URBAN ACUPUNCTURE 2.0: URBAN MANAGEMENT TOOL INSPIRED BY SOCIAL MEDIA

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ABSTRACT

This paper presents an argued vision on urban acupuncture as a research-based tool to manage urban territories by taking local actions in specific points. We argue that if based on analysis of social media data, urban acupuncture becomes an informative source for e-government and allows to design targeted urban planning decisions minimizing resources and increasing civil participation. While traditional urban acupuncture method relied on expert interviews with architects and urban planners, which is quite biased 'subjective' data source, urban acupuncture based on geo-located data from social media produced by users themselves allows to account for actual social behaviours. Urban acupuncture 2.0., as we name it here, provides insights into citizens' activities and attitudes towards certain city locations and serves as a solid grounding for taking decisions concerning specific territories. Social media data covers the whole city and involves a bigger variety of social groups; due to these specifics of data urban acupuncture 2.0. becomes more informative and representative for taking decisions. In this paper we show urban acupuncture 2.0. approach on the case-study of Samara-city, Russia, and development of its public spaces. Data used is from Vkontakte, Twitter and Instagram social media. We apply series of data mining tools, in particular, PCA and LDA methods, to user-generated texts. Results show popularity of public spaces by time and location, dominant type of activity and dominant type of users. Results also reveal mismatches between functionality of a public space and a type of activity there. Based on these findings recommendations are generated on how to develop Samara public spaces in line with acupuncture approach: targeted interventions deriving from existing citizens' subjective attitudes and habits towards these places are proposed.

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CCSConcepts

• **Human-centered computing~Ubiquitous and mobile computing design and evaluation methods** • *Human-centered computing~Empirical studies in collaborative and social computing* • *Applied computing~Sociology*

Keywords

E-Government; Participatory Design; Data Mining; Social Media**;** Urban Acupuncture.

1.INTRODUCTION

Complication of the city system brings necessity to find new tools to analyze the complexity of urban life processes and ways to manage them. One of the tools which allows to unite research and decision-taking is urban acupuncture. This tool evaluated from the ideology of sustainable development and sustainable cities. Sustainable development promotes ecosystemic thinking accounting for different systems of life, which influence each other [1]. Urban acupuncture accounts for urban life processes invisible at first glance: where and how people choose to walk in the city, what they like and what they avoid in the city. This tool is not as exhaustive as the concept of Smart City though they are related. The first one should be regarded as a method to change the city; the last one elaborates a new complex vision of an ideal city.

"Urban acupuncture" term was coined by Manuel de Sola Morales, architect and urbanist from Barcelona, and has spread worldwide. Taking from principles of traditional Chinese acupuncture, urban acupuncture suggests that transformation of city environment as a whole can be guided by local actions taken in specific points of need or possessing unique spatial resources [2]. De Sola Morales considered the city as one living organism where change in one part initiates change in another [4] [5] [6]. Creation of new public spaces, refurbishing quartiers and developing new spots of activity leads to social and economic effects: reduction of deprivation, growth of consumption, developmental profit, criminality decrease and others. Another researcher of urban acupuncture Marco Casagrande treats city as a live organism and speaks of the third generation city [7]. In his opinion, abandoned and empty spaces are the points where acupuncture methods work effectively. One of the brightest examples of planned urban acupuncture is Copenhagen harbor: once a neglected industrial city territory was transformed into a successful public space after water was cleaned, ferry terminal and industry relocated and a number of interventions undertaken, such as organizing a Bath at Brygge Islands [19]. Jaime Lerner, Curitiba former mayor, has implemented acupuncture approach during his rule targeting specific points of the city and initiating positive ripple effects, for example, an old

landfill was transformed into an Open University, a school that provides education in service sector and ecology to citizens and policymakers at little-to-no cost [8].

Starting point in the history of urban acupuncture approach was 1992 Olympics in Barcelona. This case shows the initial model of urban acupuncture. Firstly, the main target group was defined by urban planners - these were tourists, as far as Barcelona government aimed to redevelop and rebrand the city as a touristic centre. Secondly, main 'pressure points' were defined: major transport hubs and cultural heritage sites, as well as routes connecting the former with the latter. These were designed along with infrastructure necessary for tourists' comfortable movement and consumption - information offices, shops, cafés, etc. Thirdly, 150 spots for local interventions were allocated and streets were beautified; above mentioned infrastructure was created there. Touristic infrastructure improvement was implemented via small means and in a relatively short period of time - from 1980 until 1987 [9]. Between 1986 and 1992, Barcelona's unemployment rate fell down from 18.4% to 9.6%, by 2000 number of foreign visitors doubled (and made up 3.5 million visitors per year) [21].

Simultaneously Barcelona has launched complex transformations in several industrial and dwelling areas in the outskirts of the city, which did not meet the requirements of density, insolation, hygiene and safety. In 1987 project for "new central areas", designed by Juan Busquets, was approved. It was an instrument to bring together a number of major urban development projects. In "new central areas" 12 most important districts, different by function, space and scale, including four Olympic areas, were arranged. Emphasis was made on reorganization of squares and pedestrian streets, which were acknowledged as the most important elements of the city. Every next stage was based on the previous one and addressed more ambitious targets, creating transformation of the whole urban system starting from local points. New spots of activity triggered positive transformation of the whole urban environment [10]. Eventually, urban effects of the Olympic project lasted long after the end of the game. Construction of substantial cultural infrastructures (Catalonian Museum of Art, Auditorium, National Theatre, Contemporary Art Museum, etc.) and restructuring of the historic commercial port resulted in Barcelona's transformation into a first-rank tourist destination [11].

2. URBAN ACUPUNCTURE APPROACH AND SOCIAL MEDIA USE

Barcelona acupuncture transformation was designed by an expert group and was based on previous experiences of urban planning. While we do not question high professionalism of the experts, their decisions were taken from their own standpoint and were therefore subjective. We name such design of the tool as urban acupuncture 1.0. In this early version urban acupuncture presupposed creation of a group of experts embedded in a certain urban context, possessing competences in urban planning, architecture, economic, cultural and social planning, and other ones. This version is very capacious and hindered by the lack of required staff training.

In view of these weak points we elaborate the new version of urban acupuncture tool based on analysis of social media data. We call this version urban acupuncture 2.0. The design of this version is inspired by recent boom of social media use within citizens. Fast growing volumes of social media data generated by different social groups during their daily life in the city gives rich data appropriate for urban analysis and urban acupuncture: information on spatially distributed social behaviours and attitudes towards space. Widely spread kind of data provided by users are geo-located posts created in Twitter, Instagram, facebook, etc, while being in, using and perceiving a certain space in the city. Such posts about urban spaces contain various layers of data: (a) type of activity undertaken in the place, such as celebrating, listening to music, drinking coffee, working on a laptop or meeting friends; (b) user's' attitude towards the place, expressed in likes and dislikes, emoticons, colours of photos, and emotionally loaded comments; (c) meanings ascribed to the place expressed textually through comments as well as nonverbally through symbols. Thousands of posts created in the city each day is an unending and massive source of data on the condition of the local urban spots. Moreover, a set of data collected on city-scale on longitudinal basis can give a picture of the city provided not by a handful of experts but by millions of people, which can be divided into social groups with specific needs. Such a dataset gives a grounding for objectifying urban planning process and enhancing urban acupuncture method by designing interventions for city locations with specific profile of use or profile of problems. This approach also minimizes expenditures for urban planning process, for example, for extensive sociological research of specific locations**.** Nowadays we have a unique possibility to build models of urban use with spontaneous data, which is part of 'big data' universe [12]. Big data is understood as a series of approaches, instruments and methods of processing structured and unstructured volumetric and variable data, generated in virtual space and maintained by computer networks [13] [14]. Every act taken in Internet leaves a digital footprint - a bit of voluntarily disseminated information, for instance, photos in social networks, statements on forums, likes, etc. Digital footprints are also created as a side effect of actions taken in virtual space, for example, information about the visited sites or committed purchases. A set of such information allows researchers to form profiles of needs and preferences of different social groups that are invaluable for socially responsible decision making. One has to account for ethical use of social media data, which we will not consider here in detail.

Advantages of spontaneous social media data for urban planning can be summarized in the following list [15]:

1. Coverage. Data is generated by more and more users due to spread of personal computers and smartphones lately, hence more and more people are represented in the data set.
2. Availability. Social media data is stored on servers and in online archives and is more available for public use unlike GPS data on mobile service or CDR data on transportation owned by government or private companies.
3. Details. User-generated data provides detailed account on urban behaviours on individual level, for example, it allows to track routes of individual mobility in the city, peculiarities of individual attitudes and preferences towards city space as well as social and demographic details of a certain user.
4. Richness. Social media provides extensive information on different aspects of urban behaviours: mobility, space use (types of activity in the space), attitudes towards space. The range of spaces is not limited and covers formal and informal environments, spaces for work and leisure, third spaces and transit spaces, etc.

There are already several examples of using urban acupuncture 2.0. for decision making but they are still scarce. Houghton reports on central Brisbane where urban acupuncture tool was used to create a festival in underused urban spaces. Urban acupuncture was considered by Brisbane authorities as a new planning approach for hyperlocal placemaking that broadened communication and strategically targeted interventions in the city [16]. In Rome and Turin several public art interventions were designed to activate city sites, all of them were based on social media data. In Turin public art installation 'Emotional Landmark' was created: the statue displays the level of love expressed to the city by users of Twitter, Instagram, Foursquare, Facebook, LinkedIn in their posts about Turin and its places. In Rome a digital artwork shows ongoing expressions of citizens about culture - music, theatre, cinema, arts and others - captured from social media [17].

Social media based acupuncture approach has not been used in Russian urban planning and e-governance to our knowledge. However such approach is relevant for urban planning while it allows territory monitoring and analysis in conditions when other sources of data are unavailable or unreliable (for instance, Russian national census does not provide a detailed account on urban life in different cities). In the framework of e-governance urban acupuncture approach allows to optimize governmental decisions based on informational technologies and to include knowledge about people's needs expressed in social media into planning targeted interventions. Urban acupuncture 2.0. helps municipality officers together with urban planners and analysts of urban data (researchers) to take research-based decisions with minimal budget in logic of sustainable urban development. In this frameworks citizens are immediate source of data about their needs and preferences. Bringing urban acupuncture 2.0. further, citizens can become active contributors into information on specific city problems if they voluntarily provide reports through specifically designed online platforms. This extension depends on the level of activity and infrastructure possibilities for e-participation in a given context. If active e-participation is low, analysis of spontaneous data from social media becomes the only source to track public interests and actual behaviours on large scale.

To show advantages of urban acupuncture 2.0. we consider here the case of public spaces redesign in the city of Samara, largest city at Volga river with population 1,170,910 people [20]. The football World Cup, which will be held here in 2018, has created the need for city authorities to improve public infrastructure for tourists as well as city dwellers. City government has defined 11 historic spots (Fig. 1**)** in historical city centre that should become cultural attractions for tourists: 1. Gagarin Park, 2. Country park, 3.Embankment (part 1), 4. Square of Flame, 5.Embankment (part 2), 6. Strukovsky park, 7.Kuibyshev Square, 8. Leningradskaya street, 9. Hlebnaya square, 10. Revolution square, 11. Komsomolskaya square

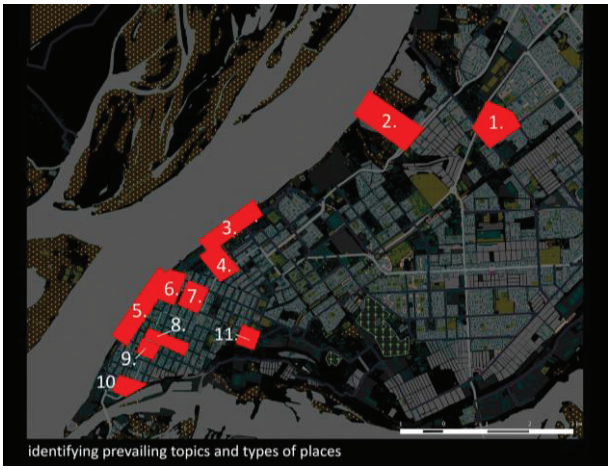

Figure 1. 11 historic spots defined for urban planning.

3. METHODS AND DATA FOR URBAN ACUPUNCTURE 2.0: THE STUDY OF SAMARA

3.1. Data Collection: Popular Social Media

A pre-project research has been designed to define situation in these 11 plots (Annex 1) as well as to define other significant open public spaces. Social media data was used to define popularity of public spaces and types of activities in public spaces. The methodology of the study was based on synthesis of spontaneous data analysis and qualitative data analysis.

According to the PRT agency study [22] almost all respondents in Russia have an account in VKontakte social network - local social network widespread in Russia and Russian-speaking countries similar to facebook: Saint-Petersburg – 95%, Moscow – 85%, Novosibirsk – 89%, Yekaterinburg – 85%, Nizhny Novgorod – 89%, Kazan – 97%, Samara 92%. The next most popular social network in Samara is Odnoklassniki (61%) [23]. This social network is popular mostly among 31-40 years old. Twitter and Instagram are not so popular with only 28% citizens of Samara using them; however these sources allow to obtain different types of data. Users of mobile social networks such as Twitter and Instagram make posts while moving through the city. Mobile social networks allow to get a dynamic picture on user activity.

For this study we have chosen three data sources: VKontakte, Twitter, and Instagram: VKontakte provides the biggest sample of users, Twitter and Instagram provide 'dynamic' data.

To triangulate results received from the social media we used method of field observations. Field survey of all objects was carried out in daytime and evening hours on weekdays during December 2015.

Data from VKontakte, Twitter, and Instagram for Samara was collected via API requests. Actual amount of data is limited by the number of API-requests available for downloading on each social network server for a period of one week. Data contains geo-coordinates of the sender, message text, user's id, user's gender and place of residence, and information about type of place. Type of place is created either by social media moderator or by users themselves. Every place contains a name or a description, which correlates with its function. Nine types of places were received for Samara dataset: 1. tourist cluster (bars,

restaurants, hotels), 2. retail (shops, beauty salons, hairdressers and other services), 3. culture cluster (education, culture facilities), 4. parks and recreation places, 5. business centers and offices, 6. hospitals and medical facilities, 7. home, 8. industry, 9. sport cluster (fitness clubs, sports playgrounds, etc.). Eventually 5000 Twitter messages, 17748 check-ins without text messages and 14979 text messages in Vkontakte, and 20509 places and 66474 massages in Instagram made up the dataset.

3.2. Computer Analysis of Message Texts

Text mining methods were applied to explore types of places reported by users, emotional tonality of the texts about the places and topics (describing activities in the space) related to each type of place. Lemmatization procedure was applied to all textual data (every word is transformed into its initial form) with the help of mystem.exe software created by Yandex (Russia)[24].

All places from VKontakte were divided into nine categories classification. While places description make up unstructured data dictionary-based text mining approach was used. First of all, dictionary of places descriptions and nine categories were manually created. The dictionary was formed from 2228 random chosen places descriptions from 20509 general population variables. Confidence probability was 95 % and confidence interval +- 2 %. To form places classification RTextTools from R package was used containing 9 computer studying methods for text analysis: SVM (support vector machines), GLMNET (Generalized Linear Models), MAXENT (Maximum Entropy), SLDA (Supervised Latent Dirichlet Allocation), BAGGING (Bootstrap Aggregating), BOOSTING, RF (Random Forest), NNET (Neural Networks), TREE (Decision Tree). Afterwards SLDA, GLMNET and BAGGING were used to classify activities into nine categories. These methods were used because it predicted all categories despite of the the different numbers of dictionary variables. After the places classification Principal Component Analysis (PCA) to define topics associated with a certain type of place. The max number of thematic were limited to 5 for not overloading of understanding places thematics. PCA has strong predictive power for small text messages. Furthermore, for understanding the sentiment of texts were used SVM (support vector machines) method which based on 200000 positive and negative text messages dictionary. That method used in some search as the best with the «white noise» texts [19].

4. RESULTS

Below we present maps with data visualized according to 4 aspects: popularity of places within local citizens and tourists (unlocal actors), gender usage of places, emotional attitude towards place, and thematic (activity) associated with a place. Concentration of check-ins is showed through intensity of the colour - from pale to deep, meaning from less to more check-ins.

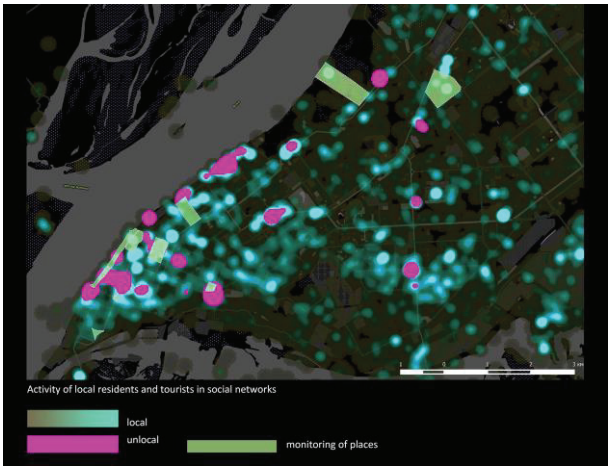

Figure 3. Activity areas concentration for tourists and citizens in Samara.

Social media analysis reveals the main area of activity across all the maps created - Samara historic centre and embankment. Activities of tourists as well as local citizens concentrate in the same areas, which overlap with 3-11 spots designated for redesign by city authorities, in particular, embankments (Fig. 3**)**. This is explained by the fact that embankments are full of parks, squares and pedestrian zones. Parks in Northern East of the city (the area containing spots 1 and 2) are not so popular. This inequality of usage informs the city authorities which places are in more need of managerial decisions.

Figure 4. Gender activity analysis.

As for gender dimension of public space usage results of social media analysis show that female activity is more widespread and more intense, at least, the way it appears in social media (Fig. 4). Male activity concentrates in historic centre and in industrial zones. In terms of data female/male distribution was quite even: 720,604 male and 772,224 female posts. Check-in behaviour is quite different: we have collected 7,036 male and 16,992 female check-ins. Women in Samara tend to represent their spatial behaviour in social media more than men. Both genders are active in the area next to the embankment. The most active place for females is Gagarin park. Field observation of this area showed that this is a place where young mothers take a walk with their children. Male activity concentrates at Komsomolskaya

square. Field observation shows that this place is a big transport hub (with Samara railroad station and other modes of transportation concentrated here.

To receive information about perception of the city areas we have conducted sentiment analysis and visualized distribution of posts with positive and negative tonality (Fig. 5). Negative check-ins are more 'dotted', while positive are wider and clustered. Areas with bigger social activity, in particular, Samara historic centre, are perceived more emotionally - both negatively and positively - than others. There are some unique cases, such as Samara railroad station, which is a concentration of negative tags. Field observation of this spot and qualitative analysis of the message texts inform about one of the reasons for negative emotions. These are local minibuses - main mean of transportation here: behaviour of minibuses drivers with background from ethnic minorities and regulation of minibuses movement are perceived negatively by citizens.

Figure 5. Allocation of messages with positive and negative tonality.

9 type of places:
1.Touristic places (bars, restaurants, hotels).
2. Retail (shops, beauty salons, other services).
3. Cultural places (education, cultural facilities).
4. Parks and recreation places.
5. Business centers and offices.
6. Hospitals and medical facilities.
7. Home.
8. Industry.
9. Sports (fitness clubs, sports playgrounds etc.)

Analyzing these types of places along with the topics or the description of activities reported for these places and defined via LDA analysis of posts, we have received the 'profile' of use of different types of places (see Annex 2 for details). Type of place 'house' appeared to be the most popular place for check-ins; possible interpretation could be that Samara residents prefer to spend their leisure time at home and they write about parties, family meetings and other events (Fig. 6**).** Analysis of social media also highlights unique usage of spaces. For example, we registered big activity at Komsomolskaya square. The square doesn't have any landmarks or points of attraction and is an empty lot, however, according to social network data, this space is heavily used: analysis by type of activity shows that this is a retail cluster. Field observations solve the mystery: there are a lot of services and shops located on the ground floors of adjacent buildings, and their visitors park on the square. After they return to their cars they check in the shops and services.

Quantitative analysis of social media data allows to define distribution of popularity, type of usage and emotional evaluation of public spaces. Qualitative tools, such as field observation and text analysis, implemented for selected cases with unique features (such as Samara railroad station), help to define reasons for inconsistencies.

We compared the results we have received on condition of Samara public spaces with value principles of quality public spaces presented in [23], which include: (a) access and linkages, (b) comfort and image, (c) uses and activities, (d) group and individual use, (e) age diversity, (f) gender diversity, (g) diversity of activities, (h) all-day usage, (i) efficient space management. As for Samara, user's activity is distributed unevenly: majority of activities is concentrated in historical centre along the embankments. The gender distribution in the city is also uneven: activities of female population is more widely spread than male one. The diversity of activities is concentrated in the historic downtown, while other areas are not so diverse. There is shortage of high-quality public spaces in the city periphery. These findings make arguments for city authorities and urban planners to consider the situation with public spaces in general, not focusing only on 11 spots.

Figure 6. Functional clusters formed from different types of places.

Urban acupuncture 2.0. based on social media analysis can stimulate development of the public spaces defined by Samara authorities and also take into account resources of other public spaces defined during research. Analyzing geolocated posts further, we have defined clusters of public spaces which have the highest activity of use and are most positively evaluated. These clusters were defined after linking different types of places by the proximity of their functional use (with the help of 'closest neighbor' algorithm) and further filtration (Fig. 6) (see also Annex 2) . We suggest uniting public spaces, which have high level of social activity and high positive rating among citizens and tourists, into one touristic route (Fig. 7). This decision follows urban acupuncture principles; it will increase connectivity of public spaces and it will unite cultural and historical landmarks placed there into one network, thus enforcing them through each other. Besides this solution will

create a popular pedestrian route, which will reorganize the flows of people in the city: tourists and citizens willing to travel around historic centre will have a possibility to move along the pedestrian road system instead of a system used by transportation, which will improve quality of their leisure. Another related and data-driven decision is to create a thematic index for exciting and comfortable travel routes. This thematic index might include information about visitor's geolocation, nearest points of interest and ways to get to them.

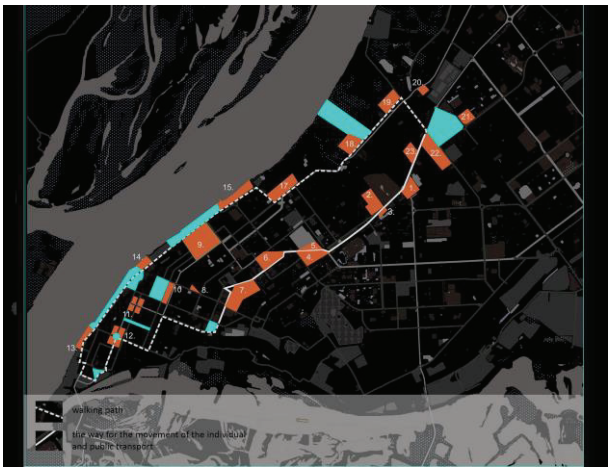

Figure 7. One network of attractive public spaces - one pedestrian route (see also Annex 4).

DISCUSSION

Social media based urban acupuncture method is capable to born novel decisions based on actual data on urban behaviours. It provides possibilities to adjust governmental decisions based on informational technologies and in more direct and fine-tuned connection with citizens' opinions. It also gives opportunity to decrease research and planning costs. However, there are certain limitations of social media data. We have to take into account 'subjectivity' in users' accounts of public spaces. From one hand, this subjectivity can be eliminated by the rule of 'big numbers', i.e. big datasets, and from another, such subjective variations are themselves significant and a more detailed account on unique cases with the help of qualitative methods (observations, interviews, textual analysis) can pour light into individual preferences. Another factor is specific rules of expression in social networks in comparison to real life: this discussion was significant in connection with Leo Manovich projects [26], when he found out that people are smiling much more in social networks than in real life. The behaviour display in virtual life might be other than the one in real life. Another limitation of social media data is underrepresentation of elderly users; their sample has to be 'mended' with traditional sociological methods. In view of these factors research underlying urban acupuncture approach has to be synthetic: analysis of social media data has to go hand in hand with other sociological methods: field observations, polls and interviews. Such a synthetic methodology allows municipalities and urban planners to develop a view on public spaces on a city-scale in less time and with less resources (which would be needed for natural observations or sociological polls). Besides, social media analysis can be fruitfully used for developing a targeted design project for the spaces in logic of urban acupuncture.

In the case of Samara, analysis of social media gave information on 11 spots chosen by city authorities to be touristic destinations as well as brought into light other public spaces with great potential for redevelopment, which are already actively used and positively evaluated by citizens. Based on these research results and urban acupuncture perspective we have came up with a suggestion for the city authorities to organize an integrative network of public spaces, which would reinforce selected areas through linking together their values and resources. Places of great historic importance and with heritage resources will be linked with the places popular for consumption and the network will be able to satisfy different needs and attract a massive human flow. Thus urban acupuncture tool allows city authorities, urban planners and urban analysts to think 'out of the box' and implement not mere renovation of existing areas but new concept of public spaces based on actual public needs and nearly with the same costs.

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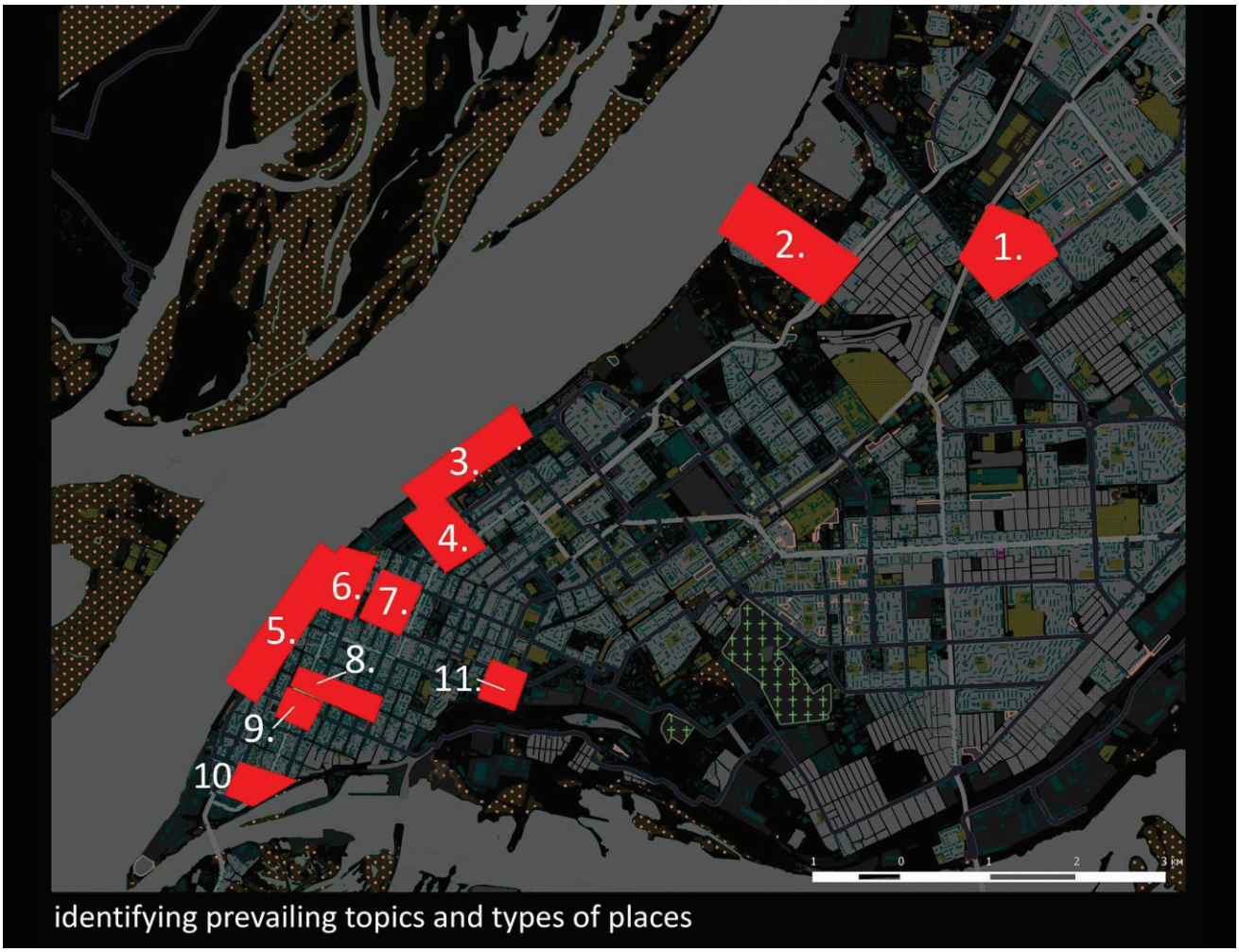
ANNEX

Annex 1. Map of 11 plots defined for redevelopment in Samara

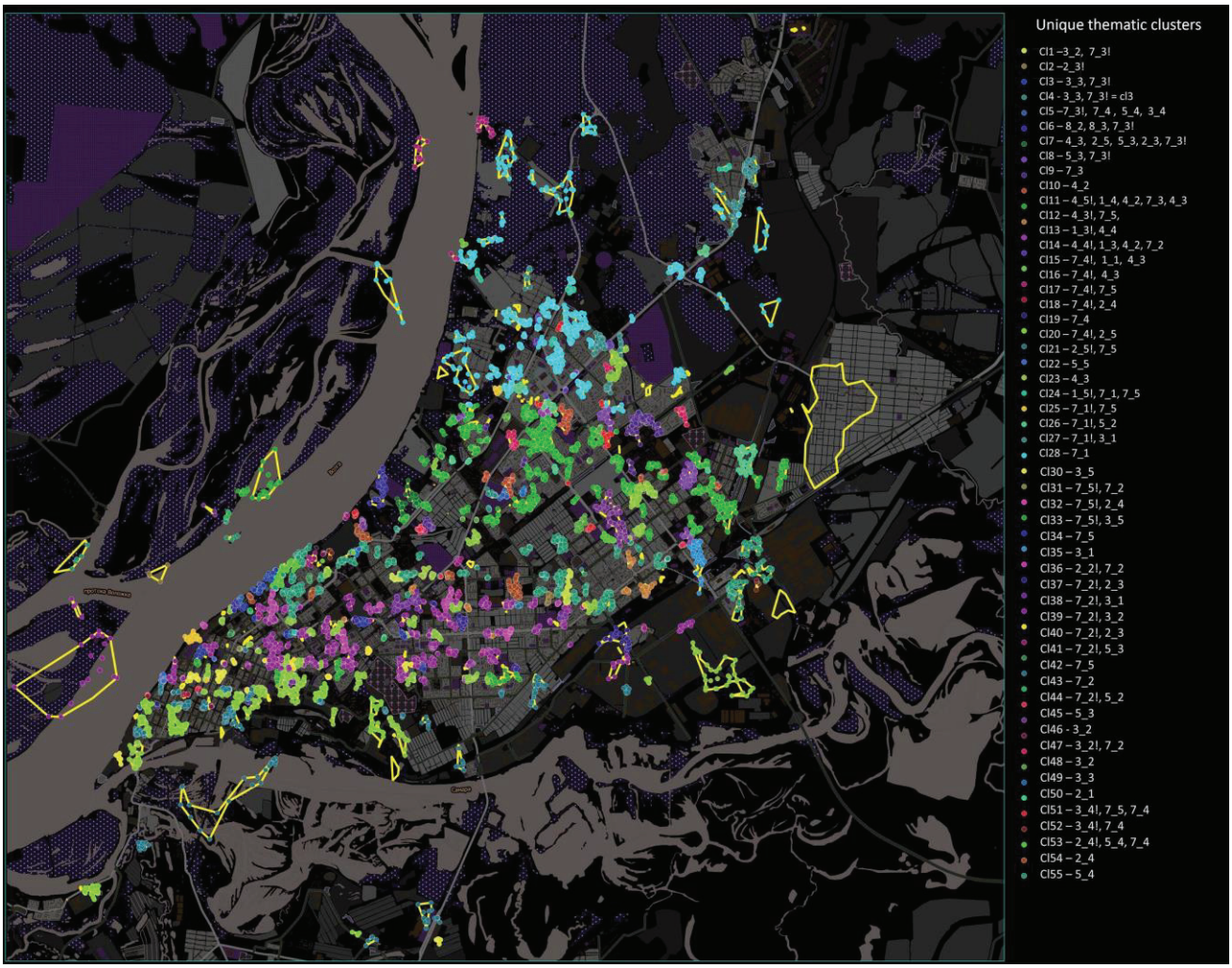


Annex 2. The main theme detection

1. Type: Parks and recreation places. Theme: playgrounds, new year, public event.
2. Type: Parks and recreation places. Theme: playgrounds, new year, public event, Summer walks with the child.
3. Type: Tourist.cluster (bars, restaurants, hotels) Theme: Restaurants and family dinner.
4. Type: Parks and recreation places. Theme: playgrounds, new year, public event, Summer walks with the child.
5. Type: Parks and recreation places. Theme: playgrounds, new year, public.
6. Type: Tourist cluster (bars, restaurants, hotels) Theme: Holiday / trip with family.
7. Type: Tourist cluster (bars, restaurants, hotels). Theme: theater. Type: Home. Themtic: home comfort, New Year holiday, wedding at home.
8. Type: retail, house. Theme: holiday, New Year eve, wedding, vacation, family trip.
9. Type: house, Tourist cluster (bars, restaurants, hotels). Theme: New Year holiday, wedding at home , Holiday / trip with family.
10. Type: retail, house. Theme: theater, home comfort, New Year holiday, wedding at home.
11. Type: dwelling, education, culture. Theme: NA.
12. Type: retail, business, office. Theme: NA.

Annex 2. The results clustering locations

Each cluster includes a unique set of topics. 55 clusters contain different configurations of thematics.



Annex 3. Comparison of types of places and thematic clusters