

IDENTIFICATION OF ACCIDENT HOT SPOTS, FACTORS & MEASUREMENTS: TO ACTIVE SAFETY IMPROVEMENT PROGRAMS BASED ON REACTIVE & PROACTIVE APPROACHES

Muhammad Asim Azim*, Abdul Basit Khan, Dang Jianwu, Wang Yangping, WU Yong Liang
 1, 5 School of Electronics and Information Engineering, Lanzhou Jiaotong University, Lanzhou, 730070 China.

Email: gis.edu_lzjtu@yahoo.com

ABSTRACT: An effort is made to maintain safety level at maximum, using active road safety improvement programs. In this context, proactive and reactive approaches were followed based on road casualties data confirmed by records kept by Road Traffic Injury and Prevention Centre Karachi (Pakistan). It is imperative to take novel initiatives besides predefined manners and measurements to establish a positive safety culture and these initiatives must take into account the participant’s behavior and affected areas.

Keywords: Positive safety culture; High Crash Locations (HCLs); Contributory factors; Measurements; RSIPs (Road Safety Improvement Programs); Proactive and reactive approaches; Vector map

1.0. INTRODUCTION

Road traffic casualties prevention is an increasing demand because the numbers of people are getting killed or injured in road crashes are increasing day by day across the world. To reduce collision potential, it is vital to identify factors and launch road safety campaigns. However, transportation specialist should also consider proactive approaches in dealing with emerging road safety problems (RSIPs) to maintain a positive safety culture.

There are two main approaches for positive safety culture to define measurements for traffic safety improvements: proactive & reactive. No, doubt, reactive approach are always considered costly than proactive approach because of occurrences treatment.

The best option of appreciating the importance of safety problem and developing new methods for safety improvements is to notice casualty’s data. The data shows that in each year across the world, approximately 1.3 million people died in road traffic mishaps and 50 million injured (WHO, 2009).

The average value is very dangerous; in fact 3,500 people are getting killed daily or in other words one person in every 25 seconds. This prevailing safety culture is alarming especially for the departments responsible for maintaining road traffic safety (1). The situation in developing countries is even worse due to lack of positive safety culture and sources. Herein the jurisdiction’s action high crash locations (HCLs) list is case in point of reactive approach; in general discussion related to promote safety culture by identified safety problems based location. To maintain positive safety for proactive actions, some indirect indicators are crucial that are frequently associated with participant’s behavior (traffic violations). An irregular and unsafe road traffic action is also a kind of violation (2).

In order to develop safety culture, transportation specialists should focus on emerging problems and devise proactive strategies for the improvement of new infrastructure. Reactive strategies should also be considered to identify High Crash Locations (HCLs) among highly affected areas. This paper focuses the possibilities of positive safety culture based on road traffic casualties & violation data (3). The work presented here is an effort to identify hot spots, factors and measurements that can be implemented as countermeasure approaches by RSIPs.

2.0. REVIEW OF PROCEEDING REPORTS (2007-2012)

In the light of preceding reports, road crashes consequences pertaining worst road safety situation regarding casualties; in injuries (minor and serious) and fatalities. Herein, the estimation only focused on average casualties rate occur by road crashes, this is not difficult to understand that road casualties are going to become a major cause of death in Karachi. During year 2007 - 2012, approximately 33,114 average cases were registered; in which 1,115 (average) cases were related to fatalities, 6,772 (average) cases were related to serious (injuries) and 25,187 (average) cases were related to minor (injuries), as shown in Fig.1.

Feature study regarding abnormal no. of injuries (serious injuries & slight injuries) by road crashes, clearly describes worst safety situation. Meanwhile, serious injuries have major contribution in increasing no. of fatalities in Karachi.

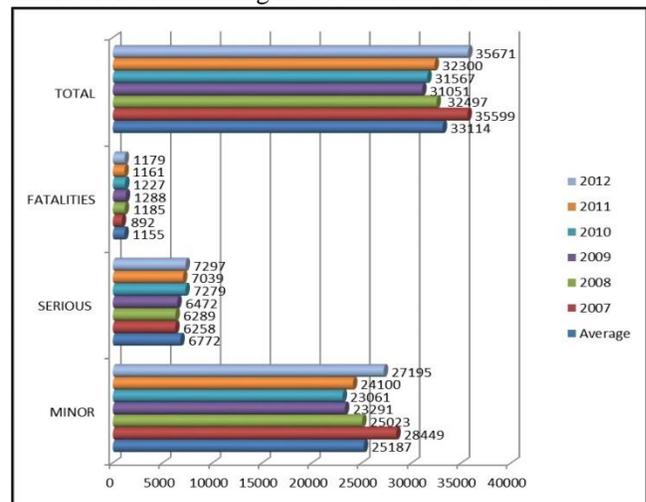


Fig.1. Introduction to preceding reviews during 2007 ÷ 2012

3.0. STUDY AREA

Karachi is the largest and the most populated city of Pakistan, as well as the capital of Sindh province and before it was the capital City of Pakistan (1947 – 1958). The city is spread over 3,527 sq. kilometers which consists of 18 towns, six cantonment boards and some agencies. According to population, Karachi is ranked as the 3rd largest city in the world with an estimated population of 23.5 million by 2011.

The city is located in south of the country (24°51' N 67°02' E), on the coast of the Arabian Sea and is referred to as an industrial hub of Pakistan.

Urbanization in Karachi is quite extensive with large number of road networks connecting hospitals, industries and educational institutions.

Due to overwhelming commercial activities, the city is considered as a financial hub of Pakistan. However, the city is confronted with enormous social and environmental challenges primarily due to population burden which is on rise after every passing day.

Traffic safety is one imminent issue among all of them as most of the people pay no respect in observing traffic rules. This fact has created an unprecedented number of road mishaps and is a major hurdle in maintaining positive road safety culture in Karachi.

4.0. RSIPs

There are two main types of programs to improve road safety program and they are:

- A. Proactive programs
- B. Reactive programs

On behalf of proactive safety programs, these RSIPs are called as anticipates dangerous situation and/or for new infrastructure. Proactive approach based programs are less expensive, results in fewer casualties and helpful to keep positive safety culture. Meanwhile, the proactive strategies can be applied in the development of new infrastructure and their improvements at state and district level (4).

Although proactive approach is considered to utilize the improvement of overall performance to maintain positive safety culture (5) but actual situation becomes different in case of addressing causes to utilize reactive approach. Consequently, the situation becomes highly detrimental and more than 90 % casualties are occurring in developing countries. Few actions that could be helpful in this regards are mentioned below which focuses on developing positive traffic culture as well as to control prevailing risks on roads.

- Local level and state level safety committees and/or safety teams.
- Emergency based Analysis programs
- Introduction of daily or month wise inspection programs.
- Enhance safety education and training at local and/or state level: must not be viewed as punishment.
- Incentive/Recognition programs that recognize complying, reporting, suggesting, involvement.
- Encourage accountability system and avoid those factors that change consequences of actual situation.

On the other hand, reactive response must always be active when proactive response fails due to any reason. Reactive based RSIPs usually involves higher cost than proactive programs, Whereas a reactive retort after incidences can be introduced with focus on cost reduction and other related occurrences. When administration at state level or district level put emphasis on reactive approach to promote and maintain safety culture then it sends a negative impact to the department concerned with road safety.

Reactive approach is always considered costly than proactive approach because of occurrences, as shown in Fig. 2.

Indirectly it sends failure message to employees because reactive programs kick in only after an accident has occurred. In order to make proactive strategic actions more effective, following aspects can be adapted to improve positive safety culture. Despite of limitations, no road safety organization or department management system can be well thought without a reactive component. For instant, these following actions should be taken:

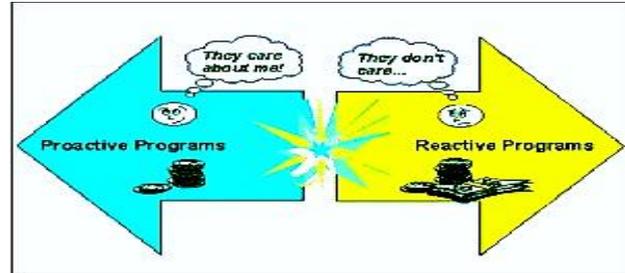


Fig. 2. Cost difference between proactive & reactive approach based RSIPs

- Involve more accountability system to investigate crash causes.
- Discipline should be maintained.
- Involve deserter level action plan to impede maximum threat.
- Extra cover programs based on treatment of high crash locations (HCLs).
- Launch awareness programs for prevention to impede maximum violations.
- Incentives for better communication between local level and state level.

5.0. APPROACHES RELATIONSHIP & REACTIVE LIMITATION

Approaches relationships and reactive limitations are as follows:

- At the beginning of improvement program, use of examination based results to find HCL for treatment would prove highly beneficial. However, it's application in developing countries appears difficult due to limited resources.
- Frequently at the bottom, crash data is often insufficient and/or incomplete to maintain accurate diagnosis treatment, so relationship becomes clear between pro-active and reactive approaches.
- Indeed reactive based RSIPs are relatively costly than proactive based RSIPs but sometime this relationship can be more credible to keep safety culture.

Effective safety improvement programs should be rigorously exercised to maintain balance between reactive and proactive strategies. Proactive approach involves application of this knowledge to any new infrastructure but in case of treatment, it will have an added benefit of being implied as case study for better examination (6). But there are two important advantages of proactive knowledge over reactive approach which are as under: In case of prevention, proactive measures may be practiced as treatment for critical analysis, and due to low cost involved, the effectiveness of proactive approach increases manifold especially in those cases where traffic safety plan is operationalized on a road already used by public.

6.0. ANALYSIS

A large number of road accidents take place every day in Karachi which involves numerous factors however, without access to complete crash records, it becomes very hard to trace the actual cause of such injuries. This study is also an attempt to provide detailed observations to address countermeasures. Our findings directly points out that city data pertaining to road crash incidents that can be utilized to create positive safety culture, and to address HCLs safety issues (Fig. 3).The injudicious action (IA) crash rate is calculated by dividing the number of registered IA crashes to the total number of crashes in selected locations, as shown in Eq. (1). In fact, the IA crash ratio should be based on the nature of safety problem being evaluated. For instance, the number of registered crashes occurred due to over speeding can be divided by the total number of crashes in the same zone or location. This will give a more rational IA crash value if over speeding action is the major factor.

IA crash ratio should be greater than average IA crash ratio to identify HCLs for entire study area. As most treatment locations are implemented at specific point locations therefore radius should be as small as possible.

$$\% \text{ of IA Crashes} = \frac{\text{Total \# of Registered IA Crashes}}{\text{Total Crashes of study location}} \cdot 100 \quad (1)$$

According to crash record, there are five (ranked by a, b, c, d and e) IAs and every individual IA appears to be a threat for positive safety culture.

The percent estimation of each IA crash action rate is calculated by Eq. (2), for example:

$$\% \text{ of "a" Action} = \frac{\text{Total Registered Crashes by Action "a"}}{\text{Total Crashes by IA Action}} \cdot 100 \quad (2)$$

In the next step, HCLs are defined by average crash rate. According to crash data analysis, the locations showing ratios above than average ratios (985.305) are considered as HCLs. There are total 36 locations and each location has a different crash severity, as shown in Fig. 4 (a&b).

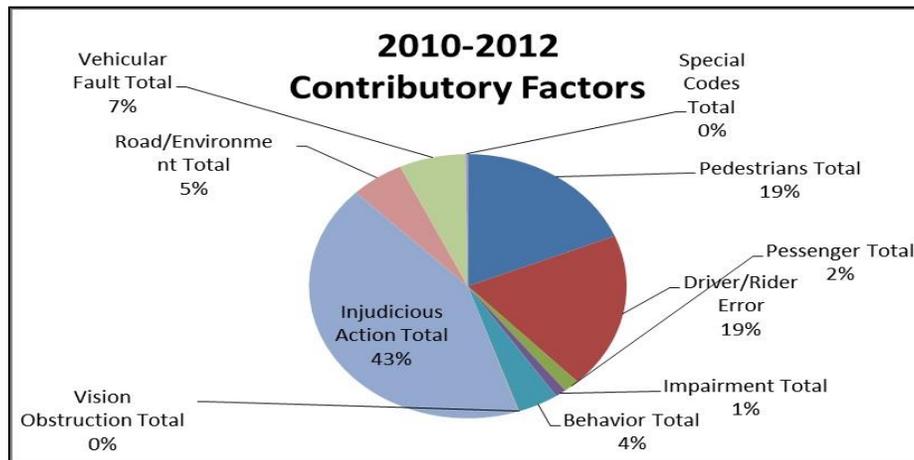


Fig.3. 2010 ÷ 2012 Contributory Factors

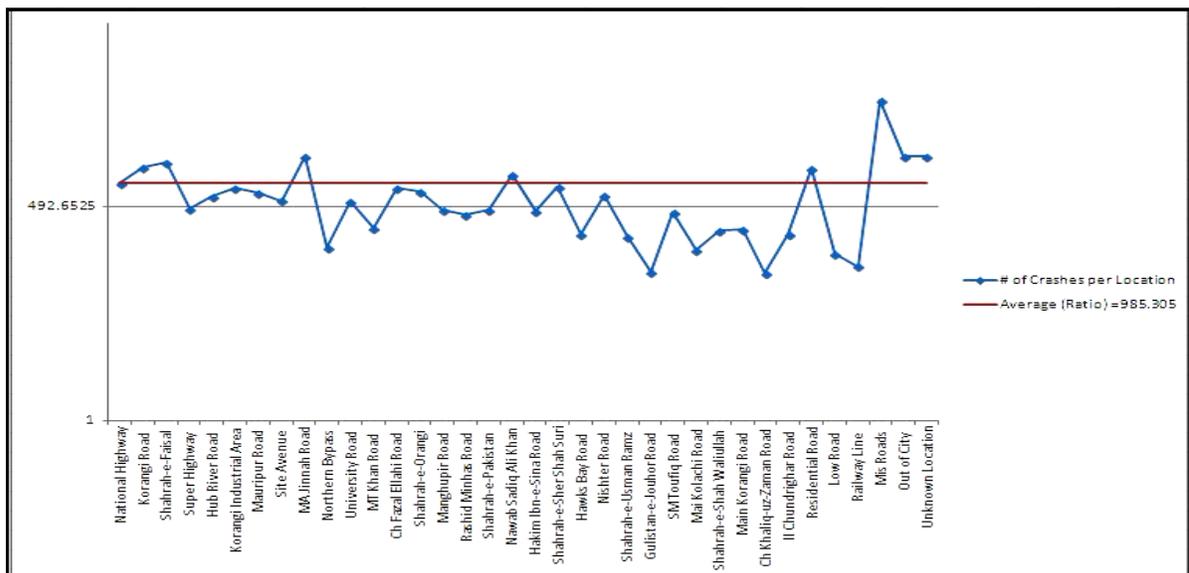


Fig.4(a).Identification of HCLs by average crash rate

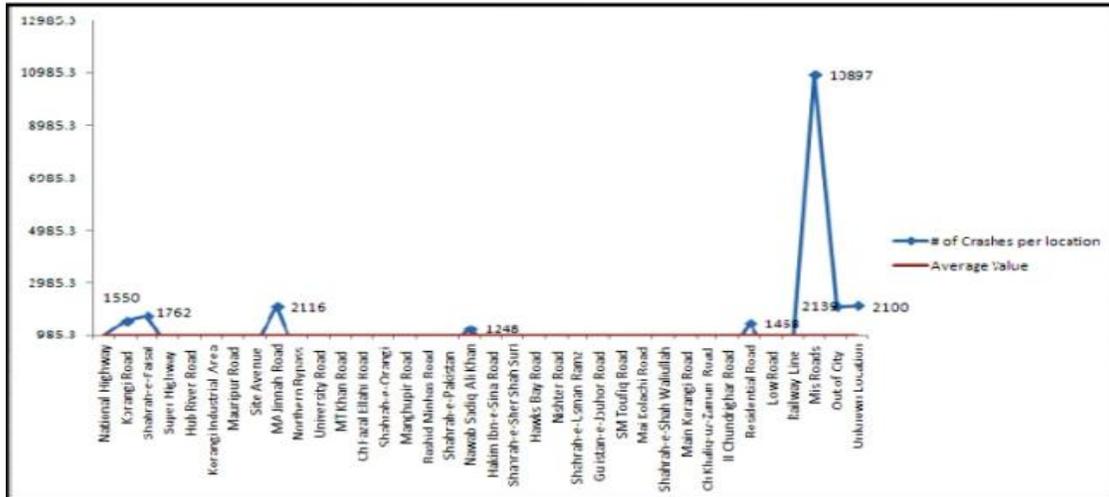


Fig.4(b).High Crash Locations

7.0. DISCUSSION

Proactive based RSIPs recommends countermeasure only when major improvements and/or new infrastructure are required. On the other hand reactive based RSIPs are effective in identification and handling of dangerous situations. To overcome road safety threats it is important to identify main causes and HCLs, because this will enable local departments to maintain positive culture defined by proactive approach based RSIPs. Also there is a need to highlight every location with abnormal number of casualties. Hence a broader and clearer picture will emerge for safety authorities to rank HCLs if it lies above average value. Such HCLs can be effectively treated by following reactive approach based RSIPs. Although Karachi is highly populated city with dense traffic, the road network is still comparatively better than other major cities of Pakistan. Yet the prevailing situation is not encouraging as lot of accidents and injurious actions undermines the traffic safety system (7). In order to impede most of the existing threats, identification of high crash location seems to be a high value

and prime contributory factors to devise an action plan. During analysis much of our emphasis was on two common aspects of reasoning. First was about casualty identification as a major factor while second one was related to HCLs characterization.

It seems reasonable to state that without proper identification, proactive & reactive RSIPs would turn out to be extremely difficult. Good judgment analysis would therefore be an appropriate choice to utilize limited sources and to impede maximum threats. Therefore we require any accomplishment analysis for factual action.

The casualty data presented in this study (Table 1) comprised of 36 locations (including unknowns) shows wide range of crash intensities but our focus was on identification of causes, locations (inside city) and policy outcomes for positive safety culture in limited sources.

Table. 1. Location’s Names and Casualties Intensity

	Locations' Names	# of Crashes per Location	Average (Ratio) = 985.305	HCLs (Inside City)	HCLs (Outside City)	Undefined HCLs	% of IA
1	National Highway	962	-	0	0	0	3
2	Korangi Road	1550	-	1	0	0	4
3	Shahrah-e-Faisal	1762	-	1	0	0	5
4	Super Highway	463	-	0	0	0	1
5	Hub River Road	662	-	0	0	0	2
6	Korangi Industrial Area	835	-	0	0	0	2
7	Mauripur Road	725	-	0	0	0	2
8	Site Avenue	584	-	0	0	0	2
9	MA Jinnah Road	2116	-	1	0	0	6
10	Northern Bypass	148	-	0	0	0	0
11	University Road	582	-	0	0	0	2
12	MT Khan Road	264	-	0	0	0	1
13	Ch Fazal Ellahi Road	842	-	0	0	0	2
14	Shahrah-e-Orangi	768	-	0	0	0	2
15	Manghupir Road	443	-	0	0	0	1

16	Rashid Minhas Road	394	-	0	0	0	1
17	Shahrah-e-Pakistan	452	-	0	0	0	1
18	Nawab Sadiq Ali Khan	1248	-	1	0	0	4
19	Hakim Ibn-e-Sina Road	432	-	0	0	0	1
20	Shahrah-e-Sher Shah Suri	878	-	0	0	0	3
21	Hawks Bay Road	222	-	0	0	0	1
22	Nishter Road	690	-	0	0	0	2
23	Shahrah-e-USman Ramz	208	-	0	0	0	1
24	Gulistan-e-Jouhor Road	74	-	0	0	0	0
25	SM Toufiq Road	415	-	0	0	0	1
26	Mai Kolachi Road	141	-	0	0	0	0
27	Shahrah-e-Shah Waliullah	247	-	0	0	0	1
28	Main Korangi Road	256	-	0	0	0	1
29	Ch Khaliq-uz-Zaman Road	72	-	0	0	0	0
30	II Chundrighar Road	220	-	0	0	0	1
31	Residential Road	1468	-	1	0	0	4
32	Low Road	125	-	0	0	0	0
33	Railway Line	87	-	0	0	0	0
34	Mis Roads	10897	-	0	0	1	31
35	Out of City	2100	-	0	1	1	6
36	Unknown Location	2139	-	0	0	1	6
	Total:	35471		5	1	3	100

Out of 36 locations analyzed in this study, highest average casualty values were shown by 8 locations (Tab. 1) and including those which were outside city and undefined. Results further showed that all sites above average values are confirmed by “1” and below average by “0” which clearly points out that these locations are of considerable significance in enhancing the level of threat. These locations must be dealt with reactive RSIPs immediately otherwise in future, threat level will rise beyond controllable limits. Such as enhanced threat for these sites is the consequence of imprudent and unjustified actions by local authorities. As a result, lower average locations are also much affected.

However, we believe that their situation is still manageable. From road traffic perspective, it seems that concerned organizations should take a leading role in proposing safety initiatives which will definitely improve the existing situation. In this context, findings of this study suggest some indispensable measures. Currently it appears very difficult to apply active RSIPs for all sites but if adequate financial resources are provided to local or state authorities, and measurements suggested in our analysis are followed in true spirit, immense improvement in road safety can be achieved.

It is important to note that casualties data presented here is irrespective of participant’s behaviors but revealed a high casualties percentage. To find out crash locations on vector map, therefore we require some analysis related to find out passion. Our calculations based on average values has highlighted five locations with abnormal number of casualties marked on vector map (as shown in Fig. 6.) and labeled by geographical coordinates. This has been quite useful in analyzing the features of hotspot locations. The outcome shows the highest concentration points, features, position, passion and in attendance circumstances. Using this



Fig.6. Map showing the HCLs in Karachi (Pakistan)

data, detailed analysis of individual locations can be performed to suggest specific intervention measures (8). The responsibility lies on local administration to respond on emergency basis in order to maintain positive safety culture at maximum level. The enterprise could either be development of new infrastructure and/or substantial improvement in existing one.

8.0. CONCLUSION

The problems in aiming positive road safety culture are brought to light which are too often related to participant’s behaviour and their reactions. In conclusion, proactive and reactive based RSIPs are vital in identifying factors and necessary for developing a safety culture. Proactive approach based RSIPs are very effective to bring improvements in new infrastructure. Whereas, HCLs further analyses by reactive strategies can show promising results in the identification of highly affected areas in Karachi, Pakistan. To keep positive safety culture, initiatives after predefined manners seems to

be a fitting strategy but these initiatives must take into account participant's behaviour and features of affected areas. Funding is a major problem to sustain safety improvements programs especially in developing countries so analysis of actual crash data is required before any conclusive result is drawn. On the basis of casualties calculated in this study, we have finally identified HCLs to be considered for reactive approach based safety improvements programs. We further conclude that both approaches can be simultaneously pursued as safety programs to obtain better road safety results.

9.0. ACKNOWLEDGEMENT

The authors acknowledge with deepest gratitude, supported by Road Traffic Injury Research and Prevention Centre Karachi, Pakistan; for permission to utilize proceeding reports Information collected by different trauma centers, to complete this research.

REFERENCES

- [1] D., Pesic, M, Vujanic, K., & B, Antic, (2011). Analysis of possibility for traffic safety improvement based on Serbian traffic violation database analysis. *Scientific Research and Essays*, 6(29), 6140-6151.
- [2] Sheraz., E.B.A.L.A.E.K. 2012, Road Accident on Sindh, Situation Analysis. By Social Research and Development Organization(SRDO, 2012)
- [3] Ministry of Health Govt. of Sindh, P.S.B.A.F., Road Traffic Injury Research & Prevention Centre Six Years Performance Report With Statistical Report (From 2007 To 2012). Department of Neurosurgery, Jinnah Postgraduate Medical Centre, Rafiqui Shaheed Road, Karachi-75510, Pakistan.
- [4] De, Leur., P., & T. Sayed., (2002). Developing a systematic framework for proactive road safety planning. *Transp. Res. Rec*, 1784, 34-42.
- [5] T. Sayed., N, Saunier, G, Lovegrove, & de Leur, P. (2010). Advances in proactive road safety planning. In *Proceedings of the 20th Canadian Multidisciplinary Road Safety Conference*. Niagara Falls, ON.
- [6] R.S.Job, (2012, October). Advantages and disadvantages of reactive (black spot) and proactive (road rating) approaches to road safety engineering treatments: When should each be used?. In *Australasian Road Safety Research Policing Education Conference*, 2012, Wellington, New Zealand
- [7] J.A. Razzak, , &L, Laflamme, (2005). Limitations of secondary data sets for road traffic injury epidemiology: a study from Karachi, Pakistan. *Prehospital Emergency Care*, 9(3), 355-360.
- [8] K.D. Jayan, & B. Ganeshkumar, (2010). Identification of Accident Hot Spots: AGIS Based Implementation for Kannur District, Kerala. *International Journal of Geomatics and Geosciences*, 1(1), 51-59.