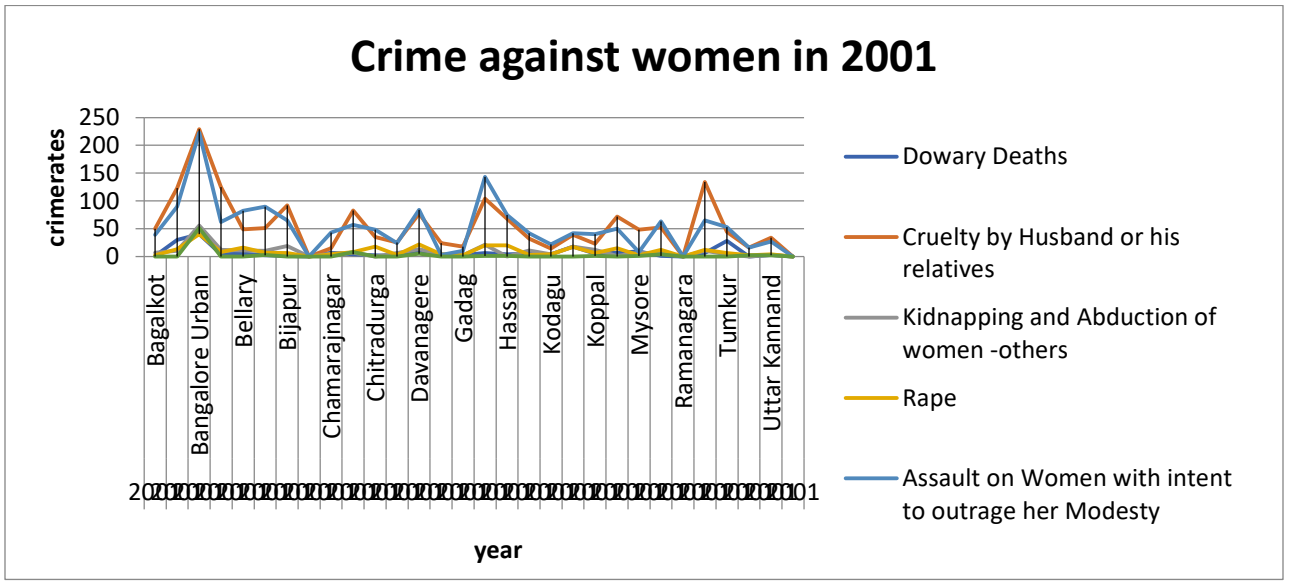
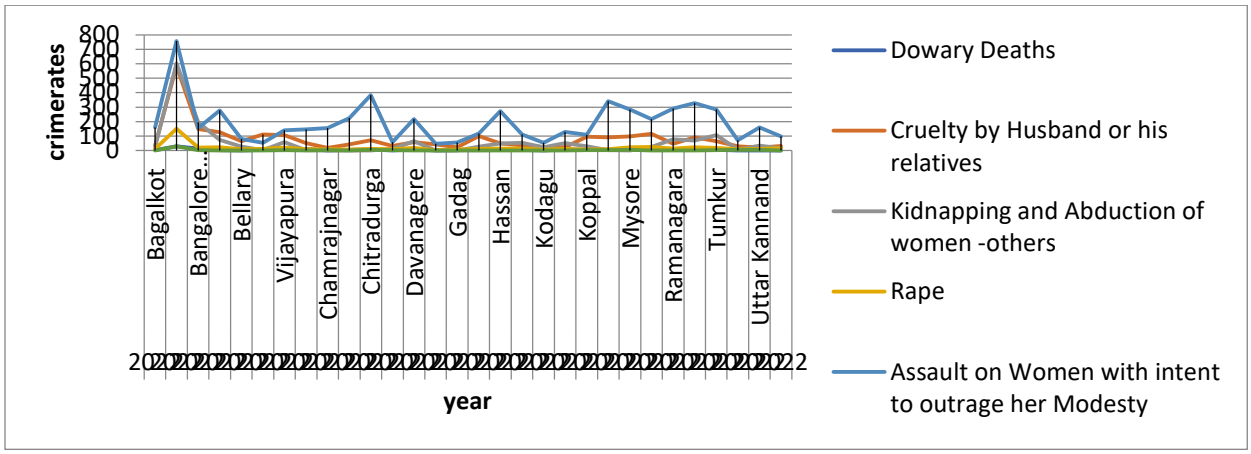



Fig 4.1shows a district wise crime against women in 2001, showing tend of all 6 different types of crime over all districts , cruelty by husband or his relatives and assault on women with intent to outrage her modesty are highly seen crimes in 2001,as compared to all other crimes , Bengaluru urban has the highest rates of assault on women and cruelty by husband , rapes and kidnapping rates were very low in districts of Karnataka. Over all there is a fluctuations in the crime rates over all districts.

Fig4.1.2 District wise 6 different crime against women rates 2022




The graph show the crime rates of crime against women in the year 2022, shows that assault rates and cruelty rates are mostly high in almost all districts as compare to other crimes. Assault rates being highest in Bangalore rural followed by Belagum, Chitradurga , but in case of Dakshin kannad assault rates are low, it shows a fluctuation. Un like in 2001 even in 2022 rape and kidnapping rates are low.

As we compare crime rates in 2001 and 2022, in 2022 Assault rates were very high , followed by dowry deaths, kidnapping . Rape cases were low as compare to other crimes. Over a periods of time crimes rates against women have been rising. Kalaburagi recorded highest number of crimes against women as compare to 2001, followed by Ballari, Kopla,Riachur and Yadgir.

By using spatio temporal analysis from 2001 to 2022, to evaluate the spatial and temporal variation exhibited by these crimes across different districts with in Karnataka .

To achieve objective 1 Moran's I test was done.

In this study the findings of moan's I analysis provide crucial facts regarding the spatial autocorrelations of various forms of crimes committed against women with the districts of Karnataka. The outcomes indicate that the higher positive values of the Moran index pertaining to the acts like dowry deaths, cruelty by husband or his relatives and insult to the modesty of women suggests a more strong tendency towards spatial clustering. Conversely , lower values particularly in relation to kidnapping is very low pointing towards a relatively weaker tendency for spatial clustering , while Rape and Assault are in a moderate stage of clustering.

It is observed that Dowry deaths exhibits a notably higher positive Moran's I value of (0.37) compared to all other crimes this indicates a strong positive spatial autocorrelation, implying that districts with dowry deaths rates tends to be geographically clustered together.

In comparison, Cruelty and Insult rates demonstrate considerably lower level of positive spatial autocorrelation with Moran's I value of (0.144 and 0.141). indicating towards lower positive autocorrelation.

Moran's values with( 0.08, 0.034 0.06,) are rape, kidnapping and assault rates suggest a minimal positive spatial autocorrelation, indicating towards lower positive spatial autocorrelation.

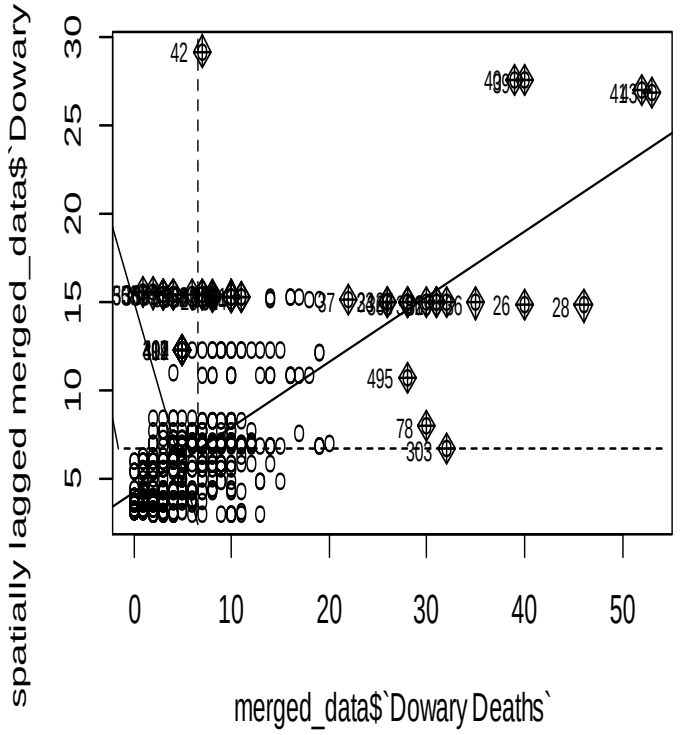
Moran's I scatter plots : When a points cluster towards the upper right and lower left corner suggesting positive spatial autocorrelation, as seen in above scatter plot of dowry deaths points and cruelty rates are positively Spatial autocorrelated along with followed by other crimes indicating a positive spatial autocorrelation

A

jm

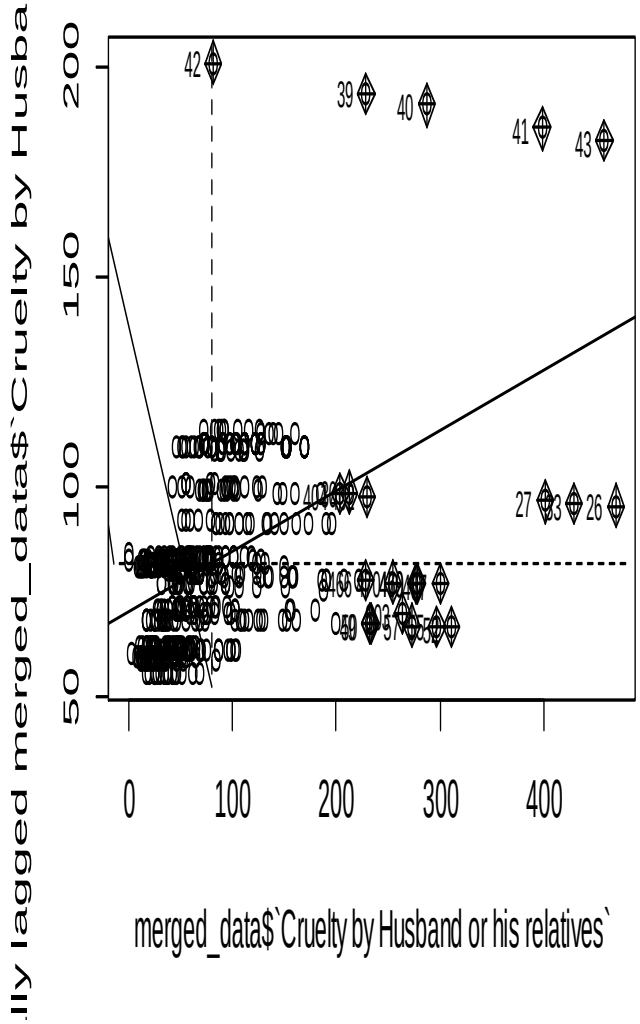
**Moran's I:0.37**

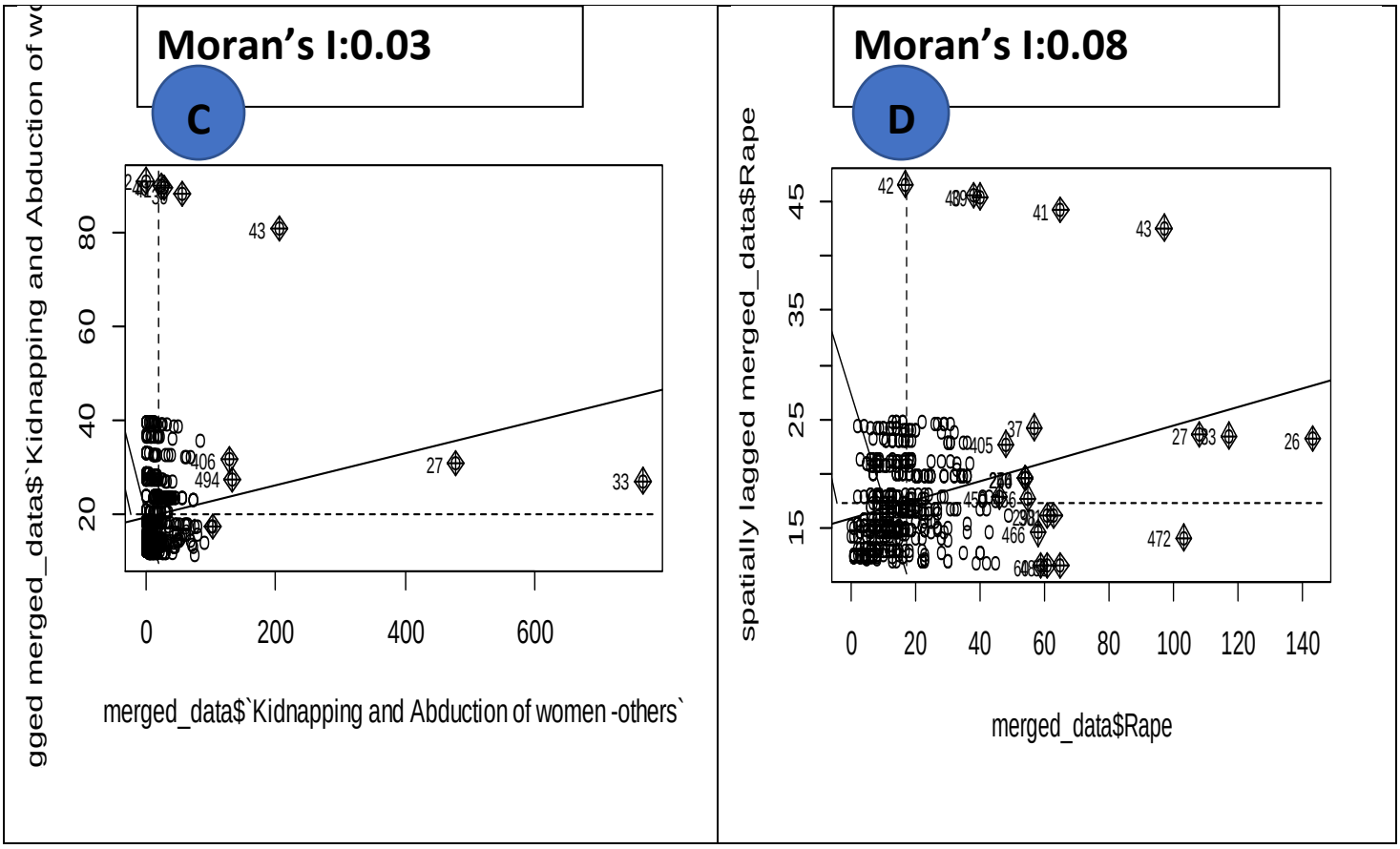
A




**Moran's I :0.144**

B




Moran's I:0.03
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merged_data$`Kidnapping and Abduction of women -others`
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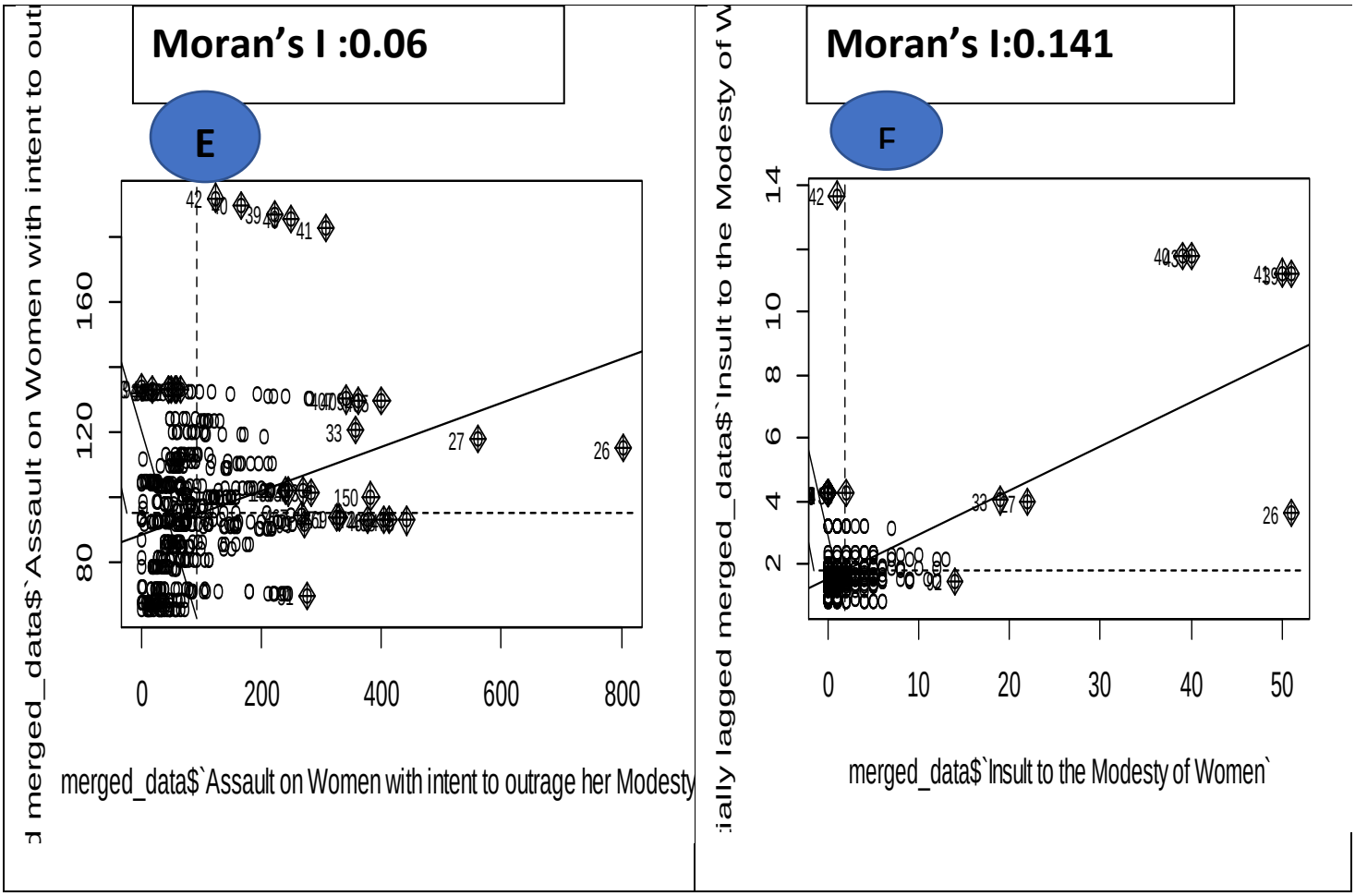
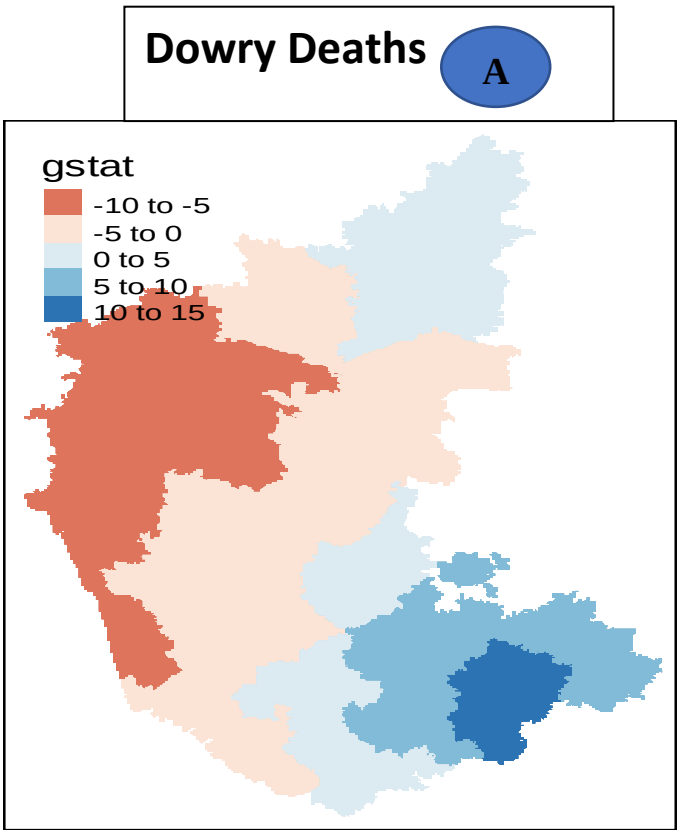



Fig 4.2.1 Moran's I Scatter plot showing the spatial autocorrelation pattern of different types of crime against women in Karnataka , a) dowry deaths, b)cruelty by husband or relatives , c)kidnapping and abduction, d)rape, e)assult, e)insult

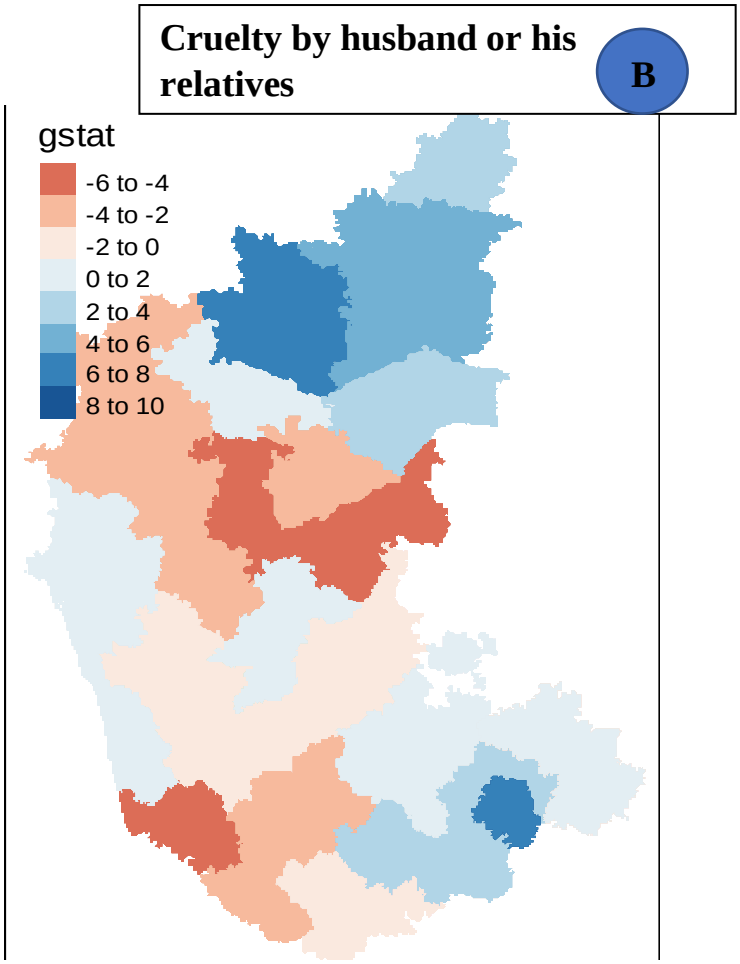
Hotspot and Coldspot analysis to identify those districts where similar forms of crimes against women tend to be concentrated.

To analysis the Getis-ord Gi* method is indeed a power full tool for hotspot and coldspot analysis in various fields . this method will help me to uncover the spatial patterns in a crime incidents , revealing where certain types of crimes tend to cluster. Identifying these hotspots with high concentrations of crime and coldspots with low concentrations is crucial for understanding the dynamics of crime with in specific districts. It's a useful approach for studying the heterogeneous nature of crime against women.



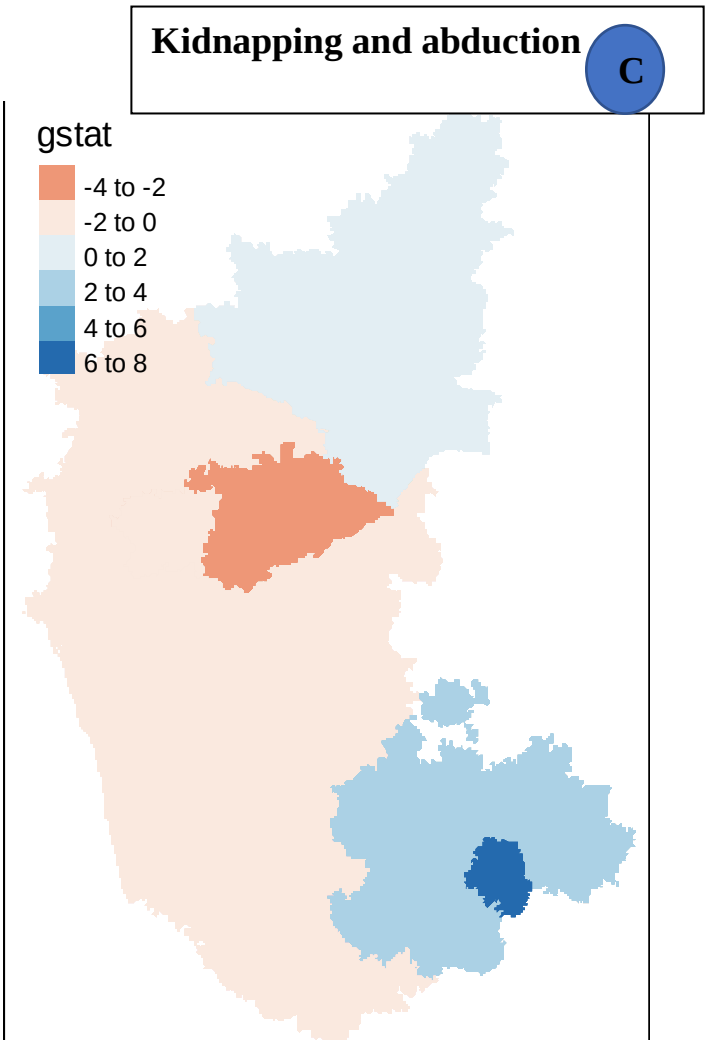

From the above map we can see that districts such as Bengaluru urban , kolar , Tumkur , Mandya, Raichur have emerged as neighboring hotsopots. This indicates a high

concentration of high dowry death rates can be seen compared to other districts other. on side districts such as Belagavi , Bijapur,Gadag, Udpi, Dharwad and baglkot can be seen as districts with neighboring coldspots, indicating a low concentration of the low dowry death rates

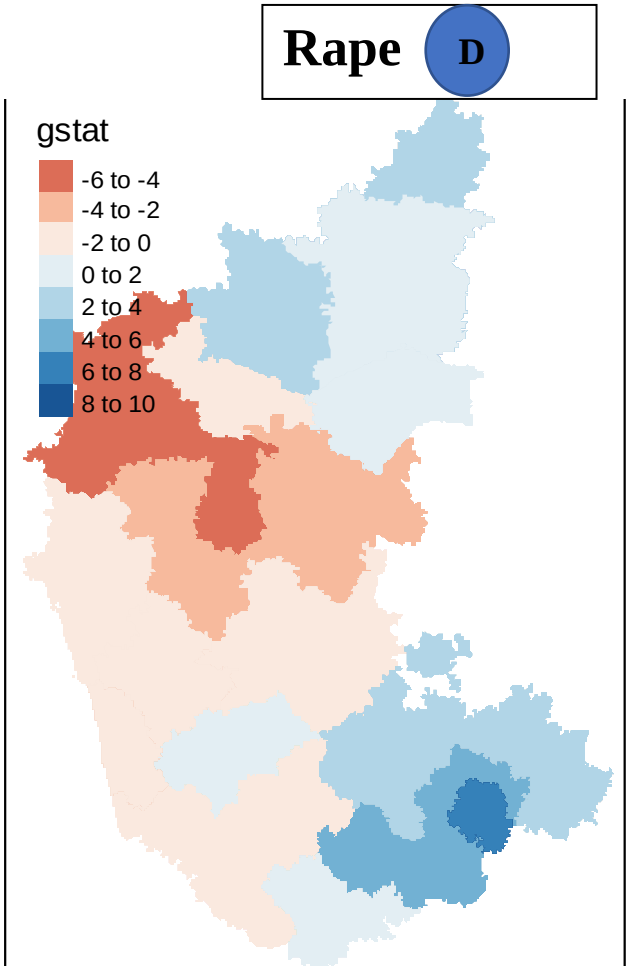



In case of Cruelty by husband or his relatives , Bidar , Bijapur , Raichur, yadgiri, Bangalore Urban, kolar, Ramanagar have emerged as neighboring hotsopots. This indicates a high concentration of high Cruelty rates as compared to other districts where as

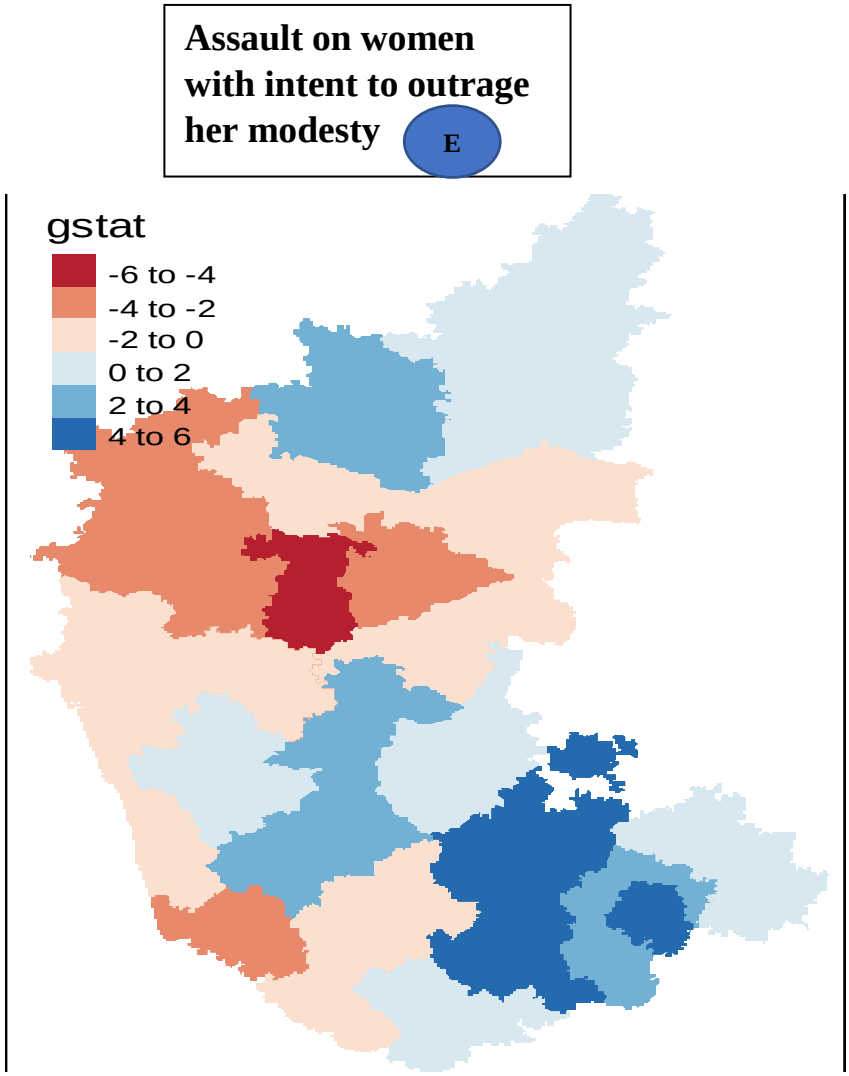
districts such as Ballari, Koagu, Davanderi, Haveri, Dharwads, Dakshin Kannada, Kodgu and Hassan have been seen as cold spot districts.




In case of Kidnapping and abduction Bangalore Urban, Chikkaballapura, kolar, Ramanagara, Tumkur , Mandya, Mysore, Chamarajnagar districts are being hotspots ,and districts with coldspots include Kopal and Gadaga showing low concentrarion of kidnapping rates .




In case of rape rates Tumkur , Bangalore , Bangalore rural , Chikkaballapura, Kolar, Ramanagara, Tumkur, Bidar, Bijapur districts have been identified as hotspots ,while districts Belgaum, Bagalkot, Gadag, Kopla, Uttar Kannada, Ballari, as seen coldspot districts .




Assault on women with intent to outrage her modesty in this case many districts are in hotspot regions, which are Tumkur, Bangalore Urban, Bangalore Rural, Ramanagra, Bijapur, Chikmangalur, Chitaduga, Hassan, which highlights huge concentration of assault

rates in this districts. Where as Dakshin Kannada , Haveri, Davangeri, Gadag, Kopla, Belgavi, districts are seen as colds pots.

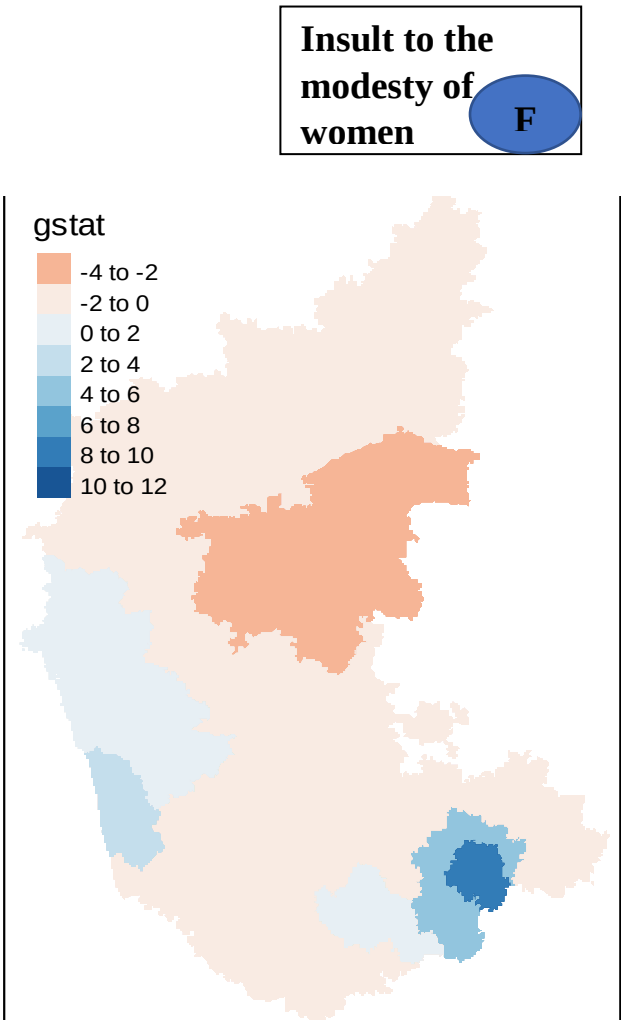



Fig. 4.3.1 Hotspots and Colds pot maps of different types of crime against women, A) Dowry Death, B) Cruelty, C)kidnapping, D)Rape, E) Assault, F) Insult.

In case of Insult to the modesty of women, Bangalore Urban, Udpi, Bangalore Rural, Ramangra, and Uttar Kannada districts have been seen as hotspots and districts such as Richur, Koppla, Ballari, Gadag, Vajrayana ,and Davanger cold spots.

Bangalore Urban has been the one of the most hotspot district of Karnataka, as it has been seen from the above analysis that mostly in all crimes it has been a main highlighted area. Only few districts fall under colds pots. Ballari and Kalaburagi in case of Assault ,Curelty by husband or his relatives

# CHAPTER 5: CONCLUSION

In conclusion, my study focusing on crime against women in Karnataka reveals unsettling increase trend of incidents over the entire state. Certain districts consistently experience higher than average rates of crime against women, while few districts show relatively lower frequences.

The analyzed offences shows a clear trends and clusters include dowry death, assault against women, cruelty by husband, insult against women, rape and kidnapping. A wide range of policy recommendations can be made in light of this these findings, primarily, it is important to strengthen law enforcement which will take immediate actions in case of crime against women incidents.

This includes building specialist units or cells to handle crime against women cases, improving police force's skills, and offering specialized training in managing situations, public awareness.

The cause of crime against women , such as gender inequality, traditional practices and social biases, should be addressed by preventive measures, which can be achieved by means of educational information , implementing community based awareness programs, enhancing law enforcement efforts etc.

The presence of localized factors contributing to the occurrence of such crimes which may include cultural norms, socioeconomic disparities, lack of access to support services for women , by implementing preventive measures like community outreach programs, education initiatives, and strengthening law enforcement can help in reducing the occurrence of crimes and create a safer environment for women.

The Domestic Violence Act should be properly implemented , monitoring crime against women related incidents is essential for determining the effective's of interventions and making necessary adjustments. By bringing the changes into the practice, Karnataka may work to create safer atmosphere that supports gender equality in all spheres of society.

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