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Community Protection with Spatial Web Services and New Spatial Objects

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Abstract

Today, societies experience different crises such as natural, political, cultural, religious, economical, and so on. The lack of understanding and timely identification of these crises may lead to the prosperity of national or international societies. On the other hand, most of the crises due to their particular characteristics cannot be resolved solely by government resources and actions. On the other side, the people have certain potential that can be cured by their effective utilization, a significant part of the consequences of the crisis. In this paper, the aim is to use a spatial crowdsourcing service in the context of spatial information systems to use the potential effective members of community to solve various classes of problems. Also, based on the data obtained from such services, there are some specific management tools and methods that can be used to monitor the balance of society in different cultural, religious, and economic sectors. In the following, a graph network is created upon the data obtained from this service. Then, based on this graph, a new definition of geographical phenomena is given. In this way, some kind of new geographical phenomena is introduced which is based on positive or negative spatial operations. Also, some existing models for processing social graphs are somehow tailored to the crowdsourcing services. The main purpose of these modifications is to apply spatial corrections to social graph models by using spatial information systems.

Keywords: Crowdsourcing, Community Balancing, Location Based Social Services, VGI

Introduction

Society must always move in a state of balance and normal in various administrative, educational, cultural, religious, and economic spheres. Maintaining this balance guarantees the survival of society, and the lack of government officials causes heavy losses and may even lead to a decline in society **(Wolensky & Wolensky, 1990)**. Since any small problem in one aspect of society can be a starting point for a large social deviance, timely identification and control can ensure the security of the community. But, on the other hand, these deviances are not recognized in the society or there is not enough means and power to solve them.

Many believe that this is the duty of the state. But if the governments cannot do their job properly for whatever reason, they are the people of the community who have to pay for it. Individuals and society are like a ship in a sea. If people are indifferent to problems that arise for other people in the community, part of the society will be hurt, and like a ship that's partly pierced, it will cause the entire society to collapse and the whole ship's sinking. Accordingly, the main problem is, firstly, how to detect any problem and small deviance in each dimension of the community. Secondly, if the government cannot solve the problems for any reason, how can people handle the problem?

Crowdsourcing and using the intellectual capacities of people **(Adams & McKenzie , 2018)** in the community is a matter of concern from the past. Solving scientific issues, public opinion polls on a particular topic, or building some commercial equipment and products has been one of the major uses of crowdsourcing. But in this paper, there is a new application of the crowdsourcing **(Zhao & Han , 2016)**.

Indeed, we want to outline a strategy that can rely on the potential of people and crowdsourcing in the production of spatial data in the context of spatial information systems to identify the location based problems and deviances of the community, and furthermore, using potential of the people to resolve or mitigate the problems created in the community.

In the past, we have seen how the entry of Volunteer Geographic Information **(Ostermann & Granell , 2016)** and the mobile GIS led to the development and improvement of GI systems in the field of production and application of spatial information. We believe that the use of crowdsourcing in spatial information systems can have the same effect again in spatial information systems. Considering the existing and different potentialities of the crowd of the people, it is expected that we will see significant improvements in the field of spatial data production as well as spatial data application in GIS.

Thus, the use of crowdsourcing in this field, on the one hand, promotes the improvement of the quality and balance of the community **(Ghose, 2001)**, and, on the other hand, promotes the acceptance of GIS by statesmen and the community **(Lin, 2008)**.

Although crowdsourcing service seems to be somewhat similar to the location-based social network services, but due to some differences, these two services should be explored in two separate areas. In terms of functionality, the main purpose of these services is to use crowd potential in solving difficult problems, while services such as foursquare try to share spatial experiences. On the other hand, in such services, time did not matter much, while crowdsourcing services are based on time constraints.

In addition, location-based social systems offer suggestions based on the fixed features of individuals while crowdsourcing services is based on the fixed and instantaneous features of individuals. Furthermore, in such services, after the proposal, the choice of people is not so important, while in crowdsourcing services, the system based on the selection of individuals should do other supplement or modifier activities.

Technically, the solutions of crowdsourcing systems should be based on the instantaneous performance, operation and the state of the users. Thus, there is a close relationship between the users and the system. On the other hand, depending on the subject of crowdsourcing, the solution should be more confident than the social network solutions.

Likewise social network solutions are usually based on social-spatial graphs, while in crowdsourcing systems, solutions use a combination of search methods in space-time and based on fixed and variable characteristics of individuals.

On the other hand, due to different types of natural or social crises, crowdsourcing systems should be able to have high flexibility in adapting themselves to crises, while social networks do not require high flexibility due to their limited goals. Also, in spite of its high flexibility, the system should use a very simple user interface to deal with crisis situations. Accordingly, these services can be considered as a type of location-based services that have high-level constructive interactive with the community.

Crowdsourcing in Society

The main purpose of this research, is to use the GIS and its tools to detect and solve community problems. Therefore, we designed a kind of spatial crowdsourcing service. In order to use this service, we proposed a new subjective space. Then, we designed a number of tools to perform the necessary calculations in this space. In this section, we will consider some of the algorithms and methods close to our solution that we have used or inspired.

2.1. Crowdsourcing

Crowdsourcing for the first time was used to describe outsourcing of products to crowd **(William , 2013)**. The word "crowdsourcing" contains two concept of outsourcing and baggage of crowd **(Arolas & González-Ladrón-de-Gueva, 2012)**, **(Matthias, et al., 2011)**. Crowd could bring their money **(Johnson, et al., 2019)**, ideas **(Mohanty , et al., 2019)**, works and experiences to receive mutual benefits. Crowd will satisfy some of their demands including professional abilities, social or economic benefits **(Arolas & González-Ladrón-de-Gueva, 2012)**.

Crowdsourcing at the GIS has been mostly used as a tool for data surveying and mapping (Haklay, et al., 2014). Sometimes mobile data collecting apps are designed and used (Brovelli, et al., 2016). With the expansion of this theme, even the need to build a mechanized spatial data collection infrastructure was created in the form of mobile apps (Higgins Christopher, et al., 2016).

An important points is that, IT based technologies always participate in the crowdsourcing **(Afuah & Tucci , 2012)**. In addition to IT techniques, it also uses three other techniques as its main branches; virtual labor market, open collaborative and competition crowdsourcing **(de Vreede , et al., 2013)**. The crowdsourcing could be recognized in two phases, sending a given problem to crowd and then absorbing their contribution in an open call to solve it! Then people offer their solution in that open session. Finally Solution finders, would receive a prize or just satisfy their cognition intellectually. Contributors by different knowledge and experts would be known or unknown to crowdsourcers **(Howe, 2006)**.

In the crowdsourcing solution discussions, analysis, and computation can be done on the basis of concepts such as the equilibrium, payoffs, framework, and the game, based on different models **(Anta, et al., 2015)**. On the basis of these concepts, an equilibrium analysis based on probabilistic calculations can be performed in different scenarios. Naturally, the space for such calculations is completely out of our research **(Staab & Engel, 2009)**.

The crowdsourcing provides specific methods in performing collaborative projects such as product quality evaluation. The most prominent solution in these methods is to define multi-indicators criteria. The different models presented in this field can include one criterion, or a combination of several criteria. Although the original idea has some similarities to our solution, but in such metrics, usually the location or relation in the graph of the users is ignored **(Daniel, et al., 2018)**.

Another method used in crowdsourcing computing, is the decomposition and recomposition of a complex problem **(Zhang, et al., 2011)**. In other words, to solve a complex problem, one can first break it down into smaller ones, solve those small problems and then combine the solved problems together. The main idea of this technique, regardless of its limitations, is the proper method for us. Each of our proposed crowdsourcing service, is capable of one simple operation by one person. Obviously, the complex issues in society can be solved by proper composition of these simple actions.

The significant points is that, most crowdsourcing applications are not based on location based data; however, in the context of our topic, spatial data is the main focus of research **(Harvey , 2012)**. This attitude makes the common thinking about collecting ideas and focusing intelligence on crowdsourcing towards other activities tends. Nevertheless, the interesting thing about our subject is its similarity to the volunteers for the content provider. In other words, while in the matter of crowdsourcing and Ambient Geographic Information, the data producer is not so important **(Stefanidis, et al., 2013)**, in our subject matter, as well as Volunteer Geographic Information, the producer of spatial content is of particular importance.

2.2. Location Based Social Networks

However, the subject of this paper may seem to be somewhat similar to location-based social networks. In recent years, with the expansion of social networks, this category has been considered by many scholars, along with content growth, related issues including massive volume management, location, positioning without access to GNSS data, knowledge extraction from personal records (Wei, et al., 2012), service launching with minimal information and so on (Bao, et al., November 2012).

In some researches (Goodchild & Glennon, 2010), the complementary role of social networks and VGI in the field of spatial data production and their processing has been pointed out. Rather than quality and confidence level in such data, at least in times of crisis and emergency, when access to other spatial information is not possible, it is a good source for processing (Vieweg, et al., 2010).

LBSN data analysis is mainly over the concepts such as user profiles, update activities, mobility characteristics, social graphs, and attribute correlations (Li & Chen, 2009). The social graph is a graph that represents social relations between entities. In short, it is a model or representation of a social network, where the word graph has been taken from graph theory. The social graph has been referred to as "the global mapping of everybody and how they're related. Except for the main purpose of common LBSNs (Abdelmoty & Alrayes, 2017), in many analyzes, the location on these networks work either as a search tool, a navigation guide or a geo-tagged tool (Anon., 2019). Sometimes, spatial data directly, or parameters extracted from spatial data such as velocity, are considered as additional attributes on social graphs (Gan & Gao, 2019).

In our research, however, we seek a suitable combination of location and topological social relationships. We believe that the mere use of location or social topological information can produce inappropriate responses.

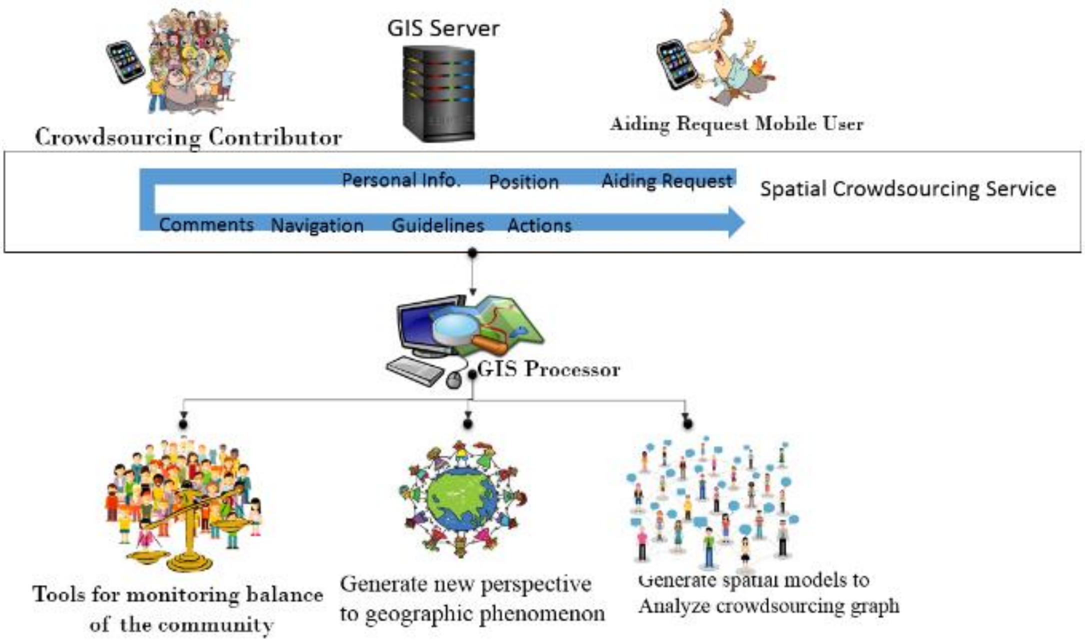
Finally, in spite of the conceptual proximity of the algorithms and techniques in topics such as social networks, volunteers and crowdsourcing to the community management, the appropriate and practical integration of these techniques, has not yet been developed in practice. However, our solution is a proper development on the right combination of the mentioned techniques.

Main data structure and model

The society has different morphologies that the balance of each of these bodies may be threatened due to various problems for people in the community (Sui , 2019). Similarly, the geographic body also has strong points that these strengths can be used to modify and correct other masts. But the first issue is how to identify these problems and these strengths in the geographic body.

Our strategy is based on the use of the spatial crowdsourcing service in the context of the GI systems as in figure 1. This XML-based service has a flexible structure that can accommodate requests, information content, location and navigation information. In this way, anyone in the community can use the service on the smartphone to express their problem at a specific location. This problem can be related to crisis situations, emotional, financial, political, cultural, scientific or religious. On the other hand, other people in the community can help them through the same service. Their help in the same field may include giving positive, negative feedback, practical action in the form of help, or suggesting a special place with a clearly identifiable situation for those in need. The applicants for help declare at the end whether their case has been resolved or remained. In this regard, a group of individuals can register the strengths of the various locations in the geographical area, in various fields, independently of the applicants' request. Of course, this part is similar to the function of some social networks. The GI system is responsible to receive aiding requests and allocate them to the right people in the community.

Figure 1: Spatial crowdsourcing Services and its applications in community balancing. Note that this service is different from social networking services for its domain and applications



Thus, a number of valuable structures and information are formed over time in the central database of GI system. The point cloud of the problems and shortcomings of the society in the geographic extent; the influential points of the various bodies of society in the context of the location; the results of successful and unsuccessful actions; and the network of communication between locations and individuals. Here are some of the spatial analysis needed on these sections.

Development of analytical tools based on GI systems

Let's assume that number of people in the community asking for help with their location in the form of several specific classes, along with additional documentation, in the system. Other people on the basis of their abilities in different categories, however, they can send their opinion or assistance through the service, to applicants of all classes. They can send a positive or negative opinion on applicants' applications, practical action or introduce them to a specific place. Regardless of the positive impact of the system on solving the community problems, the obtained information provides a new location-based management tool.

In order to express a measure of the society imbalance in one of the main discussed classes, we design the matrix as (1).

	Economical	Religious	Political	Cultural	Emotional	Scientific
Economical	$N_R^E + N_C^E - N_C^E$	0	0	0	0	0
Religious	N_{C+}^{RE}	$N_R^R + N_{C+}^R - N_{C-}^R$	0	0	0	0
Political	N_{C+}^{PE}	N_{C+}^{PR}	$N_R^P + N_{C+}^P - N_{C-}^P$	0	0	0
Cultural	N_{C+}^{CE}			$N_R^C + N_{C+}^C - N_{C-}^C$		
Emotional	N_{C+}^{Eml}				$N_R^{Em} + N_{C+}^{Em} - N_{C-}^{Em}$	
Scientific	N_{C+}^{SE}					$N_R^S + N_{C+}^S - N_{C-}^S$

(1)

N_R^E Stands for the number of given aiding requests R in economic class E, N_{C+}^E stands for the number of given aiding positive comments by people that their main expertise is in the same class, $C+$ represents positive comments and $C-$ represents negative comments. N_{C+}^{RE} Stands for the number of positive comments which was given by the aiding people of class *Religious* to the aiding requests of people in class *Economical.*

Based on this matrix, we define a criterion as (2)

$$\alpha_i = (d_{i,i} + \sum_{j=1}^{n} e_{i,j})/(\sum_{i=1}^{n} \sum_{j=1}^{n} e_{i,j}$$

(2)

α_i Specifies a criterion for a specific class within all defined classes, i and j represent rows and columns of the matrix,

$d_{i,i}$ Stands for the diagonal elements of the matrix

$e_{i,j}$ Represents non-diagonal elements of the matrix

$$if\ \alpha_i > A\left(\sqrt{\frac{\sum_{i=1}^{n}(d_{i,i}+\sum_{j=1}^{n}e_{i,j})}{n-1}}\right) \rightarrow Deviance_i$$

(3)

The coefficient A indicates the deviance volume in one of the social contexts and is determined by numerical experiments. Equation (3) states the occurrence of a deviance in one aspect of society.

Crowdsourcing graph network s

We use graph network in order to place the crowdsourcing information on the location. Assume crowdsourcing requester as orange circle, crowdsourcing contributor as green and special places as blue circles. Each person as a crowdsourcing contributor can offer aiding requester, a positive, negative, or a specific place. These relations simply form a graph network.

Figure 2: Crowdsourcing Service graph network

Once again we consider a similar matrix. This matrix may indicate the status of community problems, the level of community members' assistance, effectiveness of crowdsourcing services or the importance of different locations in society. Each of these cases, the matrix elements are designed differently.

	A_1	A_2	…	A_m	C_{1+m}	C_{2+m}	…	C_{n+m}	S_{1+m+n}	S_{2+m+n}	..	S_{j+m+n}
A_1	E_1'											
A_2		E_2'										

…			
A_m	E_m^m		
C_{1+m}			
C_{2+m}			
…			
C_{n+m}	E_{n+1}^{m}	E_{m+n}^{m+1}	
S_{1+m+n}			
S_{2+m+n}			
S_{j+m+n}			E_{n+m}^{n+m}

(4)

A_m Stands for the aiding request number *m,* C_n Stands for the crowdsourcing contributor number *n,* and S_j represents specific location *j*.

If we want to see the general condition of reported problems in society, then we can use (5)

$$E_n^m = \frac{n^{nm} A^{nm}}{l^{nm} + k}$$

(5)

When *nm* points to the both side of the link from node *m* to node *n*, A^{nm} represents number of aiding requests on both sides of link, n^{nm} indicates frequency of requests and l^{nm} stands for the length of link. *k* is a controller that can adjust the distance effect. We will determine it in practical experiments.

In order to produce an assistance level of community members we may use (6)

$$E_n^m = (l^{nm} + k) n^{nm} C^{nm}$$

(6)

C^{nm} Represents number of comments. To measure effectiveness of crowdsourcing services

$$E_n^m = n^{nm} Co^{nm} \qquad (7)$$

Co^{nm} Stands for number of confirmation messages which indicates how many aiding request have been successfully resolved. Finally to measure the point importance level (8)

$$M_{s\times s}^{t} = \left(M_{s\times s}^{p} \times M_{s\times s}^{a} \times M_{s\times s}^{Co}\right) \times M_{s\times s}^{t-1}$$

(8)

$M_{s\times s}^{p}$ Indicates problem matrix which is produced by (5), $M_{s\times s}^{a}$ refers to assistance level matrix that comes from (6), $M_{s\times s}^{Co}$ is effectiveness matrix that is produced by (7), and $M_{s\times s}^{t-1}$ displays importance matrix of the time *t-1*. Also $s = j + m + n$

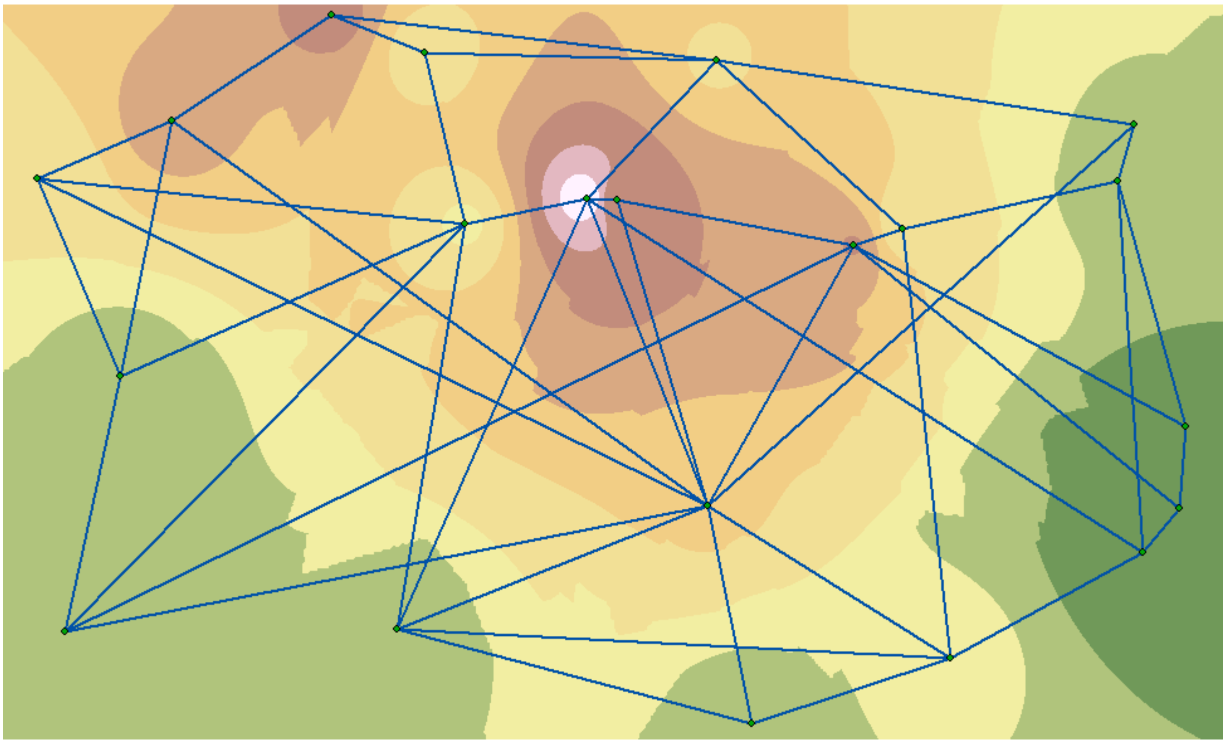
When we form the importance graph, we will actually find a new type of geographical view to all points. In other words, we want to introduce a new concept of geographical approach. In this sense, a particular geographic location does not depend solely on the existence of an external phenomenon. Positive and negative operations, however, may, if they are of sufficient importance, represent a particular geographic location.

By interpolating the importance of the points, a continuous raster map of the region can be obtained as in figure 3.

Modified Interpolation Algoirithm

By interpolating the importance of the points, a continuous raster map of the region can be obtained as in figure 3.

Figure 3: Interpolation of the point importance using simple IDW algorithm



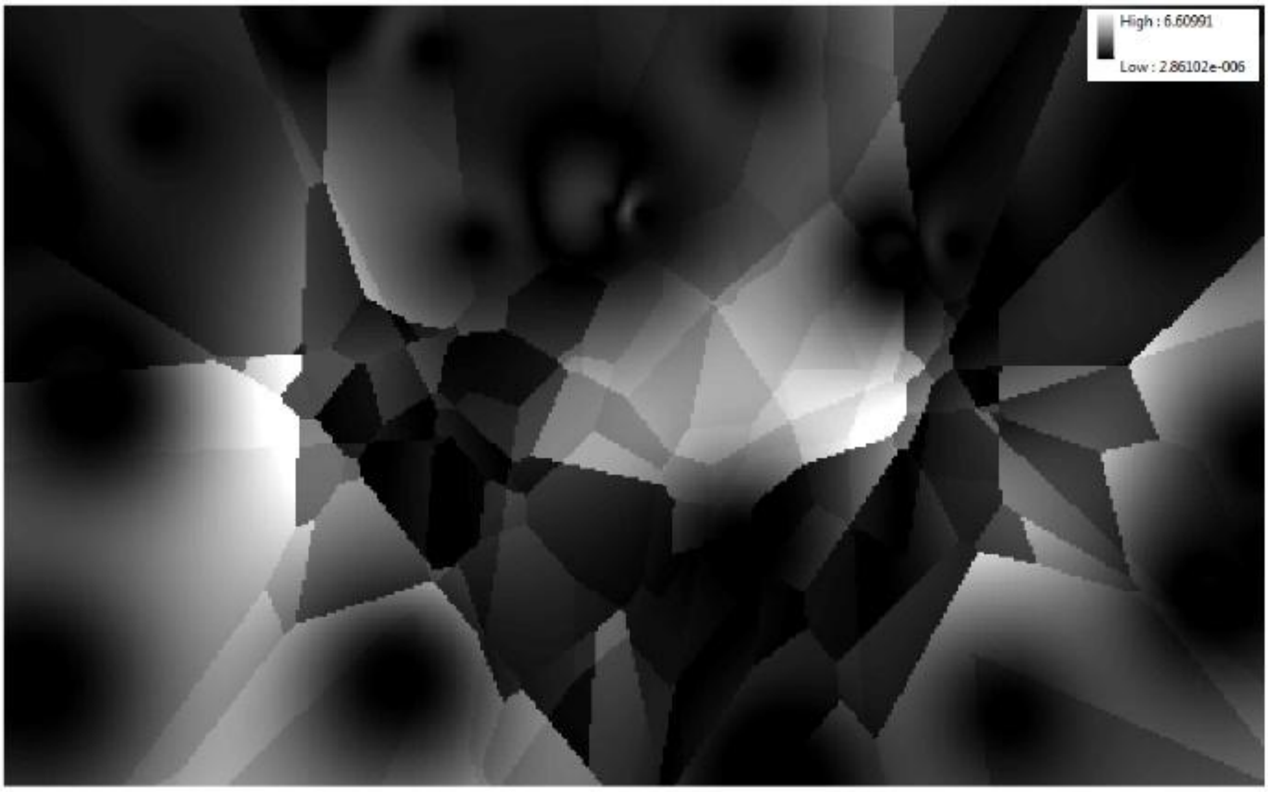
In the interpolation model e.g. Inverse Distance Weighted, the only effective parameter is the distance, but due to the correlation between the nodes of the graph, these factors have not been affected by interpolation. So, we modify the IDW interpolation model by taking such correlations. Therefore we will have (9)

$$Z_p = \frac{\sum_{i=1}^{n} \frac{z_i}{d_i^p}}{\sum_{i=1}^{n} \frac{1}{d_i^p}} \left(1 + \left(\frac{\frac{\sum_{j=1}^{m} I_j C_j}{\sum_{j=1}^{m} I_j}}{\frac{\sum_{i=1}^{n} \frac{z_i}{d_i^p}}{\sum_{i=1}^{n} \frac{1}{d_i^p}}} \right)\right)$$

(9)

In this equation, I_j represents importance of correlated point that is extracted from matrix (8), C_j indicates correlated values again comes from (8), d_i^p represents distance to given point, z_i indicates cost value that is interpolated. Having this modified IDW equation, we can interpolate the graph-related values in a more precise manner. The figure 4 shows the difference between two interpolation models for map of problems.

Figure 4: Difference between two interpolation method, simple IDW and modified one



Another issue is that in many similar studies, especially in social networks, graphs alone are solely dependent on topological parameters. In this section, a model is presented that the spatial value parameters are applied to the graph valuation as in (10)

$$V_{ij=}\sum_{m=1}^{n} l_m P_m + V_{ij}^0$$

(10)

l_m is equal to $\frac{1}{n} l$ total length of the link V_{ij}, P_m is the value which is extracted from interpolated coincident pixels in cost layer, V_{ij}^0 is the primary value of link based on graph's grade. For example, if we want to provide an effectiveness graph of the crowdsourcing services, the *cost* layer is obtained from the interpolation of the point layer of the services' success.

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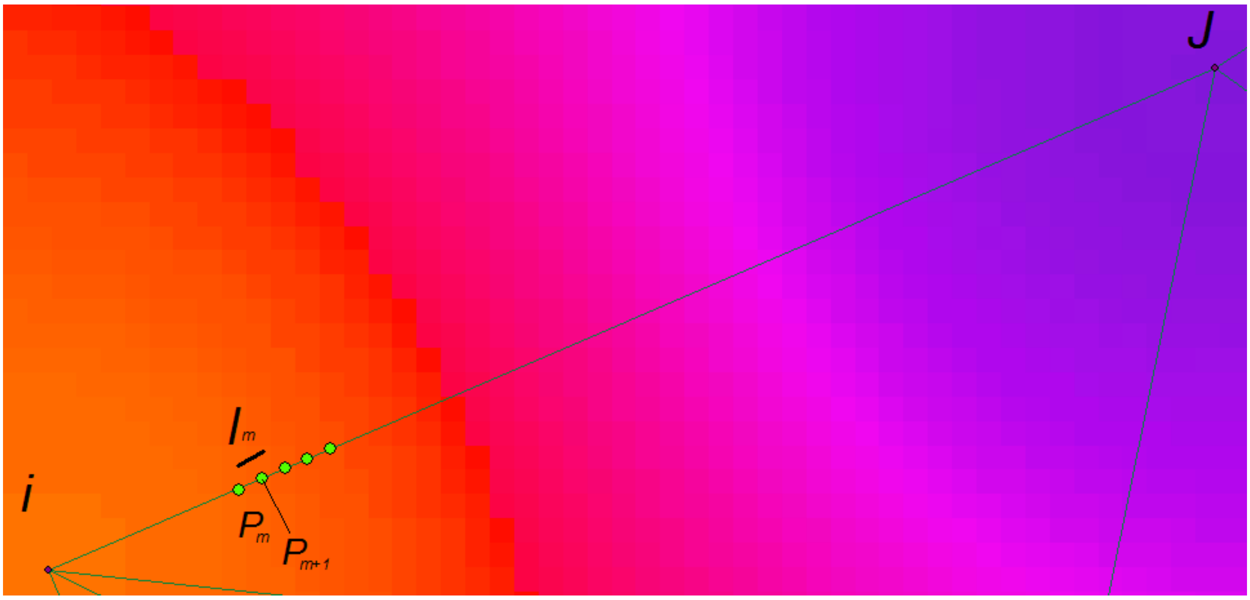
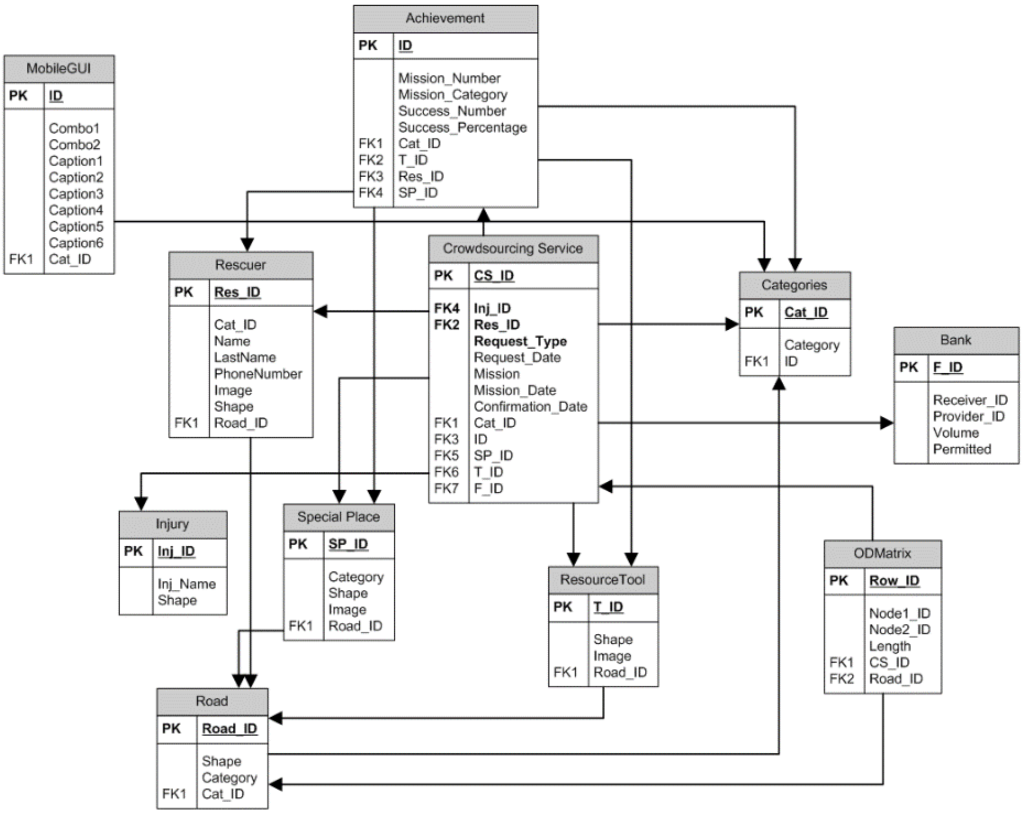
Figure 5: Split a link into small regular pieces, attaching a coefficient from the raster space to it in order to obtain the corrected coefficient of link



Implementation and Discussion

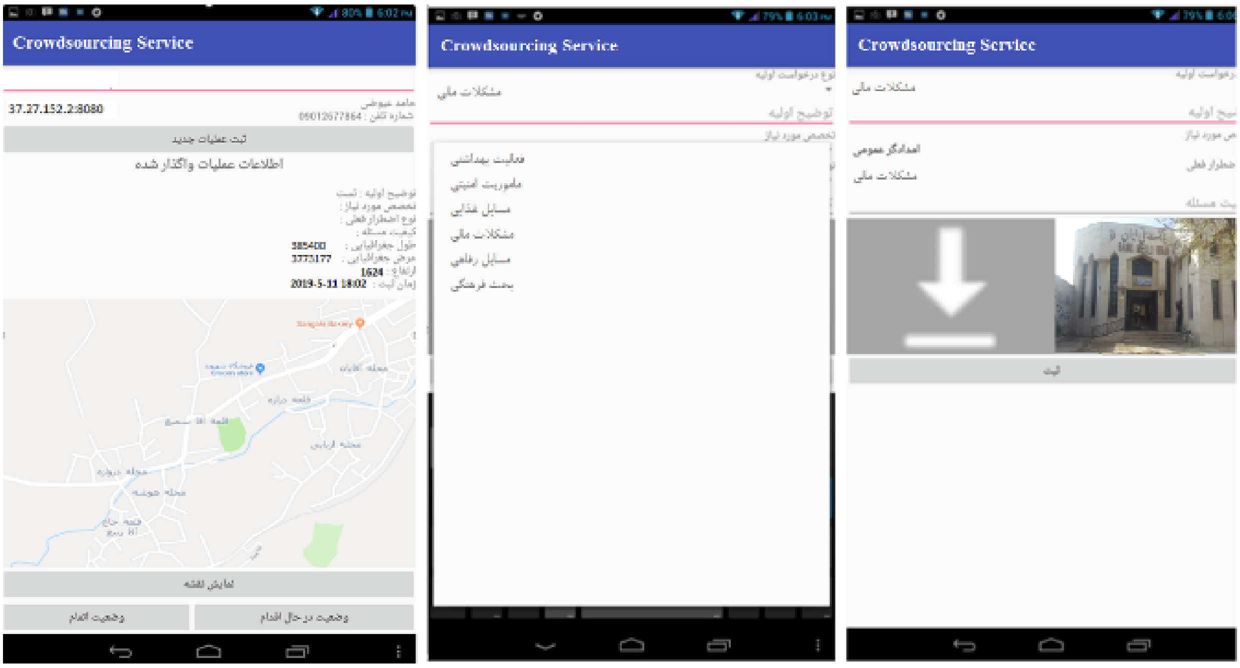
In order to test the proposed algorithms, a system based on a GIS system, a mobile interface and a central database was developed. Figure 5 shows the schema of the system's database. Spatial Crowdsourcing services are centrally located. System overall operation is designed based on these classes and their domains, triggers, and stored functions in the database.

Figure 5: System Relational Data model



The mobile interface and its subsystem are customizable and flexible. All controls of this interface and their information content are specified by multiple classes within the database. This interface together with crowdsourcing service have different roles. They can collect user requests that include geo-tagged images. Guide them with navigation information to specific locations. On the other hand, send the operational content of the crowdsourcing service to the rescuers and receive their confirmation.

Figure 6: Android GUI for collecting requests and sending commands



Then the mobile user interface was presented to the university students of a class and they were asked to work with this interface for a week. 34 students of Arak university of Technology, used the system for 1 week in Arak. During the week, a total of 55 different referrals were recorded by the system. This information in table 1, is in the previous categories (table 1) as described below.

In order to test the designed tool, a crowd of students consisting of 295 people from economic, political, religious, scientific, cultural and emotional groups was invited. The students indicated their problems in different groups via the designed app. Again, students responded to the problems in the system through the same app. The number of comments that creates matrix (5) is recorded in Table 1.

Table 1: Matrix (5) in section 3.2

		Crowds					
		Economic	Religious	Political	Cultural	Emotional	Scientific
Aiding Requests	Economic	98+24-37	57	3	24	18	0
	Religious	2	27+24-8	4	15	9	6
	Political	24	38	59+5-41	7	3	11
	Cultural	14	25	4	32+18-9	20	3
	Emotional	19	49	19	38	61+45-8	9
	Scientific	1	8	0	2	0	18+11-7

Based on the information in table 1, the estimation of the relative deviation status can be obtained as table 2.

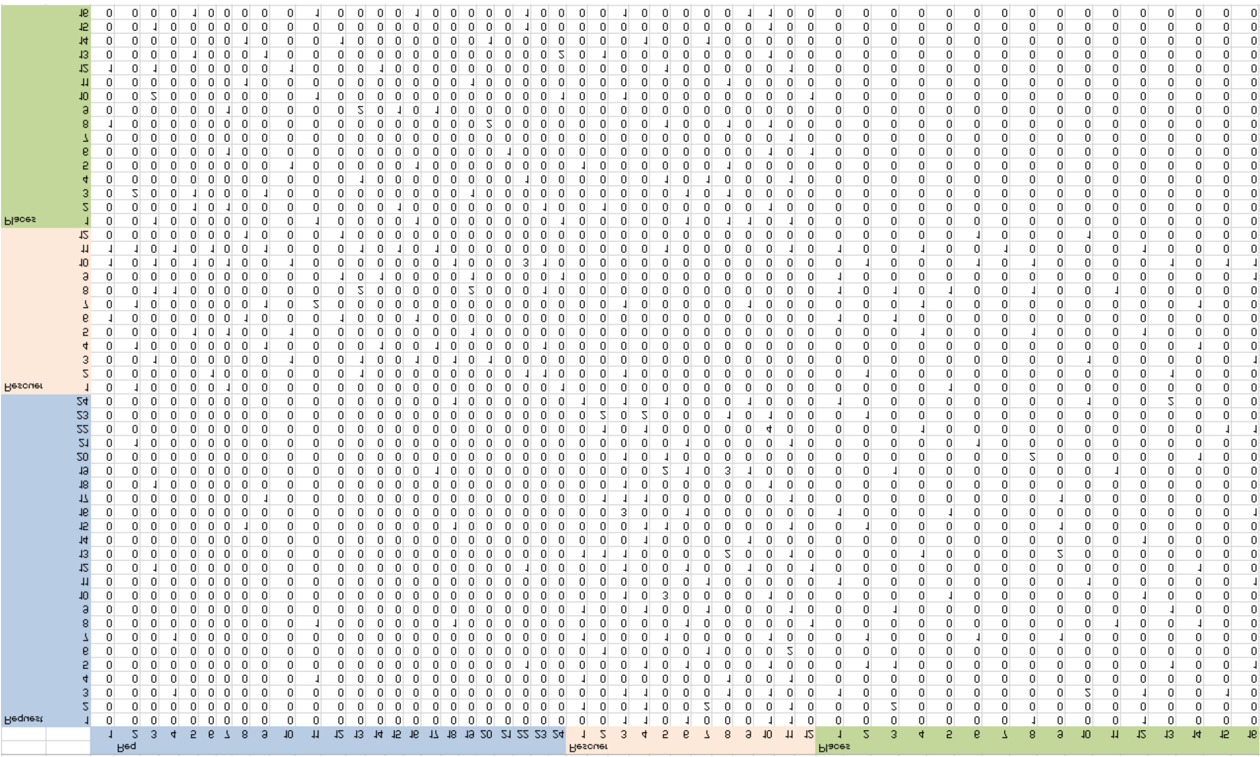
Table 2: Criteria to judge about condition

αEconomic	0.43
αReligious	0.18
αPolitical	0.24
αCultural	0.25
αEmotional	0.54
αScientific	0.08

The value of A was obtained based on the estimations of 0.8. Accordingly, the numbers in Table 1 indicate a crisis in both the emotional and economic dimensions of the student community.

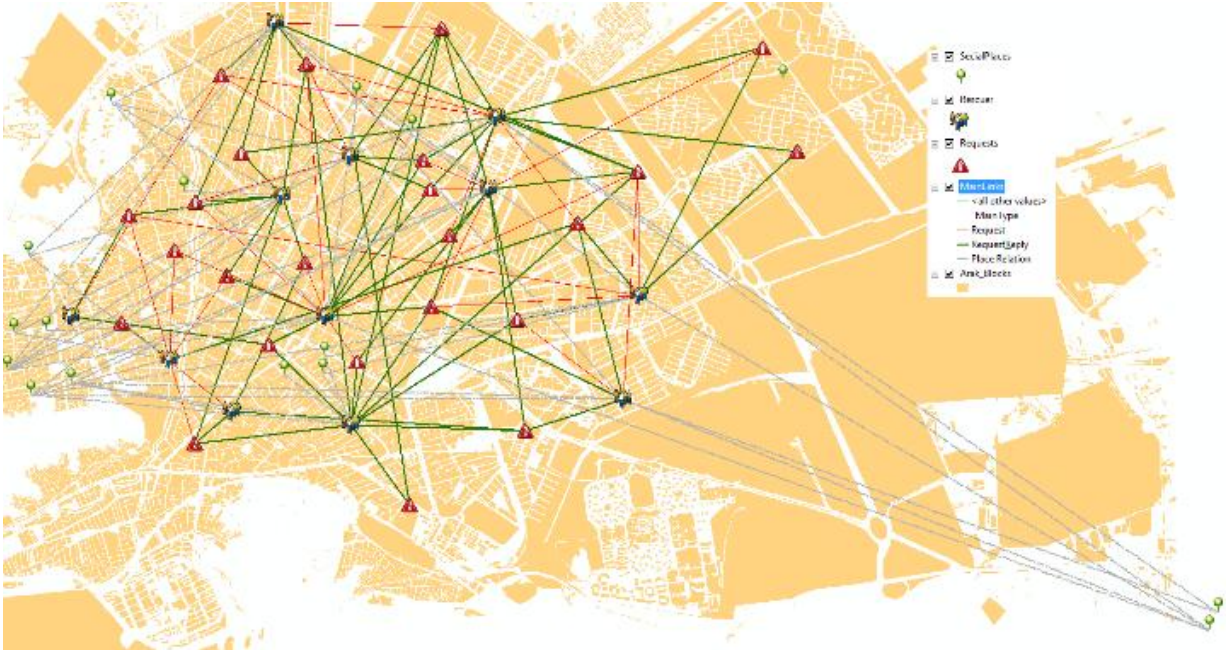
Next, to make processing easier, we extracted a 3-day snapshot of requests and responses recorded in the system. This interval included 24 applicants, 12 rescuer, and 2 locations. Based on the data collected we form the matrices (equation 1).

Figure 7: Matrix to indicates general condition of reported problems (Matrix 5)



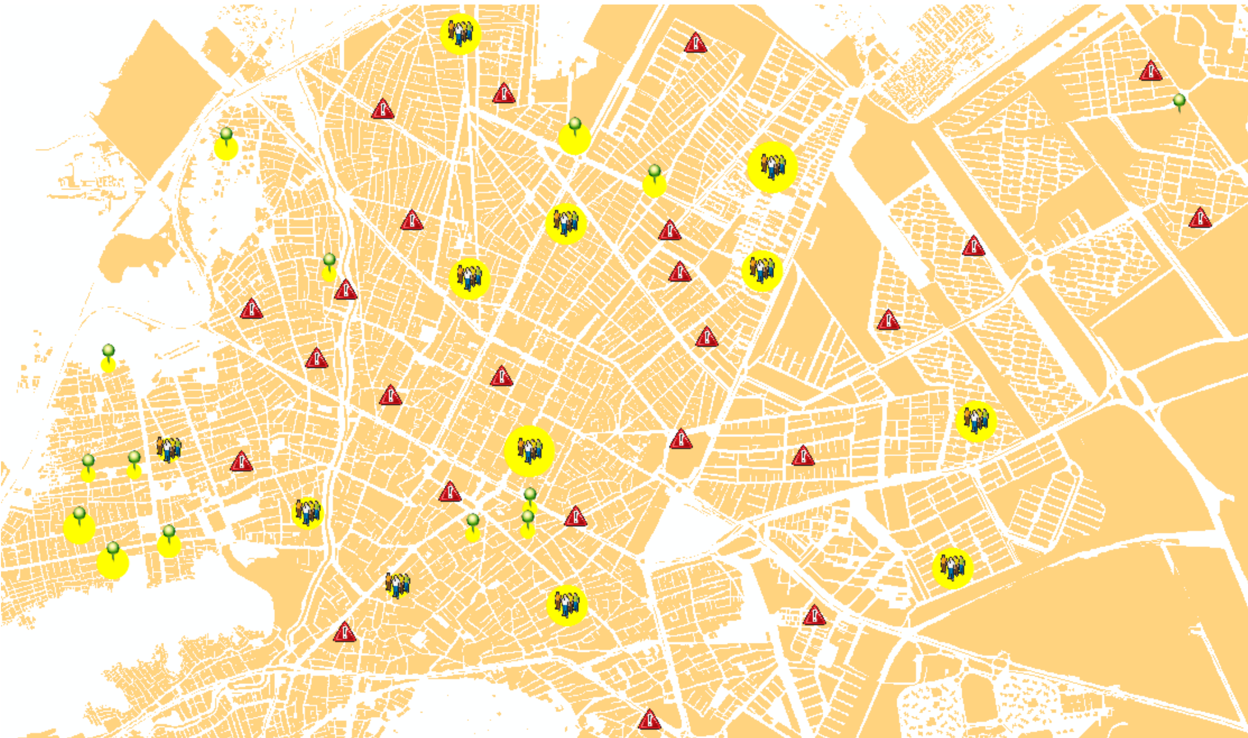
This timeframe includes 91 request, 61 replies, and 50 recommended places. Based on these values, the relations are made as a graph of figure 8.

Figure 8: Non-diagonal elements of the general condition matrix (5) indicates the power of links in relation graph



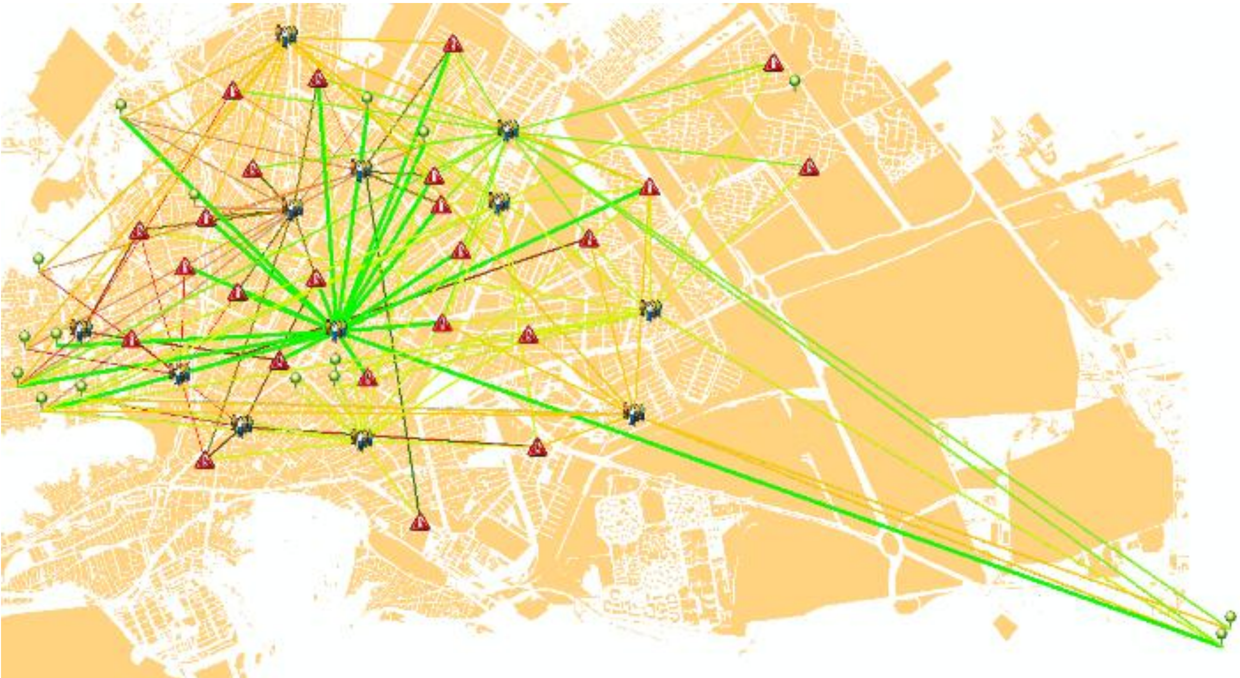
By constructing the three matrices # 1, # 1, and # 2, we can display them on the nodes.

Figure 9: Diagonal elements of the effectiveness matrix (6) indicates the power of nodes in relation graph



For example, we have shown the effectiveness of each node (rescuer or specific location) in the form of a yellow halo on each of them whose diameter is proportional to the efficiency of that node.

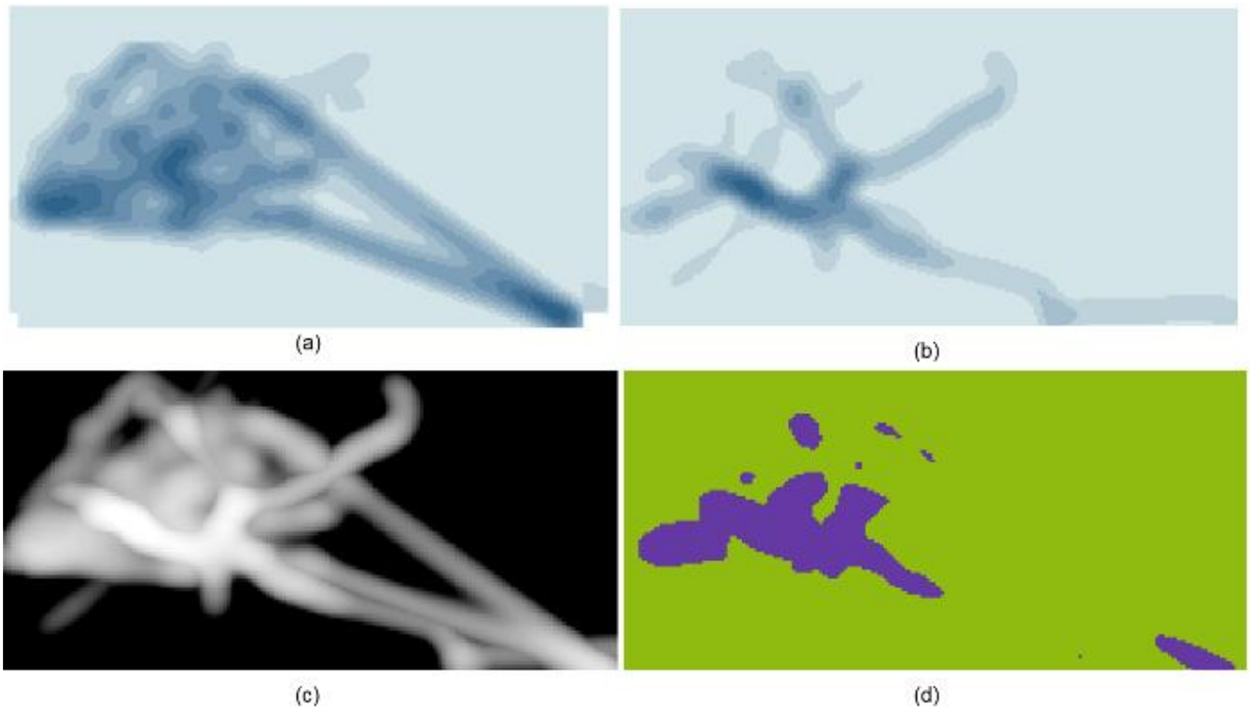
Figure 10: Non-diagonal elements of the effectiveness matrix (6) indicates the power of nodes in relation graph



Similarly, based on the non-diagonal values of the effective matrix, the graph of the relationship between nodes can be shown as in Figure 10. This graph shows the dependency between different parts of the city and its specific important features. Thus, this graph can be a very effective tool in analysing urban spaces used in urban planning and land use planning.

Evaluation

Figure 11: (a) Density map of dependency graph, (b) Density map of traffic load, (c) Fuzzy overlay, (d) Matching between two sets



Urban travel data were used to assess the accuracy of this information (Figure 10). The amount of urban traffic was mapped onto the streets, and then the traffic density map was prepared using the Kernel method with a search radius of 200 m and a pixel size of 50 m (Figure 11-b). Similarly, the density map of the previous dependency graph was also prepared (Figure 11-a). These two maps were then transformed into two fuzzy sets using the MSSmall method. This method calculates membership based on the mean and standard deviation of the input data where small values have high membership. The result can be similar to the Small function, depending on how the multipliers of the mean and standard deviation are defined. Then, a fuzzy overlay was performed on these two sets (Figure 11-c). The result, based on a 35% probability of error, reports a 87% matching between the two sets for the main urban streets, and less than 12% for other streets (Figure 11-d).

Figure 12: (a) Diagonal elements of general condition of reported problems matrix, (b) Elements of the effectiveness of crowdsourcing services matrix, (c) The assistance level of community members' matrix, (d) Result of multiplying the last three matrices.

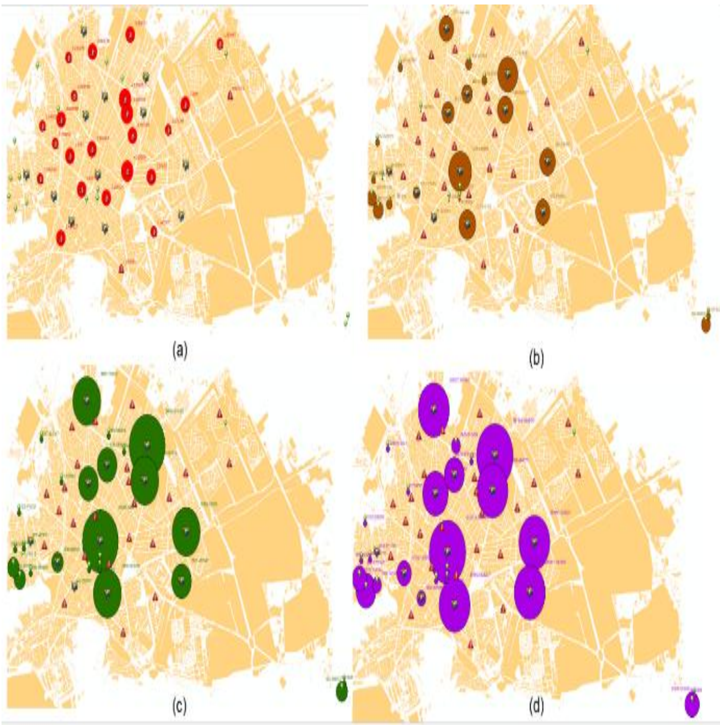
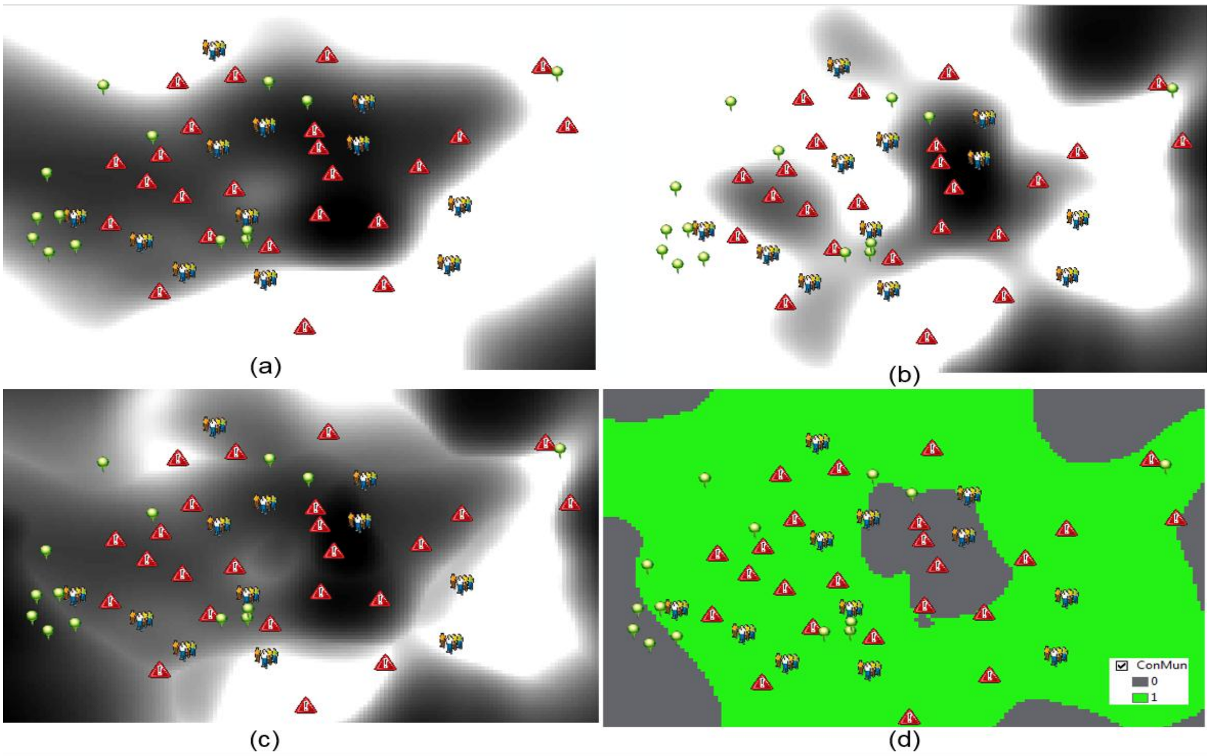


Figure 12 shows the values of the diagonal elements of matrices (5), (6) and (7) on graph nodes. Figure 12-a, displays diagonal elements of general condition of reported problems matrix, figure 12-b, Elements of the effectiveness of crowdsourcing services matrix, figure 12-c shows the assistance level of community members' matrix, and figure 12-d shows the result of multiplying the last three matrices. Figure 12-d illustrates the importance of different nodes in the graph. Accordingly, new geographical features can be defined, the importance of which depends on their performance.

In order to evaluate the general condition map, police crime information and municipal problem reports were obtained (2019). Regardless of the types of problems, based solely on their numbers, the density map of the urban problems and crimes were prepared using the Kernel density algorithm, with the search radius of 500 m, pixel size of 50 m, and the planar method. This method and its parameters were selected on the basis of several trial and error rounds to produce the best map.

Figure 13: (a) Crime density in fuzzy membership dataset (b) urban problems density map in fuzzy set (c) fuzzy overlay of general condition map, urban and crime map (d) Matching urban problems and general conditions with 65% confidence and 10% tolerance



Then all three maps, general condition, crime density (figure 13-a) and urban problem density map (figure 13-b) were transformed to fuzzy membership map using the MSSmall method. In order to detect their conformity, fuzzy overlay analysis was performed on each pair (figure 13-c). The matching rate for the pairs of urban problems and the general condition was 72%, urban problems and crimes 71% and all 61% (figure 13-d). This indicates that, despite the limitations on the number of samples and the type of population, the information obtained from the crowdsourcing service can approximate the problems of the community in different categories.

Conclusion

In this paper, the spatial crowdsourcing service was introduced to solve community problems with the aid of other community members. This service is used in the context of spatial information systems and has the functionality that is different from other similar mechanisms. Table 3 shows a comparison between the GI system that offer crowdsourcing services with other similar systems.

Table 3: Comparison between a GIS system that offers crowdsourcing services with other similar systems

	Support many users	Multi-purpose	Multi-purpose services and tools	Relying on the basics of mathematical theory	Optimizing human resource indexes	Low cost system setup and development	Ease of system development	Support spatial analysis	Location Based	Use of Structured Data	Distributed Processing	Considering the importance of data producer
VGI usual sys.	*						*	*	*			*
Crowdsourcing	*				*						*	
Disaster management		*			*		*					
Proposed sys.	*	*	*	*	*	*	*	*	*	*	*	*

In addition to this service, concepts and auxiliary tools have been introduced that can be used to take a different view of geographic and spatial data.

Regarding the proposed tools, according to the tests, the generated dependency graph was very similar to the traffic flow on the main streets. Designed tools and the crowdsourcing services to monitor the general status of the community were also tested using data from other sources such as the municipality and the police datasets. Results indicate that, despite the limitations on the number of samples and the type of population, the information obtained from the crowdsourcing service and monitoring tools can approximate the problems of the community in different categories.

However we can conclude that: First, the proposed service uses spatial data to solve community problems. In this way, serving the community, it promotes the position of spatial information systems to governments.

Second, the presented concepts and methods, would be suitable tools for continuous monitoring of the status of society in various specialized classes such as welfare, treatment, culture, security, religion, and so on. In this way, statesmen can monitor the momentum status of the society and quickly detect any deviance from the equilibrium state by continuously controlling with the help of a tangible visual instruments.

Thirdly, we can create a new perspective on the geographic phenomena based on the positive or negative effects of the community. These virtual geographic features, which have spatial operations, can cause a balance or imbalance of society in each of its aspects. Also, more abstract concepts can be created. For example, community assistance graph networks can be considered as new infrastructures such as transportation network.

When such virtual points are created, other users, like a real geographic feature, can click on it and retrieve its information. For example, they can see the history of the formation and emergence of the point, the description of the requests, or the intellectual and practical contributions sent or received and the results of it. View the degree of effectiveness or impact of that particular point and judge its connections with other points.

Fourthly, the models introduced in the implementation of assistance graph networks consider the location more effectively and provide more accurate analyses on this basis. This issue generates better social cartography maps for managers and statesmen.

Of course, aside from the crowdsourcing services that have successful experiences with its implementation in specific fields, other issues need more development and calibration to adapt to the complexities of society. This issue is under consideration with the provision of pre-prototype software. Also, after introducing new perspectives on geographical complications, we also need to provide appropriate cartographic models.

References

1. Abdelmoty, A. I. & Alrayes, F., 2017. Towards Understanding Location Privacy Awareness on Geo-Social Networks. *ISPRS Int. J. Geo-Inf.,* 6(4).
2. Adams Benjamin, McKenzie Grant , 2018. Crowdsourcing the character of a place: Character-level convolutional networks for multilingual geographic text classification. *Transactions in GIS,* 22(2), pp. 394-408.
3. Afuah A., Tucci C. L. , 2012. Crowdsourcing as a Solution to Distant Search. *Academy of Management Review,* 37(3), pp. 355-375.
4. Anon., 2019. Constructing Geographic Dictionary from Streaming Geotagged Tweets. *ISPRS International Journal of Geo-Information,* 8(5).
5. Anta, A. F., Georgiou, C., Mosteiro, M. A. & Pareja, D., 2015. Algorithmic Mechanisms for Reliable Crowdsourcing Computation under Collusion. *Plos One.*
6. Bao, J., Zheng, Y. & Mokbel, M. F., November 2012. Location-based and Preference-Aware Recommendation Using Sparse Geo-Social Networking Data,. *ACM SIGSPATIAL GIS 2012, ACM,.*
7. Brovelli, M. A., Minghini, M. & Zamboni, G., 2016. Public participation in GIS via mobile applications. . *ISPRS Journal of Photogrammetry and Remote Sensing,* Volume 114, pp. 306-315.
8. Daniel, F. et al., 2018. Quality Control in Crowdsourcing: A Survey of Quality Attributes, Assessment Techniques and Assurance Actions. *ACM Computing Surveys,* 51(1).
9. de Vreede T., Nguyen C., de Vreede G. J., Boughzala I., Reiter-Palmon, R., 2013. A Theoretical Model of User Engagement in Crowdsourcing. *Collaboration and Technology,* pp. 94-109.
10. Estellés-Arolas, Enrique; González-Ladrón-de-Guevara, Fernando , 2012. Towards an Integrated Crowdsourcing Definition. *Journal of Information Science,* 38(2), pp. 189-200.
11. Gan, M. & Gao, L., 2019. Discovering Memory-Based Preferences for POI Recommendation in Location-Based Social Networks. *ISPRS International Journal of Geo-Information,* 8(6).
12. Ghose, R., 2001. Use of Information Technology for Community Empowerment: Transforming Geographic Information Systems into Community Information Systems. *Transactions in GIS,* 5(2), pp. 141-163.
13. Goodchild, M. F. & Glennon, J. A., 2010. Crowdsourcing geographic information for disaster response. *International Journal of Digital Earth,* p. 231–241.
14. Haklay, M. et al., 2014. *Crowdsourced geographic information use in government,* s.l.: World Bank Publications.
15. Harvey Francis, 2012. *To Volunteer or to Contribute Locational Information? Towards Truth in Labeling for Crowdsourced Geographic Information.* s.l.:Springer.
16. Higgins Christopher, I. et al., 2016. Citizen OBservatory WEB (COBWEB): A generic infrastructure platform to facilitate the collection of citizen science data for environmental monitoring. *International Journal of Spatial Data Infrastructures Research,* pp. 78-87.
17. Howe J. , 2006. *The Rise of Crowdsourcing,* s.l.: Wired.
18. Johnson Brian A., Scheyvens Henry, Khalily M.A.Baqui, Onishi Akio, 2019. Investigating the relationships between climate hazards and spatial accessibility to microfinance using geographically-weighted regression. *International Journal of Disaster Risk Reduction,* Volume 33, pp. 122-130.
19. Li, N. & Chen, G., 2009. *Analysis of a Location-Based Social Network.* Vancouver, BC, Canada, s.n.
20. Lin, W., 2008. GIS Development in China's Urban Governance: A Case Study of Shenzhen. *Transactions in GIS,* 12(4), pp. 493-514.
21. Matthias H., Tobias H.; Phuoc T. , 2011. *Anatomy of a Crowdsourcing Platform - Using the Example of Microworkers.com.* s.l., s.n.
22. Mohanty Ashutosh, Hussain Mujahid, Mishra M., Kattel D.B., Pale Indra, 2019. Exploring community resilience and early warning solution for flash floods, debris flow and landslides in conflict prone villages of Badakhshan, Afghanistan. *nternational Journal of Disaster Risk Reduction,* Volume 33, pp. 5-15.
23. Ostermann Frank O., Granell Carlos, 2016. Advancing Science with VGI: Reproducibility and Replicability of Recent Studies using VGI. *Transactions in GIS,* 21(2), pp. 224-237.

24. Staab, E. & Engel, T., 2009. *Collusion Detection for Grid Computing.* s.l., s.n., p. 412–419.
25. Stefanidis Anthony, Crooks Andrew, Radzikowski Jacek , 2013. Harvesting ambient geospatial information from social media feeds. *GeoJournal,* 78(2).
26. Sui Daniel, 2019. Critical GIS and the post-truth society. *Transactions in GIS,* 23(1), pp. 173-175.
27. Vieweg, S., Hughes, A., Starbird, K. & Palen, L., 2010. *Microblogging during two natural hazards events: what twitter may contribute to situational awareness.* Atlanta, s.n., p. 1079–1088.
28. Wei, L.-Y., Zheng, Y. & Peng, W.-C., 2012. Constructing Popular Routes from Uncertain Trajectories,. *in KDD 2012, ACM.*
29. William S., 2013. *On Language,* s.l.: New York Times Magazine.
30. Wolensky, P. & Wolensky, K., 1990. LOCAL GOVERNMENT'S PROBLEM WITH DISASTER MANAGEMENT: A LITERATURE REVIEW AND STRUCTURAL ANALYSIS. *RPR,* 9(4).
31. Zhang, H., Horvitzy, E., Millerz, R. C. & Parkes, D. C., 2011. *Crowdsourcing General Computation.* Vancouver, BC, Canada., s.n.
32. Zhao Yongjian, Han Qi , 2016. *Spatial Crowdsourcing: Current State and Future Directions.* s.l., IEEE Communications Magazine · July 2016.