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Socio–Economic Impact of Urban Flooding in one of the low-lying areas of Surat in light of e-governance and Social Engineering

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Abstract

Flood is natural catastrophes that lead to massive damage to properties and lives. Its impact on socio-economic aspects has been highly recorded over the last two decades. Social and active learning efforts, such as flood monitoring through e-governance and Self Help Group's (SHGs) social engineering method, effective cooperation by allowing stakeholders to talk about issues of common interest in a spirit of mutual trust and ownership, as well as breaking down information exchange obstacles. Here, we have emphasized the social impact of the low-lying area of Surat city in the context of e-governance and social engineering. In communities defined by changing climate, local economies, and demography, social and active learning through SHGs helps build an ability to manage complex socioeconomic-political and environmental concerns. Using the Kadarshah Naal SHGs as a case study, we examined the SHGs framework as a catalyst for altering practices toward collaborative working and aiding the transition to more sustainable urban floods and their control. This study is collected on real-time basis data from urban flooding as a case study where the improvement in urban flood resiliency has been observed with the formation of the Kadarshah Naal SHGs. A socio-economic survey was carried out to evaluate the impact of the integration of SHGs with the urban local body (ULB) on resiliency. The study has found that the alone approach of e-governance of ULB was ineffective for faster and speedy resiliency but with the integration of SHGs, the resiliency is better. These SHGs have strengthened the peoples' bonding and provided leverage to the ULB for handling the flood situation with disparities in viewpoints and behaviors. These SHGs have helped to reframe the tacit knowledge of handling emergency situation through social engineering approach. The Kadarshah Naal SHGs' social learning has pushed the members to move away from traditional "siloed" activities and responsibilities and provided a platform to have an integrated and inclusive approach to developing common visions and working toward urban flood resilience.

Keywords: Socio Economic Impact, E-governance, Urban Flood
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I. INTRODUCTION

The last several years have seen catastrophic floods in highly urbanized areas around the world [1, 2]. In the post-globalization period, economists acknowledged that in order to maintain the economic growth rate, metropolitan areas must be developed as economic engines that contribute valuable GDP to the nation [3]. Movements of urban development in some of the Asian economies are witness of migration from rural areas to urban areas, converting clusters of rural settlements into urban centers, growth in urban population, development of slums in cities, development of peri-urban areas, less reliance on rural economy, and many more such issues [3, 4]. However, these urban developments were primarily unplanned or non-harmonized in nature, resulting in urban sprawl [4].

Annual predicted flooding damages are in the billions of dollars worldwide and are expected to escalate due to projected increases in the number, severity, and magnitude of storm events [5]. This is a particular problem for cities, which have mostly impermeable walls and rely on piped drainage systems [6]. Upcoming urban flood threats are exacerbated by increasing urban expansion, which may result in a 60–220% increase in indemnities caused by water flooding throughout the next fifty years [7]. The economic development of a region can be achieved by increasing the population, urbanization of peri-urban areas, and industrial development at a cost of pressure on land resources [1, 3, 4]. Due to this non-harmonized and unplanned urban development, certain issues related to land use land cover (LULC) has been surfaces out such as, (i) inadequate land use, (ii) land use pattern modification–conversion of agriculture land, construction of impermeable pavements and filling of natural water bodies–in response to urban needs for domestic, economic, and industrial growth (iii) increase in legal disputes about conflicting land, (iv) slum proliferation, (v) rising cost of land, (vi) less availability of land for housing, (vii) overcrowding, (viii) Slum settlements along the shore, in the river belt, and in low-lying regions of the city where flooding is a problem [3, 4, 8, 9, 10, 11, 12].

As this is one of the low terrain areas of the Surat city and is going to be a part of Metro Rail Network, it is important to evaluate and assess the impact of flooding due to the rain and urban runoff [13]. Several research scholars have evaluated the flood assessment of urban areas with computer modelling which are quite useful in

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decision making process in the cases of pre and post flooding events [14, 15, 16, 17].

Reference [14] has evaluated the urban area of Ahmedabad and Sabarmati River with the HEC-RAS 5 hydrodynamic model for flood of 2006 to develop the decision support system (DSS) for the authorities of urban local body of the Ahmedabad city. Reference [15] has validated the HEC-RAS 2D hydrodynamic flood model for the urban coastal area located on the Purna river of Navsari of Gujarat State of India which is useful to the authorities of urban local body for the preparation of efficient flood assessment and resiliency plan. Reference [16] has studied the flash flood scenarios in semiarid region of located at the Rel River of Gujarat state of India for a period of 2015 and 2017 with AHP-MCE method and prepared a flood risk map with the vulnerability index. This particular study is useful to handle post flood scenarios for meeting the need of the distribution of flood relief package. Reference [17] has conducted the simulation study with the help of 1D/2D couple hydrodynamic modeling to assess the flood and inundation in low-lying areas with the flood data of 2006 under unsteady state flow conditions.

In some of the recent research studies, the researchers have highlighted that, apart from the change in LULC, other variables such as unsustainable use of natural resources, pollution, climate change, and soil erosion are also posing severe hazards to urban floods [8, 18]. Post-flood scenarios are a component of the disaster response, with the primary goal of minimising socio-economic damage [19, 20]. Cities with a higher rate of urban growth are more likely to experience urban flooding and the devastation caused by floods [11, 12]. Reference [9] have examined the relation between urbanisation and flood risk. For the studying of flood and resiliancy, researchers have emphasized to use different vulnerability indicators and vulnerability models for the assessment of vulnerability of people and various assets against the flood and damages caused by the flood [21, 22, 23, 24, 25].

Based on such urban flooding events around the world, the harm caused by the floods, and the time required to recover from flood damages and restore social economic life (i.e., post flooding scenario), researchers have been directed to invest in the development of sustainable cities and communities in the framework of the United Nations Sustainable Development Goals-SDGs [1]. Due to the ease of doing business, history suggests that major human communities emerged in coastal regions [1, 26]. The pressure on the coastal line has been increasing over time as a result of rapid population growth and urbanization [1]. Because of the strategic significance of coastline cities in terms of socio - economic and environmental concerns, greater resiliency in the aftermath of urban floods has been prioritized [1, 27].

Many scholars have looked into flooding in Surat, Gujarat, and the surrounding districts. investigated the current flood management technique in the Tapi basin. The entire system of flood management control in Surat has been discovered to be dependent on: (i) data handling and decision-making mechanisms by the Gujarat government, (ii) daily influx predictions from the Water Commission, and (iii) rules for basin activities to satisfy stated aims. The conclusion is that the current flood control system does not take into account changes in temperature, flood plain, drainage line (due to urbanisation), financial analysis of overall municipal loss against aid and obstacles to 3 million people. The majority of the research focuses on floods that have occurred in the past. In light of changing climatic conditions, it is also critical to plan all vulnerable areas and municipal amenities where a large portion of the vulnerable population may congregate. For example, in a low-lying location like Kadarshah Naal, where prominent schools and huge hospitals are situated and where children and patients convene in large numbers, clearing can be difficult. If the likelihood of disastrous events and their magnitude exceeds present moral standards, more adaptive movements may need to be planned ahead of time. In this context, the current study is significant because it shows the growth of Self Help Groups (SHGs), which primarily work through social engineering and coordinate with urban local bodies through e-governance to satisfy social needs during the Surat floods.

In order to respond to the predictions, we must shift our focus from flood protection to flood risk management, leveraging portfolios of Urban Flood Risk Management (UFRM) measures rather than being overly reliant on improvised structures [28], and in order to do so, we must employ an e-governance and social engineering technique in developing nations where infrastructure, governance, and social engineering are lacking [29]. This has resulted in a shift away from solely "grey" infrastructure and toward more socio-economic approaches that discover charities that use community engineering-based solutions in broader sections of cities like Surat, which is flood prone on a regular basis. However, implementing such social engineering or self-help groups (SHGs) can be difficult because it necessitates the active participation of urban people who are not traditionally involved in flood prevention [30]. As a result, new modes of working are required that focus on collaborative partnerships, organizing, and business planning in order to achieve a multi-functional URFM structure [6, 31].

Furthermore, past flood experience gained by Surat stakeholders affirms that implementing transformation and generating SHGs necessitates investors developing long-term, common vision for reducing the socio-economic losses caused by floods [9]. This necessitates collaboration between multiple administrations and divisions of city and management [32]. Such inter and cross-organizational connections, in combination with community based social engineering activities accepted by stakeholders, reflect an emerging radical transformation in flood management governance [33]. Development from traditional knowledge and flood control supervision in the direction of collaborative community based working are in line of the recommendations made in resiliency plan of Surat city [34]. Cooperative techniques, on the other hand, are inherently difficult due to challenges such as poor communication inside and between government departments and organisations, split tasks, ‘siloed' thinking, and resource constraints that limit communication and information sharing.

'Social' and 'dynamic' learning have been recommended as techniques to conquer these hindrances by permitting partners to encounter various perspectives on best administration rehearses and turn out to be better educated prior to deciding [35]. Social realising, in which entertainers communicate to create elective points of view (at the individual or group level) on cultural concerns and, on the whole, enable change is an important component of sustainable water management [36]. Self-help groups (SHGs), similar to Learning and Action Alliances, can promote adjustments in occupied behaviours by bringing together various opinions and goals to convert explanations that provide different assistances (LAAs) [37, 38]. SHGs are essentially a group of individuals or organisations who share a common goal of improving society as a whole while avoiding environmental damage. As an additional goal, the Addition Act emphasises the importance of SHGs in empowering its members to present the solutions that their cooperative learning identifies [39].

As this study is in the domain of evaluation of the post flood socio-economic activities, usage of computer simulation modelling is outside the scope of the present research, however one can study the same with the available data.

This research shows how Surat Municipal Corporation's e-governance and SHGs' Social Engineering technique may make social learning easier by allowing multiple participant groups to unite around advanced UFRM resolutions. It began with a definition of shared learning before moving on to the agenda of the SHGs. The ability of SHGs to stimulate and complement changing practises through effective collaboration is then validated, allowing for the necessary transitions to offer sustainable UFRM. We validate how e-governance and community engineering of SHGs can work using a case analysis of the Surat, Kadarsha Naal low topography area. Finally, the Kadarsha Naal's lessons are reviewed, and recommendations for pretty social learning via e-governance and social engineering via SHGs are suggested.

A. Social learning through e-governance and social engineering through SHGs

While community learning remains a difficulty, all explanations emphasise the need of obtaining new information to promote transformation [33, 34].

Advantages of social learning as revolutionary thinking for flood management

The traditional flood risk management (FRM) approach, which is heavily relying on the fundamentals of civil engineering, hydrology, and computer modelling only provide the engineering solutions and not able to evaluate the socio-economic damages of the flooding, also they are not in a position to integrate the tacit knowledge of the humans for handling the flood risks [40]. Even after the adoption of highly technical aspects, countries like Netherland and Germany failed to mitigating the flood risk; Netherland has adopted the method of “room for the river” through land use management and Germany has adopted the “retention of floodwater and adapted use of flood-prone areas” [41].

In the context of these limitation of simulation-based models and engineering solutions for mitigation of flood risks, many countries have started to utilize adaptive and integrated approach for the good flood resiliency in view of long-term commitment towards as a part of social responsibilities [29, 42, 43, 44, 45]. The EU Flood Risk Management Directive 2007/60/EC developed in the direction of the active involvement of various stakeholders, academic bodies, and civic society for the development of flood risk management plans [46]. For the minimization of the damages caused from the flood, United Kingdom has developed a “Strategic National Framework on Community Resilience” [46].

It has been found that various organizations and stakeholders are involved in the integrated approach, governance is one of the most aspects to be considered for the evaluation of socio-economic impact of flooding [47, 48]. Use of governance and social engineering approach in flood risk management help to analyze how flood risk has been managed and the socio-economic cost and its impact on the society [40]. Both these governance and social engineering aspects are related to the organized and technical measurement of resilience [49, 50, 51]. Reference [52] advocates based on the learnings from the real life cases of Rotterdam and Hong Kong in which adaptive FRM has been linked with the integrated approach to derive the cost effective and civic centered solution.

It is possible to compare social learning to a single level change [53]; aggregate level change (relational transformation within larger social contexts [54]; and/or aggregate realization (where social or institutional changes at the SHGs level are achieved via collective learning) [55]. Chiefs and members' versatility is increased through social learning, which can lead to collaborative activity and supported conduct change cycles through collaboration and consultation [34]. Social learning is also thought to contribute to greater learning depth as compared to single, double, and triple circle learning [56]. Reference [40] has highlighted the importance of governance as one of the tools in the integrated approach to reduce flood risks. Reference [40] found that due to the limitations of computer-based models, many countries have shifted to the adaptive and integrated systems for flood risk management in which they are involving local stakeholders of governments, academic institutions, local communities and civil society organizations (CSO) for resolving the problems related to urban planning. Reference [40] has proposed a collaborative approach to strengthen the flood risk governance.

Multi-circle social learning, such as contributions from SHGs, is a critical component of land and water governance to understand institutional and administrative limits and to study more participatory models [57]. The advancement of trust among social space members takes into consideration "issue-fixing" adjustments as they occur (single circle), additional arrangement encouraging institutional adjustments (two fold circle) and discussion of essential assumptions recalling articulation of queries for recognized standards and attributes (triple circle) [56]. This type of learning inspires change because it asks, "How would we decide what is the appropriate thing to do?" [57]. It's possible that this may lead to requests for changes in strategy and administration. On a personal level, it has the ability to shift points of view, mindsets, and practices. Social learning is closely linked to triple circle learning because the required depth of discourse is difficult to foster inside orders and can happen more quickly between peers in less traditional learning environments. In the case of SHGs, social learning may take place on two levels: at the individual level, such as changing one's perspective by acquiring new information, and at the aggregate level, such as changing one's perspective by acquiring new information. For example, a local area connection might lead to a shared understanding of a problem and a widely agreed-upon activity. Momentary adjustments (for example, new working with partners) and long-term changes in methods and administrative structures can demonstrate successful multi-circle social learning in SHGs. As a result, social learning may be seen as a duality that combines the aspects of training with a strong administration outline for that training, and therefore a fundamental approach to deal with administration [58].

B. The SHGs framework

The SHGs approach aims to provide a practical tool for working with social learning through the creation of a planned vision for resolving 'underhanded' challenges LAAs are open game plans in which participants with a common interest in development and change come to a shared understanding of a problem and possible solutions based on objective analysis and discussion [38]. By removing limits to both even and vertical data exchange and speeding up ID, transformation, and take-up of fresh data, SHGs improve involvement amongst partners from diverse trains and foundations [59]. Repeated cycles of social learning enable partners to create adaptive organisations by building the trust necessary to enable collaboration through formal and informal relationships [34].

SHGs encourage partners to bring their knowledge and expertise to the table and to speak freely outside of the constraints of existing formal institutional contexts [29, 40, 60]. They share many credits with optional partner stages and social learning circumstances such as what's application, but the emphasis is on improvement rather than knowledge transfer through joint realising when no established specialists are present [22]. The atmosphere of common ownership expands the flexible limit and works with the distinguishing proof of innovative ideas for the resolution of complicated financial challenges, as well as allowing for the quick saving of hierarchical "interests" for the union. The basis for such aggregation action is the enhancement of common significance and characteristics [34]. The ultimate goal is for ideas generated at SHG gatherings to be spread through traditional dynamic channels, resulting in the implementation of creative arrangements while also accomplishing institutional transformation [61].

Handling the situation in post flood scenario, a multi-level collaboration is needed and a general computer model is not able to provide the solution [62]. The research study has indicated that, except the five countries: Australia, Canada, Italy, Netherlands and Sweden, all other are in need of the strong government involvement for handling the flooding [63]. Recent practices for handling the flood risk with governance and social engineering is one of the most promising cost-effective solutions where civic society and local people are involved in decision making process [40, 64]. In post flood scenarios for deriving the better resiliency and reducing the socio-economic damages, ground level interactions with local people, involvement of local government body and formation of SHG is essential [64, 65] Reference [65] has emphasized that in the context of faster resiliency, FRM to be integrated with spatial planning, communication with the public through SHGs to support flood risk governance.

SHGs are dynamic groupings that advance naturally dependent on the weaving of social and social qualities and customs. They are frequently driven by the gathering of individuals with an intention to serve to the general public everywhere and minimization of the harms from metropolitan flooding to them from the financial viewpoints with no secret plan. After initial contacts and functioning game plans have been established, obligations usually transfer to various persons. As part of the exploration effort with SVNIT Surat, Gujarat, under a leadership of Dr Prasit G Agnihotri a SHGs have been tested as systems to handle urban flood and water the executives in the Kadarshah Naal in Surat, Gujarat. SHGs, which were founded by former city councillor Md. Asadullakhan Gulam Mustufa Kalyani and the former Chairman of Surat City Md. Kadir Pirzada, have had a significant influence on the development of adjacent metropolitan all-inclusive plans as a part of the casual interaction for transmitting neighbourhood risk to the executives [38]. The advantages of joining include system administration opportunities, such as access to partners who would otherwise be difficult to reach; the ability to benefit from and unreservedly contribute to conversation outside of their expert dispatch; and the ability to share information, information, and contacts. SHGs are also effective tools for combining social and water design research with the needs of important stakeholders in order to advance the exploration process [66].

II. CASE STUDY: KADARSHAH NAAL LOW TERRAIN AREA OF SURAT CITY

The Study area is in a Surat city of Gujarat State of India. Surat, formerly known as Suryapur or Khubsoorat, is the commercial capital of the Indian state of Gujarat. It is the 8th largest city in India (census-2011) and one of the fastest growing cities in India with a population in 2011 nearly the double of that in 2001. The Surat is a city located on the western part of India in the state of Gujarat. The Surat city is located at a distance of 260 km North of Mumbai city and 224 km South of Ahmedabad city. On a map, it is located at Latitude 21.112^0N, Longitude 72.814^0E on a bank of river Tapi. It is one among the most dynamic cities of India and having the fastest growth rate in terms of population. The sea is near to Surat, hence its weather is humid in nature and average temperature is around 23~25 ^oC, minimum temperature is around 8 ^oC and maximum is around 45 ^oC, rainy season in the city is from May to November and total rain fall of season is around 1020 mm. The rainfall data of Table I indicates that there is a heavy rain fall in the study area in a period of June to September and demands for maximum attention from the authorities, civic bodies and SHGs for minimizing the damages to the people residing in the area.

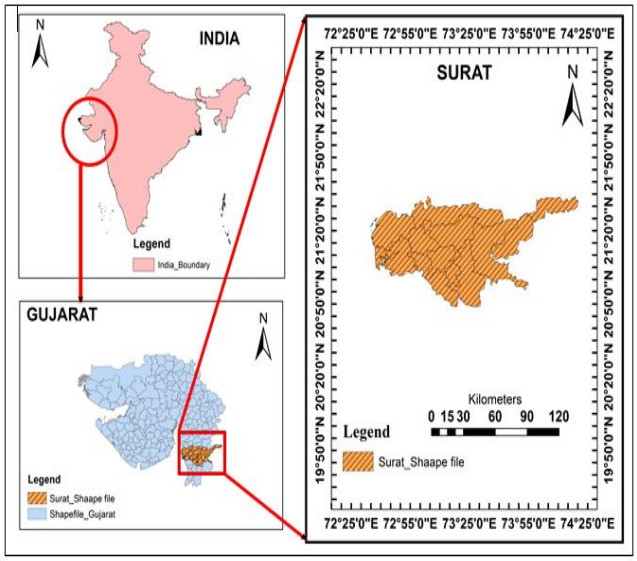

Fig. 1. Location Map of Study Area

Many areas across Surat are having low terrain and are in danger of major floods in the future, one of such area which is important to explore is Kadarshah Naal (Fig. 1.), which is highly vulnerable to frequent urban flooding in cases of heavy rain in the city area. At the time of initiation of the SHGs in Kadarshah Naal for flood management, there were already a system of e-governance of SMC resulting from the investment in information technology in response to floods and the reduction of existing dangers, and as part of localised strategies to allow for expansion and the provision of much-needed housing construction.

For example, the SHGs collaborated with their primary partners, the urban local body (ULB), i.e., Surat Municipal Corporation to lessen the effects of flooding and the creation of a more rapid recovery in terms of economic normalcy in post flood scenario that realigned the social and economic life.

However, no Surat vision for the entire city or master plan existed and no funding has been made for mitigating such flooding events. In managing the flood risk, Surat City Municipal Corporation, has recognise the value of working together of SHGs for Local Flood Management plan. The members of SHGs are well aware of the local area of Kadarsha Naal and have mobilized the resources accordingly to provide the support to local people during and after the flood event. As a result, there is a desire for further implementation through SHGs in Kadarshah Naal accompanied by a shift in attitudes

and working methods. Due to the SHGs, the range of socio-political-and-cultural barriers has been widely removed for the execution of the faster recovery and normalcy of the economic activities at the Kadarshah Naal area of Surat, Gujarat, which were earlier not possible due to the lack of institutional capacity and experience, and an unwillingness to help one another [30].

A. Importance of the study area: Kadarshah Naal

It is one of the central locations of the Surat city where major part of business activities carried out are recycling of materials, repairs of refrigerators, repairs of automobiles, garments manufacturing, fisheries and cold storages, hospitals and doctors houses and leading schools of the city are located here. Recently, the central government has announced for the establishment of Metro railway station here. In the context of its economic contribution for employment generation in informal market, imparting the health and education services to the major population of the city, it is essential to carried out such studies wherein we can focus on to reduce the damages from socio-economic perspectives.

The SHG was set up in August 2019 by the ex city mayor of Surat Md. Kadir Pirzada and ex metropolitan councilor Md. Asadullakhan Gulam Mustufa Kalyani and others and is progressing. It expands on existing connections and organizations between City partners by welcoming other expert partners to work together and co-produce a region vision for flood control and metropolitan water the executives. In building up and dealing with the SHGs they took on various stages and a few procedural strides by zeroing in on applicable issues and their answer. This multi-pronged strategy of region level gatherings on subjects of flood control and its administration has empowered the social learning, scattering of partner work, and contribution to quicker recuperation. Because of their ability to move others, a number of people assumed prominent positions on topics relating to their talent and stood strong on trusted footings inside the gathering. The selection of colleagues as volunteers in SHGs for providing work assistance in flood situations was done in a "snowball" fashion.

In the commencement stage, SHGs accepted a hierarchical job and set up a center gathering of UFRM experts from Surat, including the ex-Mayor, ex civil councilors and present official of the metropolitan company. People were allowed to join the SHGs as long as they were reliant on partner planning, which ensured that every relevant discipline and point of view were covered in order to maximize the possibility for unavoidable social learning. The ability to describe how these people and their organizations would benefit from participating in the SHGs was a critical step forward. This was necessary for two reasons: first, to legitimate the individuals' free speculation of time and effort required by SHGs, and second, to monitor assumptions about appropriate individual and institutional rewards on that endeavor.

B. Geography of the study area: Kadarshah Naal

Latitude: 21o 10’ 11.58” and Longitude: 72o 49’ 7.86”

Area: 0.51 km2 (which is highly prone to flooding)

Monsoon Season Rain fall: 38.89 inch (four months average, i.e., June to September)

Details are in (Table I & II; Fig. 2. & 3.)

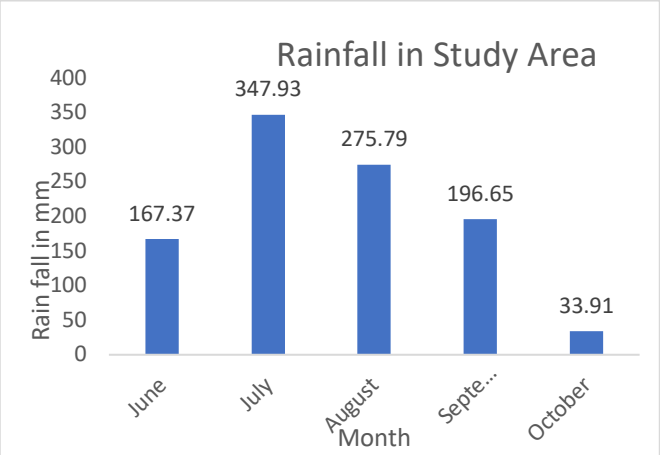

Fig. 2. Average Rainfall details of Kadarshah Naal (in mm)

TABLE I. RAINFALL DETAILS IN KADARSHAH NAAL AREA (IN MM) (SOURCE: HTTPS://CLIMATEKNOWLEDGEPORTAL.WORLDBANK.ORG)

	Month							
Year	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1991	2	41.7	316.1	124.4	24.8	0.2	1.2	2
1992	0.7	58	351.3	292.3	292.4	18.2	0.1	0
1993	0.4	69	406.5	103.3	218.9	47.1	13.8	1.6
1994	2.9	140.3	382.2	250.1	409.1	9.8	0.8	0
1995	1.4	27.1	319.7	115.2	146.6	17.5	5.6	1.2
1996	3.5	178.7	525.6	182.8	115.9	84	0.6	0
1997	7.6	199.5	252.3	315.4	232	2.3	19.4	5.6
1998	1	176.5	496.9	342.9	182.3	128.9	10.4	0
1999	4	229.1	237.3	65.4	111.9	102.8	0	0

2000	6	261.1	390.3	215.1	28.5	11.1	1	2.2
2001	45.3	292	265.3	179	28.2	52.5	2	0
2002	0.6	202.7	48.7	286	56.7	0.5	0.2	0.8
2003	0.3	157.3	381.5	411.5	82.4	6	0.2	0
2004	14.5	279.4	198.7	625.9	161	37.5	3.6	0
2005	1	250.1	335	262	429.2	4.8	0	0
2006	5.2	178	437.3	447.9	179.5	31.7	7.4	0
2007	4.4	203.9	436.3	325.1	285	0.1	2.2	0
2008	0	118.4	420.5	224.9	337	2.8	2.2	4.3
2009	2.5	139.1	445.3	188	83.1	24.6	64.5	1.1
2010	0.4	134.8	520.1	689.5	324.7	39.3	102.3	0.5
2011	0.2	323.2	342.5	424.5	171.8	11.7	0.1	0.1
2012	1.6	46	116.3	219.2	297.6	15.3	0.1	0.8
2013	0.7	250.7	440	170.3	243.8	101.8	3	0.5
2014	0.7	40.8	442.2	300.3	330.6	47.1	9.1	4.5
2015	5.9	271.2	279	52.8	163.2	8.7	15.2	0
2016	1.9	82.9	259.2	356.8	176.7	75.4	0	0
Average	4.41	167.37	347.93	275.79	196.65	33.91	10.19	0.97
Maximum	45.3	323.2	525.6	689.5	429.2	128.9	102.3	5.6

TABLE II. MONSOON SEASON RAIN FALL DETAILS IN KADARSHAH NAAL AREA (IN INCHES)

Month	June	July	Aug	Sept	Oct
Inches	6.59	13.70	10.86	7.74	1.34

C. Developing a shared vision for flood control at Kadarshah Naal

In the face of 'devilish' difficulties, SHGs routinely develop common dreams. Reference [67] advised that discussion be "based on a model of preparation as a contentious interaction in which an image of the topic and of the arrangement emerges continually among the participants, as a consequence of relentless judgement, exposed to fundamental dispute," This corresponds to SHG's visioning. The improvement of quicker recuperation of the Kadarshah Naal region from flooding and bring back the monetary exercises at the soonest epitomizes local area cooperation learning, As the vision develops, community working is used to establish trust among meetings, improve planning, and allow partners with different points of view, information, and ability to benefit from one another [68]. Study area map of Kadarshah Naal is depicts in Fig. 1., and DEM of the Study Area in the context of Surat is shown in Fig. 3. The developed DEM of the area portrays that the study area is having a lower contour compare to the nearby area and because of the same it is prone to flooding. This DEM is useful to visualize the interface of floodwater with the elevation of the ground surface of the adjacent area [69]. The developed DEM of the area provides better visualization of the floodplain, flow of small streams of water, roads of the area through which flood water flow which can significantly impact study area [69]. The developed DEM will be useful in further research for representing elevation surface in watershed modeling of the said low terrain area of Surat [70]. Reference [70] has pointed out that DEM are useful in resource management, urban planning, transportation planning, earth sciences, environmental assessments, Geographic Information System (GIS) applications and in determining the effect of surface runoff. As this low terrain area is going to be a Metro Rail Junction, this DEM study will be quite useful in the future for various need of urban and transport management system [70].

The SHGs vision is for Kadarshah Naal to turn into a space of the city that follows the standards of a superior strength by expanding freedoms to accomplish numerous advantages of the e-administration and social designing ways to deal with surface water the executives. This incorporates decreasing flood hazard; upgrading social capital through better associations with water and limiting the financial effect of flooding; further developing the wellbeing status of the networks with worked on personal satisfaction.

D. Socio-Economic Survey of Flooding

A questionnaire based survey of 150 household carried out by the researcher for the evaluation of the impact of flooding on the people residing in a low terrain area of Kadarshah Naal of Surat City. Past data of Surat Municipal Corporation indicates that Kadar Shah Naal is facing two types of flooding : (i) flood due to the waterlogged after Surat Municipal Corporation officials shut the flood gates due to increase in water level of the river and heavy rainfall in its area. As per the guidelines of the city, hydraulic department of SMC has to close all the flood

gates in the city to prevent water released in Tapi river from entering the city. However, at the same time, they are alerting the people living in low–lying areas from the possible risk of flooding due to increase in the water level in Tapi and closure of flood gates.

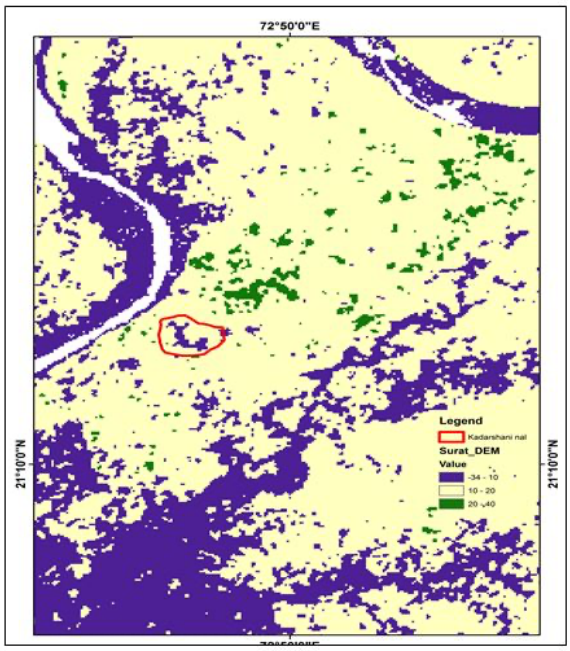

Fig. 3. DEM of the Study Area in the context of Surat

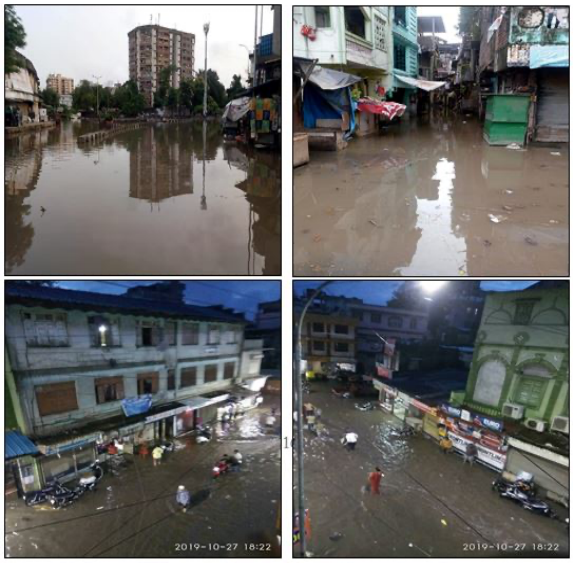

Fig. 4. Urban Flooding in the Study Area

Financial Impact Assessment here is the estimation of the expected misfortune from a flood occasion by evaluating the weakness of populace, structures and framework to this danger. It recognizes the qualities and possible results of flood, the amount of the local area could be influenced by it, and the effect on local area resources. The absence of an acknowledged technique for completing appraisals that could decide the financial effect of metropolitan floods has significantly restricted the ability to introduce an extensive picture in this examination. Current evaluation depends on the absolute number of individuals and structures covered under the overview, and the length of streets influenced by floods because of substantial precipitation in a city causes metropolitan flooding. Moreover, Work done by SHGs in coordination with team of ULB – SMC through e-governance and social engineering has been illustrated in Fig. 5.

The effect records for various classes have been registered by leading a poll overview in low territory space of Surat, for example Kadarshah naal where Metro rail line Station has been proposed. The reacted are the nearby individuals of the said region, volunteers of SHGs. The classifications considered are: private structures, non-private structures, streets, people under 6 years, people between 6 to 65 years, people over 65 years, pay not as much as Rs 8,000, pay level from Rs. 8,000 to 15,000 and pay level above Rs. 15,000. Order models are additionally founded on various effect records. Urban Flooding in the Study Area is shown in Fig. 4.

Fig. 5. Work done by SHGs in coordination with team of ULB – SMC through e-governance and social engineering

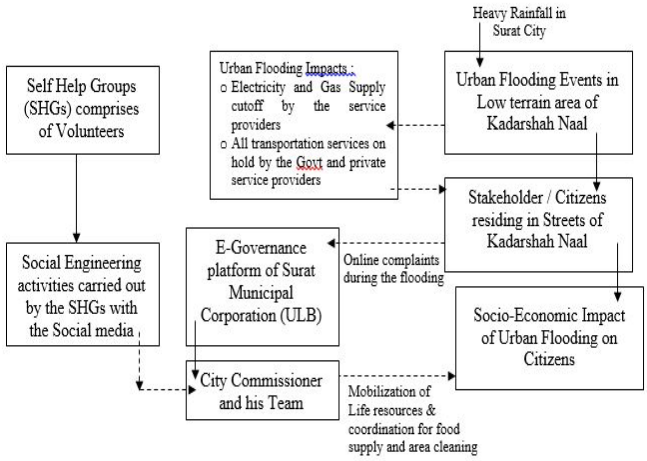

Fig. 6. Framework followed by SHGs in during the flooding and in post flood scenario for minimizing the socio-economic damages

In the current examination just a flood risk class of metropolitan flooding because of substantial precipitation has been chosen. Four basic upsides of flood profundities (0.5, 1.0, 1.5 and 2.0 m) were utilized to arrange the flood danger. In view of the profundity of flood, danger power is allocated. The lower risk power was allocated for lower profundity and it shows low danger while more noteworthy peril force demonstrates higher risk. Commonplace risk file esteems for flood profundity are ready. For the length of flooding, again three distinct classifications were utilized for the flood risks. The classes are: under 1 day, 1 to 2 days, 3 to 4 days and 4 to 5 days. In this overview, we have not considered the harms which have been caused because of the surge of 2006; in light of the fact that it was not exclusively because of the weighty precipitation in Surat City. Effect records were arranged dependent on the level of harm. The subtleties of the effect files for various profundity classification are given in Table III.

TABLE III. IMPACT INDICES

% of Damage	Impact Index
0%	No Impact
0 ~ 25 %	Less Impact
25 ~ 50 %	Moderate Impact
50 ~ 75 %	High Impact
75~100 %	Highest Impact

For the calculation of effect on individuals, under 25% harm shows that there will be a minor medical condition, assuming it is over 25% yet under half, there will be serious issue in wellbeing, under 75% harm cause unrecoverable ailment. There will be a death toll when the harm surpasses 75%. To figure the flood sway on structures, under 25% harm implies less harm to substance, structure and outside property, then, at that point on the off chance that it surpasses the reach yet underneath half which shows medium harm, under 75% harm implies high harm. There will be an extreme harm if the level of harm is over 75%.

For streets and metropolitan vehicle, under 25% harm shows that there will be a transportation interference for few hours, assuming it is over 25%

however, under half, there will be a minor street harm, under 75% harm cause minor street harm and transportation interference for few days. Serious to finish breakdown of transportation framework and need for restoration of street network are required when the harm surpasses 75%. In view of the profundity and length of floods and relying upon the level of harm sway lists are ready. An example dependent on poll study results is introduced in Table IV.

TABLE IV. FLOOD IMPACT ASSESSMENT FOR A PARTICULAR CATEGORY

Depth of Flood (in meter)	Duration of Flood			
	< 1 day	1 ~ 2 days	3 ~ 4 days	4 ~ 5 days
0.0 ~ 0.5	Less	Moderate	Moderate	Moderate
0.5 ~ 1.0	Less	Moderate	Moderate	High
1.0 ~ 1.5	Moderate	Moderate	High	High
1.5 ~ 2.0	High	High	High	High

According to the results of the questionnaire study, persons with an annual income of less than Rs. 8000 When compared to others, they are the most susceptible of the area because these people are living at the area which is the lowest of the Kadarshah Naal and these people are involved in semi-skilled work. Those with a higher income level Rs. 15,000 are less influenced as they are working in other part of the city and residing at the little higher terrain area of the Kadarshah Naal. The most affected people are the Muslims involved in repairing work and people of fisherman community. Residential buildings and non-residential buildings have shown higher vulnerability because of the storage of grains and other commodities at the ground floor of the residential premises and all goods related to repairing works are kept in shops, which are mainly in low terrain part of the Naal and are adjacent to the roads. Both the impact on transportation networks and the impact on roads are the same. People between the ages of 6 and 65 are significantly more susceptible than those between the ages of 6 and 65. The area is having a mix population of Hindu and Muslims and belongs to the lower income and lower middle income class. Majority of the population involved in semi–skill based working such as repairing of machines, electronic gadgets, automobiles etc. Muslims mainly involved in repairing work and Hindus mainly belongs to a business of fish. Socio Economic Survey details are shown in Table V.

TABLE V. SOCIO ECONOMIC SURVEY DETAILS

Sr. No.	Questions	Yes	No	Can't Say
1	Do you feel that due to the SHG the damage has been reduced	127	15	8
2	Is the normalcy of economic activities after the coordination by SHG is better	116	20	14
3	Do you feel that in this time of flood, the support of govt was good	119	16	15
4	Were you get the timely food supply from SHGs	143	7	0
5	Is the cleaning of the area (mud removal and spraying of insecticides) was better than the earlier	142	5	3
6	Is the supply of electricity and natural gas was stopped by the providers	150	0	0
	for how many days			
	1 ~ 2 days	37		
	2 ~ 3 days	52		
	3 ~ 4 days	61		
7	Were you getting the timely messages of the steps / actions initiated by the ULB ?	128	17	5
8	Were you getting the timely messages on social media, such as what's app	102	37	11
9	Is the damage from flooding is on a lower side than the earlier (with SHGs)	87	24	39
10	Is the recovery period in post flooding has been reduced due to SHGs	134	11	5
11	Do you feel that such SHGs are essential for flood management & control	127	12	11
12	Were you being relocated from your residence place by SHGs	61	89	0
13	Is the SHGs have supported for the removal of your goods to avoid the damages	132	12	6
14	Were the members of SHGs were easily accessible to you	143	5	2
15	Do you feel that SHGs are essential for flood management activities	145	0	5
16	Is the roads are affected by the urban flooding	143	0	7
17	Have you seen that in flooding situation, SHGs have relocated the childrens and patients	132	18	
18	Were the members of SHGs were friendly with you	143	0	7
19	Is the SHGs members have demanded for money in exchange of help or support	0	143	7
20	Is the SHGs members have supported to the people of specific community only	12	120	18

III. RESULTS AND DISCUSSIONS

The statistical analysis of Table I data is mentioned Table VI, VII and VIII. From the Table VI, all the main statistical terms such as mean, standard error, median, standard deviation etc., are well explained [71]. Discussion on terms like kurtosis and skewness will give more focus on the rainfall parameters and their statistical significance. Kurtosis is used for comparison of distribution curve with normal distribution curve of 'bell shape' and characterizes the relative peakedness or flatness of the statistical curve. It describes how the data is concentrated around a mean value. If the data is more peaked or flat, the distribution is not a normal distribution. For normal distribution of data, the value of kurtosis is 0, and the variables of such type of kurtosis are known as Gaussian random variables. Positive value of kurtosis is for peaked distribution or leptokurtic distribution which is observed in the month of May, July, August and October are super-Gaussian and negative value of kurtosis is for flat distribution or platykurtic distribution which is observed in the month of June and September are sub-Gaussian The value of kurtosis for a month of July, September and October are near to 0 and hence they are exhibiting behavior near to normal distribution of rainfall and all the variable of rainfall in these month exhibits Gaussian random behavior. The bell shaped curve is known as mesokurtic distribution and is having a value of 3. The value higher than 3 (in the month of May) for kurtosis, indicates that the distribution is peaked or leptokurtic and value lower than 3 (in all other months of June to October) for kurtosis indicates that the distribution is flat or platykurtic. Here in this study none of the kurtosis has exhibited a value of 3. Hence the values of rainfall data belong to non-Gaussian random variables, means the rain fall in this study area cannot be predicted by the standard computer forecasting models. The skewness of June and July are negatively skewed. The kurtosis data of July, September and October indicate that they are near the normal distribution and out of which July has a negative skewness and September and October has positive skewness. Negative skewness indicates that a distribution with an asymmetric tail extending toward more negative value. Positive skewness

indicates that a distribution with an asymmetric tail extending toward more positive value.

TABLE VI. STATISTICAL ANALYSIS OF RAINFALL IN STUDY AREA

	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean	4.41	167.37	347.93	275.79	196.65	33.91	10.19	0.97
Standard Error	1.75	17.26	23.11	30.37	22.74	7.18	4.48	0.31
Median	1.75	177.25	366.40	256.05	178.10	17.85	2.10	0.05
Mode	0.70	0.00	0.00	0.00	0.00	47.10	0.10	0.00
Standard Deviation	8.92	87.99	117.84	154.86	115.97	36.62	22.84	1.57
Sample Variance	79.63	7742.24	13886.02	23982.27	13448.52	1340.70	521.55	2.46
Kurtosis	19.14	-1.10	0.44	1.29	-0.73	0.66	11.72	2.94
Skewness	4.19	-0.07	-0.73	1.03	0.29	1.25	3.38	1.92
Range	45.30	296.10	476.90	636.70	404.40	128.80	102.30	5.60
Minimum	0.00	27.10	48.70	52.80	24.80	0.10	0.00	0.00
Maximum	45.30	323.20	525.60	689.50	429.20	128.90	102.30	5.60
Confidence Level (95.0%)	3.60	35.54	47.60	62.55	46.84	14.79	9.22	0.63

The rainfall data of May, July and October have a spicy probability distribution function and probability at the zero is large. Form these data it can be said that in these three months pattern is affected by the factors which are having flat or platykurtic distribution (or non-Laplace distribution), out of these, rainfall in June is negatively skewed whereas August and September are positively skewed. Positive skewness indicates that a distribution with an asymmetric tail extending toward more positive value.

Along with skewness, if the value of kurtosis is too high or too low, then it may have an impact on the normality of distribution of data. As it is known that rainfall in months of July and August are the peak of the rain fall season and are related with each other, in the same way the beginning of rainfall generally in June and ends in September month, here an attempt has been made to find out the same by taking a hypothesis (H_0) that they are not related to each other and for the same regression analysis has been made between the data of July and August and June and September with the help of MS EXCEL spreadsheet programming software and the details are given in Table VII and VIII.

the rainfall pattern is affected by the factors which are following Laplace distribution function of probability. Where as in months of June, August and September, the rainfall

TABLE VII. REGRESSION ANALYSIS OUTPUT JULY AND AUGUST

Regression Statistics	
Multiple R	0.13
R Square	0.02
Adjusted R Square	-0.02
Standard Error	119.29
Observations	26.00

ANOVA

	df	**SS**	**MS**	**F**	**Significance F**
Regression	1	5621.25	5621.25	0.40	0.54
Residual	24	341529.20	14230.38		
Total	25	347150.45			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	321.222	48.504	6.623	0.000001	221.115	421.330
X Variable 1	0.097	0.154	0.629	0.535610	-0.221	0.415

From the above data (Table VII, it can be said that the y intercept of the estimated regression line, $b_0 = 321.222$ and the slope of the estimated regression line, $b_1 = 0.097$. The standard deviation of b_1 is $s_{b1} = 0.154$. For establishment of significant relationship between the variables, t-test is used and for the same computation of t statistics is essential, $t = b_1 / s_{b1}$, here for July and August rainfall data, the value of $t = 0.097 / 0.154 = 0.629$ (tabulated above in t-State column). The p-values are also tabulated in above table, indicates that p-value = 0.536 > $\alpha = 0.05$ (95% confidence level), hence we can reject H_0 and conclude that there is a significant relationship between the pattern of rainfall in the month of July and August. The values after p-value in above table can be used to develop confidence interval estimates of y intercept and slope of the estimated regression equation. For 95% confidence interval estimate of β_1 is -0.221 and 0.415.

Table VII ANOVA represents the details of analysis of variance of the rainfall in July and August month. In this table three sources of variation are represented as regression, residual and total. In this table D_f, SS, and MS represents degree of freedom, sum of squares and mean square. Here 14230.38 is a mean square error for regression output. Also, F test is also used for representing the significance of regression. The value of 0.54 is the p-value associated with F test for significance. p-value = 0.5356 > $\alpha = 0.05$, hence we can reject the H_0 and conclude that there is a significant relationship between the rainfall in the month of July and August.

From the above data (Table VIII), it can be said that the y intercept of the estimated regression line, $b_0 = 200.10$ and the slope of the estimated regression line, $b_1 = -0.166$. The standard deviation of b_1 is $s_{b1} = 0.151$. For establishment of significant relationship between the variables, t-test is used and for the same computation of t statistics is essential, $t = b_1 / s_{b1}$, here for June and September rainfall data, the value of $t = -0.166 / 0.151 = - 1.102$ (tabulated above in t-State column). The p-values are also tabulated in above table, indicates that p-value = 0.281 > $\alpha = 0.05$ (95% confidence level), hence we can reject H_0 and conclude that there is a significant relationship between the pattern of rainfall in the month of June and September. The values after p-value in above table can be used to develop confidence interval estimates of y intercept and slope of the estimated regression equation. For 95% confidence interval estimate of β_1 is -0.478 and 0.145.

TABLE VIII. REGRESSION ANALYSIS OUTPUT JUNE AND SEPTEMBER

Regression Statistics	
Multiple R	0.21939
R Square	0.048132
Adjusted R Square	0.008471
Standard Error	87.61652
Observations	26

ANOVA

	df	SS	MS	F	Significance F
Regression	1	9316.21	9316.21	1.213577	0.281551
Residual	24	184239.7	7676.655		
Total	25	193555.9			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	200.100	34.325	5.830	0.00001	129.256	270.944
X Variable 1	-0.166	0.151	-1.102	0.28155	-0.478	0.145

Table VIII ANOVA represents the details of analysis of variance of the rainfall in June and September month. In this table three sources of variation are represented as regression, residual and total. In this table D_f, SS, and MS represents degree of freedom, sum of squares and mean square. Here 7676.655 is a mean square error for regression output. Also F test is also

used for representing the significance of regression. The value of 1.214 is the p-value associated with F test for significance. p-value = 0.2816 > α = 0.05, hence we can reject the H_0 and conclude that there is a significant relationship between the rainfall in the month of June and September.

The analysis of the data of Table V, it can be said that around 85% of the responses indicates that there is a significant improvement in the resiliency level after the incorporation of SHGs for handling the post flooding scenario. Around 77% of people of the area are of the opinion that, with the help of SHGs, the normalcy of economic activities in post flood period is better than the previous years. Around 79% of the people have replied that due to the social engineering efforts of SHGs with e-governance of ULB, they have realized better support from the government agencies for needed support. More than 95% of the local people have opined that due to the flooding they are not able to move out of their residence and not able to get the food but due to the SHGs coordination with other social groups, they are able to get the food packets and milk pouches on time. Earlier in a period of flooding, in the absence of the SHGs, they were not able to get the food packets and milk pouches on time and such situations were difficult to handle for the families who are having small kids. The respondents have replied that earlier in absence of SHGs, the mud removal and spraying of insecticides were not done on time and because of the same they faced the epidemic issues. Around 95% of the residents have opined that the with the help of SHGs, the mud removal and area cleaning activities have been faster than the earlier and this time they have not faced any epidemic issues. In this reply of cleaning, the 5% people are the one who are at the interior side area. The cleaning activities performed in the area by the SHGs is visible in the photographs.

For maintaining the safety in the area and to avoid the accidents, the local supply of electricity and natural gas have been stopped by the suppliers; after the flood is over with the help of SHGs, the normalcy of the supply of both the utilities achieved; around 25% of the respondents have opined that the supplies of gas and electricity restored with 1~2 days; 35% of the respondents have opined that the supplies of gas and electricity restored with 2~3 days; 40 % of the respondents have opined that the supplies of gas and electricity restored with 3~4 days; this particular variation is due to the depth of the flooding. The area where the depth of flood water was more took more time to restore the services.

Around 85% of the respondents have replied that due to the SHGs, they were getting messages from early warning systems (EWS) regarding the steps and actions initiated by ULB and food distribution by the social groups through the group formed on social media, such as what's app, this is a kind of citizen science approach and crowdsourcing applications for flood management; similar findings are reported in the study of Pluvial Flooding and hydrological monitoring and ecosystem services management [72, 73].

58% of the people are of opinion that their economic damages have been reduced due to the SHGs and their approach of social engineering with the civic groups and coordination with the e-governance applications of ULB. Around 85% of the people have opined that such types of SHGs are essential for flood management and its proper control to minimize the socio-economic impact to the people of lower income groups.

Around 41% of the people are being rescued and relocated by the SHGs in small boats to the other locations. These are the people whose residents are totally submerged in the flood water and have no other option to manage their lively hoods. They also discussed that in absence of SHGs, in earlier floods, there were so many deaths of the people due to no rescue activities on time but with SHGs, they are being rescued on time. The rescue operation carried out by the SHGs is visible in photographs.

The above data of Table V indicates that the SHGs has support to the people of Kadarshah Naal to a great extent. Traditional approaches to urban flood and water management and governance are challenged by the 'villainous' problem of urban flood and water management and governance, which is beyond the capabilities of a single institution to grasp and handle. Indeed, majority of the residents of the area of Kadarshah Naal have the need of collaborative collaboration through e-governance and social engineering to integrate fresh information to tackle flooding concerns was highlighted in particular faster recovery and minimization of the impact of flood in terms of socio-economic aspects.

In natural administration, e-administration systems that enable partner involvement and joint functioning through friendly design have grown increasingly limitless [33]. where dialogue and sharing contribute to social learning and the acquisition of new information (individual or collective) in order to enable change [53, 54, 55]. SHGs embody deliberative administration; making a space for various establishments, offices, gatherings, and associations to discuss both specialized and social issues. By venturing outside the institutional laying out a lot the objective of affecting choices instead of actioning change the SHGs bypasses the obliging issues of force connections and keeps away from inquiries of obligation sharing during the learning and visioning measure. The SHGs system empowers partners to advance from siloed-thinking and information protection towards an incorporated methodology that advances information sharing and inclusivity to convey metropolitan flood flexibility, similar findings are reported in the study of Japan [40].

SHGs have enabled new forms of collaboration that are well suited to overcoming roadblocks to progress. As a result, the SHGs structure aids in the transition from over-reliance on outdated processes to more maintainable and adaptable arrangements that promote "living with water" and pushing beyond the border [74].

The incorporated and all-encompassing methodology of SHGs constructs shared information and dreams (learning) and energizes activity towards a shared objective of minimization of financial effect of flooding. Individuals are less likely to start deals from dug in positions when they are encouraged to communicate openly outside of the constraints of current formal institutional contexts, which fosters creativity and development [75]. Instead, then being mired in concerns of administrative consistency, common trust allows for dialogue that imagines innovative arrangements. This is especially true when discussing 'non-conventional' approaches to UFRM that are not currently supported by legislation, are absent from normal practice, and are seen as a 'curio' by many (for example, strategy makers, experts, and networks) [30]. Work done by SHGs in coordination with team of ULB – SMC through e-governance and social engineering is shown in Fig. 5.

Above Fig. 6. represents the structure that the SHGs followed with social designing strides to organize with e-administration assemblages of SMC-ULB. This is dependent on the co-creation of information to identify mediations that address local concerns and the issues of diverse partners, as well

as the subsequent joining into a flood control and practice arrangement to induce an adjustment of flood the board arrangements. The foundations of the structure and principal to progress with social learning are the commitment of SHG members and the enrolment of new members during the interaction.

A. Social learning within the SHGs of Kadarshah Naal

Organizations and individuals' capacities to manage differences in perspectives and behaviours, reframe knowledge, make collective decisions based on negotiation and conflict resolution, and learn about the drivers that motivate particular courses of action improved as a result of social learning in Kadarshah Naal's SHGs. The Kadarshah Naal SHGs also supported three decision-making threads: 1) evaluating and resolving issues, 2) devising and recommending solutions, and 3) bringing people together and seeking political commitment in order to have an impact on politics [74].

Evaluations of 'intermediary outcomes' can be used to assess the success of collaborative working and stakeholder engagement, which refers to the creation of 'process' goods such as mutual agreements and information sharing, as well as the improvement of social capital and trust through networking for flood control and minimizing the adverse effects of flooding from the socio-economic perspectives [76].

The SHGs of Kadarsha Naal produced intermediary results such as co-production of emergent, contextualised knowledge and improved social connections amongst stakeholders. These efforts combined to reinforce existing ties and establish new ones, laying the groundwork for coordinated action. The development, exchange, and application of new knowledge has progressed from a linear 'mode one' approach to knowledge production by researchers and experts to a 'mode two' approach that includes social and institutional learning, multiple actor interaction, and co-production of knowledge by those who need and will use it [77].

The SHGs were effective in establishing a platform for the debate of novel methods to remove obstacles to urban flood risk management and control innovation in Kadarshah Naal area of Surat, by bringing disparate data together and rallying people behind a similar goal of faster recovery and minimizing the flood damage from the socio-economic perspectives. As seen by the construction of a SHF for the low terrain area of Surat city, interactions allowed by the visioning process promoted consensus decision making. The success derived through SHGs from the perspective of faster resiliency is a kind of an example like a 'process' product. A basis for action established by demonstrating a new mentality among key stakeholders that favours collaborative working [76].

The effectiveness of diverse stakeholders' engagement in flood control management may also be assessed in terms of their social learning [33]. While this was not specifically tested within the Kadarshah Naal SHGs, observations made by the researchers during meetings revealed social learning on several levels. Collaboration amongst stakeholders (especially those not normally engaged in urban flood risk management) in the early normality of economic activity in the region exemplifies social learning on a short-medium time frame.

Similar to this study of Kadarshah Naal, a study has been carried out in Japan in a Tsurumigawa river basin in the Tokyo Metropolitan Region, where they have achieved the better results with the collaborated and integrated efforts of various SHGs with the governance [29, 40, 60, 78]. In Japan, the FRM handled by the field office of the national ministry in coordination with the wide range of organizations and river basin committees [40]. Similarly, here in Kadarshah Naal, a SHGs formed by ex-Mayor of Surat city and they have coordinated with the e-governance body of ULB and collaborated with the other civic groups through social engineering and citizen science platform to handle the flooding situation and establish the resiliency in the area by reduction of socio-economic damages [72, 73].

Similar findings to our study reported in other countries where the SHGs at the local level play important roles in launching flood risk governance [40]. Here in our case an e-governance platform of ULB has played a crucial role for connecting the SHGs and government officers but in Japan, the national government headquarters showed a principal role [40].

Similar to Japan case, in our case of Kadarshah Naal, we have also found that mutual trust, tacit knowledge to handle emergency, knowledge of local geographical aspects of the area and social perception of local people are some of the important factors to strengthen the e-governance of ULB [40]. SHGs has formed various whats app group according to the streets of the Kadarshah Naal and created mutual trusts with the local civic groups and ULB [40]. With the citizen science approach, technical staff of ULB has effectively utilized the resources and collaborated with the other social and civic bodies for the channelization of resources on time [40, 72, 73].

So here in this case of handling of post flood scenario in Kadarshah Naal of Surat, the blending of social science and technical science has paved a new way for the mobilization of social and engineering resources. This particular SHGs has helped to establish long-term relationship with the technical staff, researchers from academia and through exchanging views on the speedy and effective resiliency in the area.

B. Recommendations

Effective SHGs give possibilities for social learning and the creation of new knowledge, both of which are required for innovation in the management of important socioeconomic challenges. The lessons gained from the Kadarshah Naal SHGs are given here in conjunction with the literature study to provide suggestions for the formation and functioning of SHGs in other cities and situations.

C. Membership

Enrollment should be comprehensive, embracing however many as could be allowed of the partners that can influence, or be influenced by, the working of the SHGs or implantation of its common vision. Commitment with recipient networks is fundamental for adaptable and straightforward dynamic that accepts different information's and qualities and can assist agreement with being reached in approach conversations [79, 80].

In any case, multi-circle social learning necessitates an interpersonal trust structure that incorporates deep reflective dialogues as well as the testing of hierarchical norms and practises. If experts perceive that local residents are unable to divorce their individual part views from their hierarchical position, such trust may be compelled by consideration of recipient networks. Enrollment in SHGs for Kadarshah Naal

was limited to residents of nearby regions and strategic partners in order to respect the expressed preferences of the founding persons. Besides as a non-legal and non-dynamic body the Kadarshah Naal SHGs is trying to impact early choices evaluation that will be dependent upon a more extensive discussion and public commitment if partners move towards execution of parts of the vision.

Consideration of public agents might be alluring, however will fundamentally be subject to the neighborhood setting and explicit destinations of the SHGs and benefits and impediments ought to be considered at the beginning and reconsidered intermittently. Definite partner planning ought to give the premise to introductory consideration of SHGs individuals, focusing on distinguishing the significance of including every partner bunch, their inclinations, inspirations, and what results or change could be delivered through their contribution.

While the Kadarshah Naal SHGs focused on a wide and adjusted portrayal from various partner associations this was not generally accomplished, and the disciplines addressed in bunch gatherings were regularly inclined towards flooding and its control. This was seen to become pervasive once the SHGs moved from figuring out how to activity, and non-flooding and its control partners (with less immediate dynamic limit) maybe felt their commitment to be less important and participation of less worth. To counter this propensity, it very well might be important for the getting sorted out gathering to audit consistently before the rainstorm season to help the core values of the SHGs.

In outline, experimental experience has been acquired in Kadarshah Naal supports the hypothetical case for remembering for a SHGs a wide scope of city entertainers, for example councilors, officials of ULB, and chief of city, and significant volunteers who are answerable for contributing their endeavors in such low landscape spaces of the City. This is expected to help change to economical water the executives and flood control, and addresses a proceeding with objective of the low territory space of the Surat city.

D. Organization

SHGs association by an impartial party (for example a gathering of volunteers) gives the collusion opportunity to resolve new and politically touchy issues and separate from conventional working systems limited by frameworks developed by their associations [74]. Effective SHGs are normally determined by a solid center gathering with thoughts and energy to keep up with force and make a climate that advances social learning. Preferably, this will incorporate individuals from each key partner association (in Surat, this was the Urban Local Body, Local Collectorate, University in their double job as scholastic information and significant landowner/home administration) to devise subjects of shared revenue.

Strength can be incorporated into the SHGs by making shared proprietorship among center individuals that diminishes the effect of key individuals leaving. The facilitator assumes a fundamental part in making a compatibility between SHGs individuals (especially in the beginning phases) and is vital to making trust and creating excitement for inclusion in the SHGs. Facilitators are critical in overseeing possibly clashing connections between SHGs individuals that might be an imperative to compelling discourse, for example, in light of past antagonistic working encounters, varying characters or troubles in leaving vested association interests outside [81].

The open and straight to the point conversation advanced by the SHGs structure might assist with defeating these issues by making a climate where individuals regard sensitivities and can talk casually. In the underlying stages, exercises intended to permit assorted voices to be heard without blue pencil, for example, the utilization of post-it notes and soliciting mysterious "glaring issues at hand" sets up the extent of challenged issues and different perspectives that must then be recognized as substantial except if, and until, shared learning changes people's outlook.

Whenever trust has been set up, SHGs expect to oversee struggle emerging from the various perspectives, positions, and levels of specialized information on the framework being broke down, through conversation and arrangement. In Kadarshah Naal, this was helped by discipline-crossing champions (primarily the neighborhood councilors) who advanced the general goals of the SHGs instead of the perspectives of their associations. Champions are additionally fundamental for the introduction of imaginative thoughts in formal between hierarchical dynamic cycles and guaranteeing broad spread of the development message [74].

Advocate out of neighborhood councilors will in general emerge naturally because of energy and individual responsibility towards advancing the vision. Champions and facilitators ought to effectively urge individuals to participate in friendly learning and exchange as opposed to just educating different individuals in a hierarchical methodology [38].

E. Social science practices

Sociology rehearses, for example, nukkad get-togethers, can be successful in advancing conversation and defeating institutional boundaries in gatherings, and are pushed for intuitive data trade, information creation and inevitable social learning. The more elevated level of accomplishment of the online gathering of people stage exhibits that no need of vis-à-vis contact between individuals to have successful appropriation of food and different wares, with the virtual stage, it tends to be effortlessly overseen.

Similar to the SHG formed by the ex-city councilor and ex-mayor of Surat city, the governing body of ULB has to form SHGs in a similar way to Kadarshah Naal by the existing city councilor of the area and connect them with the citizen science applications [40, 72, 73]. This will help to the ULB and officers to take prompt actions in case of flooding caused due to the high water discharge from Ukai dam.

Considering both the cases of Kadarshah Naal and a Tsurumigawa river basin in the Tokyo Metropolitan Region, one can utilize the concept of social engineering to connect the people through citizen science platform such as whats app and connect them with the e-governance applications of local government will help them to derive faster resiliency and minimum socio-economic damages from flooding [40, 72, 73].

IV. CONCLUSION

Collaborative efforts and partnership involvement are frequently suggested as tools for improving the dynamic during flooding and its control. This helps with the transition from a solely "dark" foundation to a more robust methodology that

employs non-traditional flood control and facilitates the arrangement of diverse benefits. Regardless, a variety of impediments, such as ineffective correspondence inside and across divisions and affiliations, split liabilities,'siloed' thinking, and realisations that 'it would be another person's responsibility,' may reduce the sufficiency of potential associations.

Social and dynamic learning objectives, such as flood detection through e-administration and social design technique by SHGs, invigorate collaborative effort by allowing partners to discuss issues of shared profitability in an atmosphere of common belief and ownership, and remove data sharing barriers. SHGs aid in the development of competence to address complicated socio-prudent political and environmental concerns in social regimes characterised by changing environments, local economies, and socioeconomics. The SHGs framework encourages collaboration and the development of innovative, well-organized arrangements that defy restrictive rules and customary standards. Consideration of non-water executives who are professionals in urban flooding and its control through components such as SHGs may excite more significant affirmation of the numerous advantages and can help a variety of organisations and divisions realise their critical objectives. SHGs may improve people's understanding of an issue by co-creating knowledge, eventually leading to the construction of imaginative arrangements based on trust, honesty, and straightforwardness, by connecting multiple understandings of an issue through the arrangement of a common vision.

Using the Kadarshah Naal SHGs as a context study, we evaluated the SHGs system as an impulse for shifting behaviours toward collectivist working and continuing to work with the progress to more controllable urban flooding and its control in this exploratory effort. The Kadarshah Naal SHGs enhanced associations' and people's capacities to manage differences in opinions and practises, as well as reconsider information. The Kadarshah Naal SHGs prompted people to move away from traditional'siloed' activities and perceptions of obligations and toward an integrated, comprehensive approach to encourage normal dreams and strive toward metropolitan flood flexibility.

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