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Finding Appropriate Site for Public Art Center and Eco-Effective Design Potential Analysis among Abandoned Buildings in Khabarovsk City Applying GIS Methodology

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Abstract

Using GIS principles this study attempts to review abandoned buildings situated in Khabarovsk city, analyze them and their surroundings in terms of present condition, accessibility and other criteria to select appropriate site for creating Public Art Center where citizens could develop their art skills and share them with others. Also in this study was collected simple geographical data that could be helpful in analyses of renewable resources potential as in different parts of Khabarovsk and in the whole city. During the study process were reviewed worldwide examples of abandoned buildings regeneration, methods of energy consumption reduction in newly built facilities, principles and objectives in creating public places and methods of analyzing data in GIS program. Also on the base of different kinds of city maps such as land use map, road map and geographical map were prepared attribute tables with various criteria and their characterizations, which are important for studied city spaces analyses. As a result was proposed model that could be created in GIS and was shown the whole process of specific site selection with implementation of various program tools. Furthermore was made model map that shows graphically all project steps and provides easier understanding of whole analyses process.

Keywords*: public art center, abandoned buildings, redevelopment, eco-efficiency, GIS*

1. Introduction

1.1. Background

High developing modern cities and fast changing economic situation rises the number of abandoned buildings and territories. Most of them are factories that lost their city-forming role and could not adapt to new technological processes, some are residential and administrative facilities which construction was stopped due to the economic crisis and remained unfinished. All these buildings contribute neighborhood decline and do not meet modern ecological, economic and esthetic requirements anymore.

On the other hand, while being a dangerous, vandalism and crime zones, abandoned buildings become a place of attraction for many citizens. They create a communities in social networks and not only share information such as pictures, addresses, plans and original views, but make meetings to clean abandoned territory from garbage and construction waste. One of the brightest examples is the website “impossibleliving.com” made by Italian volunteers, where residents could take an active part in city development, map abandoned buildings in their neighborhood and suggest the ideas on their reactivation [1]. Thus, one of the important issues is to demonstrate all the advantages of redevelopment over demolition and new construction to transform virtual projects into real ones.

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1.2. Study Method and Objectives

This study attempts to analyze abandoned territories of Khabarovsk city and detect the most appropriate places for further architectural design. Physical data is represented by the climate and land-use characteristics of the city, location, condition and accessibility of abandoned facilities and criteria used for their defining. Theoretical research includes evaluations of chosen criteria, model and map created on the principles of GIS work. All the data focused to find a facility most suitable for public building regeneration.

Based on the wind and solar radiation characteristics of Khabarovsk city and abandoned facilities location in the paper made basic analyses of eco-effective design technologies implementation potential.

Current project is preparation step based on which could be proposed architectural design idea for abandoned building adaptive reuse into Public Art Center.

2. Theoretical Research

2.1. Public Art Center

Modern art is different from the traditional one and require different creative approach in architectural and design solutions. Abandoned buildings are excellently suitable for these objectives as an objects even reconstruction process of which could be transformed into art. As an example could be taken factory in Saint Petersburg that is without expensive time-consuming reconstructions became a museum of street art (Figure 1). At the moment, abandoned buildings are used by young artist to demonstrate and develop their creativity that is accepted by society as an act of crime. However, in Vladivostok painted walls of unfinished abandoned hospital building attracted the attention of residents (Figure 2).

Purpose of this project is attempt to elevate this creativity from vandalism to higher standards level by creating the public vital space that citizens could use freely to share ideas, practice their art skills, teach and learn from others.

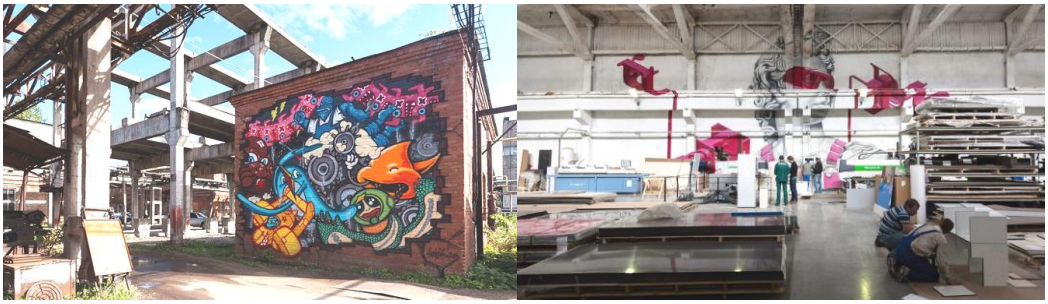

Figure 1. Factory Transformed into Museum of Street Art, Saint Petersburg, RF

Figure 2. Unfinished Hospital Building, Vladivostok, RF

2.2. Redevelopment and Adaptive Reuse

Redevelopment is the process of reconstruction and designated purpose transformation of facilities and territories for their most effective use. Namely, redevelopment involves the comprehensive solution of issues that require specialists capable to solve challenging problems at the interface of the different areas, such as coordination, construction, engineering, economic analysis, logistics and marketing [2].

The first major projects of adaptive reuse appeared in 1930s in United States of America, when large organizations acquired titles to smaller, detrimental and distressed ones and redeveloped them into more attractive from socioeconomic and environmental points of view objects [3]. Nowadays redevelopment grows in popularity. Former factories and military facilities, damaged historical buildings in different countries become residential complexes, offices, museums and art centers (Figure 3). One of the main reasons of this process is economic effectiveness and desire of residents save their city historical heritage. Even though reconstruction works are characterized by high labor intensity comparatively to the new construction (about 25 -30%), overall time required for redevelopment is 1,5 -2 times less than construction of projects started "with the clean slate" [4]. Furthermore, redevelopment of abandoned constructions is not isolated. It affects all surrounding area. The best example is the High Line project in New York City, which transform old railway into beautiful park creating the new center of attraction. Thanks to High Line park in that area appear many new high-grade architecture. Thus, from the 2009 there was started the new residential complex of Zaha Hadid and by the end of 2015 is planned to create Whitney Museum building by the Renzo Piano project (Figure 4) [5].

Figure 3. Redevelopment of Former Police Station into Apartment Building, Riga, Latvia

Figure 4. High Line Park, New York, USA

2.3. Eco-Effective Design

Energy efficiency is the complex way toward achieving sustainability in buildings. Orientation and shape of the building, implemented materials and smart systems, awareness of residents – all this significantly influence the amount of consumed energy. With the people's understanding how bad and harmful is the impact of traditional style of using energy started to develop new technologies that allow to transform renewable natural resources such as hydropower, solar, wind, tidal power, biomass and biofuels in real energy.

Whereas power of this resources is strongly connected with the climate zone. Environmental conditions could be beneficial to the renewable resources development, and on the other hand uncomfortable for living. That is why the main goals of eco-effective design are creating healthier and more comfortable life while contributing positively on the energy balance of building and providing positive impact on the environment.

2.4. GIS

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. GIS lets us visualize, question, analyze, and interpret data to understand relationships, patterns, and trends.

GIS is the go-to technology for making better decisions about location. Common examples include real estate site selection, route/corridor selection, evacuation planning, conservation, natural resource extraction, *etc.* Making correct decisions about location is critical to the success of an organization. GIS was widely used in the project "Imagine New York", dedicated to the World Trade Center tragedy. Using detailed data of the locations of fire and police stations which had lost significant number of their officers, impacted neighborhoods could be mapped, and outreach focus on them. The destruction of World Trade Center complex caused severe damage to many historic buildings several miles away. Using a database of building locations and GIS the Municipal Art Society mapped all the historic structures in lower Manhattan. Having all these structures identified on a map, with notations about their status and location, made preservation fund allocation and field inspections efficient and effective [6].

Due to absence of part of basic data in the current study used only methodology and principles of GIS work in solving certain problem.

3. Project Process

3.1. Data Gathering

First step of the project was collecting all the necessary for research data included physical information of abandoned buildings, such as location, nowadays condition, public and private transport accessibility. Than all the buildings were mapped and reviewed from city geographical and land use maps, which allowed revealing the correspondence between selected places and city urban space. Also for the research of eco-effectiveness were analyzed fundamental climate characteristics of the Khabarovsk city such as wind speed, frequency, prevailing direction and solar irradiation.

3.2. Site Selection Criteria

Second step was specification of criteria and their evaluation based on which could be made analysis and selected appropriate facility. For criteria was created an attribute tables

connected with the different types of city maps. As a final step, all the criteria evaluation results would be summarized and analyzed. On the base of result could be chosen two or more facilities further detailed study and development.

3.3. Attribute Tables Description

City map attribute table contains following fields and criteria: number of the building, name, location, present condition, convenience of private transport access, public transport and pedestrian accessibility, presence of educational facilities in the area, capability of construction equipment access, existence of newly constructed or in the process of construction facilities.

Present condition criterion define building's quality level. 'Good' and 'medium' means that facility is not fully destroyed almost remained in its original look and do not need any extra structural stability control. 'Bad' and 'critical' represent almost destroyed buildings that need special examination. For the project selection preferable are buildings marked with "good" and "medium" condition.

Convenience of private transport access (CPA) characterizes the quality of the road leading to chosen facility and evaluated from '0' to '5', where '0' means absence of road and '5' is existence of good covered road.

Public transport and pedestrian accessibility (PPA) criterion evaluate the pedestrian shed from the public transport stop to the chosen place. It is rated from '0' to '5', where '0' means walking distance over 2500 m and '5' less than 500 m. In both criteria preferable are evaluations '4' and '5'.

Primary audience that will use Public Art Center are children, teenagers and students. In the educational facilities criterion (EF) counted the amount of schools, universities/kindergartens in the radius of 1500 m from the studied building. Preferable is higher amount of schools and higher educational facilities in the area.

Construction equipment access capability (CE) measured by easy '+' and difficult '-' access of construction equipment on the building territory. Redevelopment process would need continuous building works. That is why in this field preferable is easy access.

Newly constructed facilities and the ones under construction might be sign of area vitality and continuous development. In the field NCF reviewed constructions in the radius of 2000 m and rated with existence '+' or absence '-'of this kind of buildings on the territory.

Land use map attribute table includes information about land use types in Khabarovsk city (name of land use and marker used on the map), location of studied abandoned buildings relatively to the land use and preferable zones for public facility construction. In this attribute would be excluded zones that are not appropriate for Public Art Center creation such as public health facilities zone, cemeteries zones and industrial zones.

Table 1. Abandoned Buildings List and City Map Attribute Table

№	Name	Location	Condition	CPA	PPA	EF	CE	NCF
1	179 Khabarovsk ship-repair facility	Portovaya St., 1	good	4	4	2/1	+	+
2	Shipbuilding facility in the name of Kirov	Kirova St., 1	bad	4	4	4/3	+	+
3	Infidel tower	Mostovaya St., 2b	medium	4	5	3/5	-	-
4	Bogdanov manor house	Sanatornaya St., 17a	critical	4	5	-/1	-	+
5	“Daldizel” Factory	Tikhookeanskaya St., 73	medium	4	5	3/5	+	+
6	Miling plant	Sovetskaya St., 3	critical	5	5	6/4	+	+
7	Training complex	Sovetskaya St., 1	good	5	5	6/4	+	+
8	Unfinished building	Dikipoltseva St., 32	medium	5	5	11/11	+	+
9	Gorky Khabarovsk Factory	Gagarina St., 22	critical	4	5	3/3	+	-
10	Oil and Fat Plant	Krasnorechenskaya St., 74	critical	4	5	6/7	+	+
11	Structural aluminum factory	Suvorova St., 82a	bad	5	5	-/-	+	-
12	Khabarovsk brick factory	Montazhnaya St.,36	good	4	5	5/6	+	-
13	Concrete products plant 154	Avtobusnaya St., 75	medium	4	5	1/1	+	-

Table 2. Land-Use Map Attribute Table

№	Marker	Land-use	Studied buildings	Pref.
1	C-10H	Public core of historical city center		+
2	C-1A	Business core of city center		+
3	C-1	Business, public and commercial activity zone	6, 7, 8	+
4	C-1H	Business, public and commercial activity zone on the territory of cultural heritage sites constrains		+
5	C-2	Service and commercial activity center regional zone		+
6	C-T	Business, production and commercial activity zone along transport hubs		+
7	RS-1	Low rise private houses residential zone	3	+
8	RS-2	Low rise mixed residential zone		+
9	RS-3	Mixed residential zone		+
10	RS-4	High rise residential zone		+
11	RS-5	High rise residential zone among business, public and commercial activity centers		+
12	RS-6	Communal gardens zone		+

13	S-1	Public health care facilities zone		-
14	S-2	Educational facilities zone		+
15	S-3	Sports and leisure facilities zone		+
16	S-4	Cemetery zone		-
17	T	Transport's land zone		-
18	K-1	Storage and wholesale business zones		-
19	K-2	Public utilities, transport, storage and products distribution zone	1,2, 13	-
20	I-1	I-II toxic matters class enterprises		-
21	I-2	III-IV toxic matters class enterprises	5, 9, 11, 12	-
22	I-3	V toxic matters class enterprises	10	-
23	P-1	Parks zone		+
24	P-2	Local health and recreational areas zone		-
25	P-3	Public recreational zone		+
26	P-4	Recreational landscape territories zone	4	+

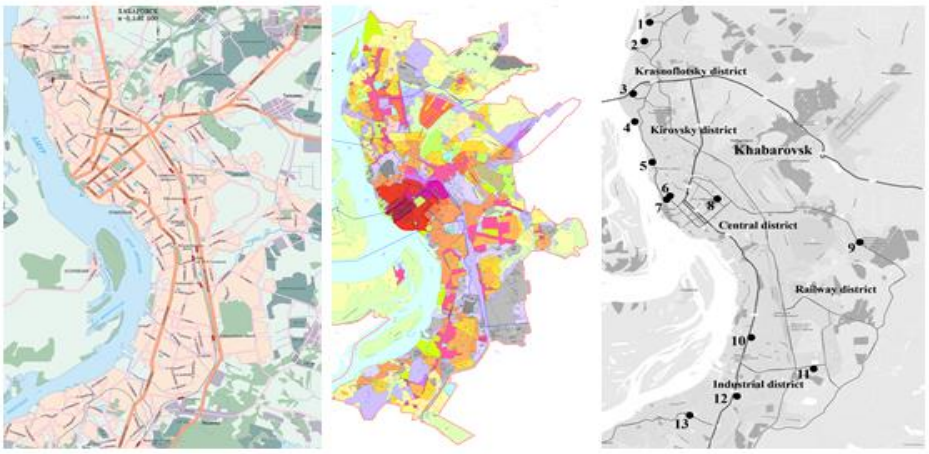

Figure 5. Khabarovsk City Map, Land-Use Map, Abandoned Buildings Location

3.4. Model Creation

After collecting all the necessary data and defining criteria and their evaluation was created the model that shows process of GIS work.

With the selection tool were chosen abandoned buildings in good and medium condition. Than public transport stops were buffered with the radius 1000 m and road accesses to facilities with the radius 500 m. Also using buffer tool were defined educational facilities in the radius of 1500 m. Next step was selection of buildings with capable access for construction equipment and on the borderline with newly constructed facilities. Buildings situated on the industrial, cemetery and health facilities zones were erased and remained abandoned buildings examined one more time.

Furthermore was created a sample map that graphically shows the analysis process.

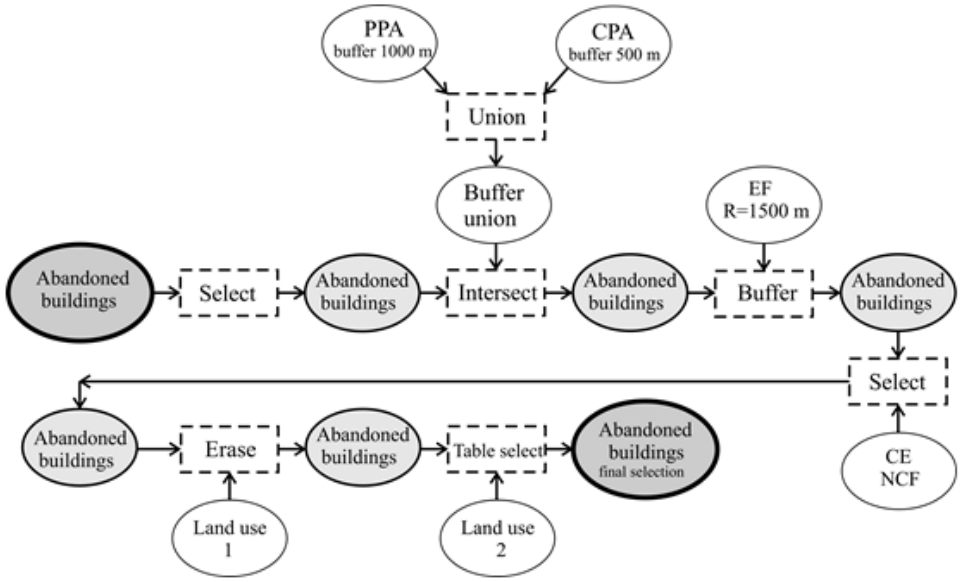

Figure 6. Model

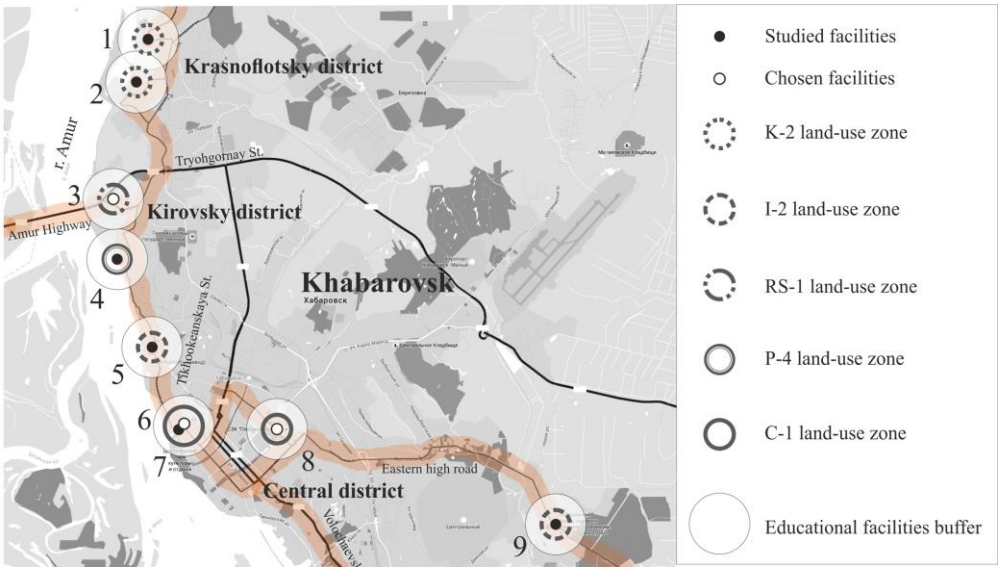

Figure 7. Model Map Fragment

3.5. Eco-Effective Design Potential

Also in the project was made attempt to analyze potential of renewable energy in Khabarovsk city on the basic level. Wind characteristics table represented by wind frequency, average speed and directions during the most cold and most warm months [7]. Prevailing wind direction in January South West, in July most intensive wind also come from North East direction. Calculation of wind generator power could be made by formula:

$$P=k \cdot R \cdot V^3 \cdot S/2 \quad (1)$$

Where k – coefficient of turbine efficiency (0,2-0,5), R- atmospheric density (in normal conditions 1,225 kg/m³), V- wind speed, S- wind stream area.

In a speed of 5 m/s and with 1 m diameter blades generator can develop only 30 W of power.

Solar energy represented by the direct and defuse irradiation values on horizontal and vertical surfaces during the 10 hours.

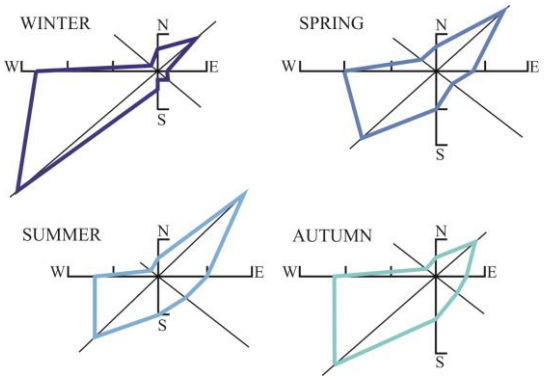

Figure 8. Khabarovsk City Wind Diagram

Table 3. Wind Characteristics of Khabarovsk City

Indicator	Indicator values by points							
	N	NE	E	SE	S	SW	W	NW
January								
Wind frequency, %	2	7	6	2	2	74	6	1
Wind speed, m/s	3,3	5,7	4,2	2,7	3,5	5,9	4,1	2,2
Maximum of average wind speed 5,9 m/s				Prevailing wind direction SW				
July								
Wind frequency, %	3	25	17	5	4	35	7	4
Wind speed, m/s	3,4	6	4,6	3,3	3,6	4,6	3,6	2,9
Maximum of average wind speed 4,6 m/s				Prevailing wind direction SW				

Table 4. Direct and Defuse Solar Irradiation on Horizontal and Vertical Surfaces of Different Orientation in July under the Clear Sky, W/m^2

Latitude 48 N	Time till noon										Sum for 24 hours	Average number for 24 hours
	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12		
Horizontal surface												
direct	-	-	16	91	209	356	495	593	685	733	6356	328
defuse	-	-	13	56	84	99	112	126	129	133	1504	
Vertical surface of South orientation												
direct	-	-	-	-	-	28	137	242	327	370	2208	149
defuse	-	-	7	36	73	99	110	116	118	120	1358	
Vertical surface of East and West orientations												
direct	-	-	90	371	536	590	565	454	279	105	2990	184
defuse	-	-	16	88	155	174	164	135	110	98	1433	

4. Results

During the study process were selected three abandoned territories, which respond to performed objectives. However for more impartial assessment should be done complex analysis of area potential factor, infrastructure, ecological situation and territory urban development plan. In addition, more detailed analysis needed for the industrial zones of the city. Most of them have lost their primary function but remained potential for adaptive reuse and revitalization.

Renewable energy analysis showed that in the city energy output is not enough to supply the whole building. However, there is possibility that could rise energy-efficient level of the building.

5. Conclusion

GIS played important role as necessary basic part of the project. With it help all the data performed in tables, schemes and separate images was connected graphically into effective information which allows to see the examined problems more clearly and better understand the relation between different city spaces, how they influence on surrounding areas and each other, how could be transformed and improved. GIS helped to make an informative effective decision with the minimum information used.

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