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1. INTRODUCTION

1.1 Background

GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data [1]. Practitioners also regard the total GIS as including the operating personnel and the data that go into the system. Spatial features are stored in a coordinate system (latitude/longitude, state plane, UTM, etc.), which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS can be used for scientific investigations, resource management, and development planning.

GIS differs from CAD and other graphical computer applications in that all spatial data is geographically referenced to a map projection in an earth coordinate system. For the most part, spatial data can be "re-projected" from one coordinate system into another, thus data from various sources can be brought together into a common database and integrated using GIS software. Boundaries of spatial features should "register" or align properly when re-projected into the same coordinate system. Another property of a GIS database is that it has "topology," which defines the spatial relationships between features. The fundamental components of spatial data in a GIS are points, lines (arcs), and polygons. When topological relationships exist, you can perform analyses, such as modeling the flow through connecting lines in a network, combining adjacent polygons that have similar characteristics, and overlaying geographic features.

Today, the increased rate of change within modern societies has created a need for faster and more efficient data collection and this has led to the development of new collection techniques. Photogrammetric plotting, for example, was developed within the arena of topographic mapping, but even this involved the presentation of different data types as a series of separate maps. Gradually the demand for computer storage of spatial information grew, along with the need for systems, which allowed the easy retrieval of such data for the production of thematic maps. This goal has only been possible as a result of the startling development of computer design during the 1960's and 1970's. These changes allowed the initial development of Geographical Information Systems (**GIS**).

1.2 GIS IN FLOOD MODELING

The number of damages caused by extreme flood events increased dramatically during the last years worldwide. Determination of flood risk areas is an essential for the flood protection measures. To facilitate detailed spatial analysis of hydraulic data "Spatial Data link and Analysis Module" was developed. The main functions of the module are,

- Transferring, embedding and spatially locating the output of hydraulic simulation in GIS.

- Generating the water surface.
- Deriving the water depths and relative ground elevations along the study area.

Furthermore, it is possible to carry out spatial analysis of the derived and thematic data. It is possible, for example, to define the amount of buildings vulnerable to flood in different degrees.

The main data requirements on the GIS side include Digital Elevation Model (DEM), the shapes of river cross sections, spatial thematic data, and the output of hydraulic model. The methodology was applied on rivers: Sulm (Germany), Necker (Germany), and Volga (Russia).

The same techniques were also used for the large scale inundation analysis in the Caspian region. The level of the Caspian Sea rose dramatically in the end of the last century. The study was carried out to make a rough assessment of potentially flooded areas and territories flooded over different periods in the past. The approach was based on the DEM bathymetric data and water levels for different periods. The DEM was generated on the base of Remote Sensing data and corrected using topographic maps [2].

In addition, the utilization of GIS tools has helped to simplify and automate various tasks involved in the production of Flood Insurance Rate Maps (FIRMs) for Federal Emergency Management Agency (FEMA0. The GIS tools have assisted in the evaluation of topographic information, gathering of model input parameters, and the determination of the flood hazard boundaries.

A flood hazard study in Pinellas County in Florida State, utilized aerial photographic imagery and one-foot contour data transects for wave height analysis. An ArcView tool comprised of Avenue scripts was developed to extract station and elevation information, along each transect, from the contour data. The aerial imagery and topographic contours within the GIS aided in interpolation between transect. In addition, a line digitizing and smoothing tool was utilized to assist in flood hazard boundary delineation [3].

2. PROBLEM STATEMENT

During the last decade a revolution has occurred in the property insurance industry as a result of the application of GIS technology to the estimation of the risks to insurance companies of catastrophic insured losses from major hazards. This development has its origin in work undertaken within the research department of the Travelers Insurance Company, and within a number of university civil engineering departments in Australia, in the 1970's, but only became taken seriously after its commercialization and success in predicting the losses from Hurricane Andrew in 1992. It had a relatively rapid take up in the United Sates, and its use underpinned the establishment of a new breed of property re-insurers in Bermuda in the mid 1990's. It has taken longer to become established in other parts of the world, but the majority of insurance companies in Australia now use the results of this type of analysis in purchasing re-insurance [4].

City Maplewood in United States that located near to a river that floods regularly. However massive floods were experienced in different years, different types of buildings were constructed near to the riverbanks. Buildings in the vicinity of the river are considered under risk as per the insurance companies' classifications. An insurance company needs to formalize insurance premium guidelines for buildings that fall within the flood zone in certain city.

In this project, it is required by the GIS specialist to identify buildings that located within the flood zone, in order to deal with them for insurance, accordingly.

3. OBJECTIVE

The objective of this project is to locate the river flood plain that intersects with the city boundaries and hence identifying buildings that exist within the flood plain.

4. TOOLS OF STUDY

Software is defined as the group of instructions, which enable the execution of a certain procedure, by a computer. A computer without software is a dead machine. Within this section we do not intend to discuss computer operating systems, this is of little value to the general reader, rather we will discuss characteristics, which are shared by most GIS software packages.

GIS usually has a series of software modules which can be broken down into the following groups:

- The data acquisition modules
- The data processing modules
- The analytical modules - the data presentation modules

ARC-GIS Software version 8.3 will be used all through this project. This product of **ESRI** is believed to be a powerful tool in order to perform the required analysis.

5. Data

A virtual data module is used for this project, which downloaded from the ESRI virtual campus web site (http://campus.esri.com/campus/courses/psearcgis/displaygis). Different layers were loaded in order to make a well constructed project. The theme of the project is extended in order to use and practice different GIS tools.

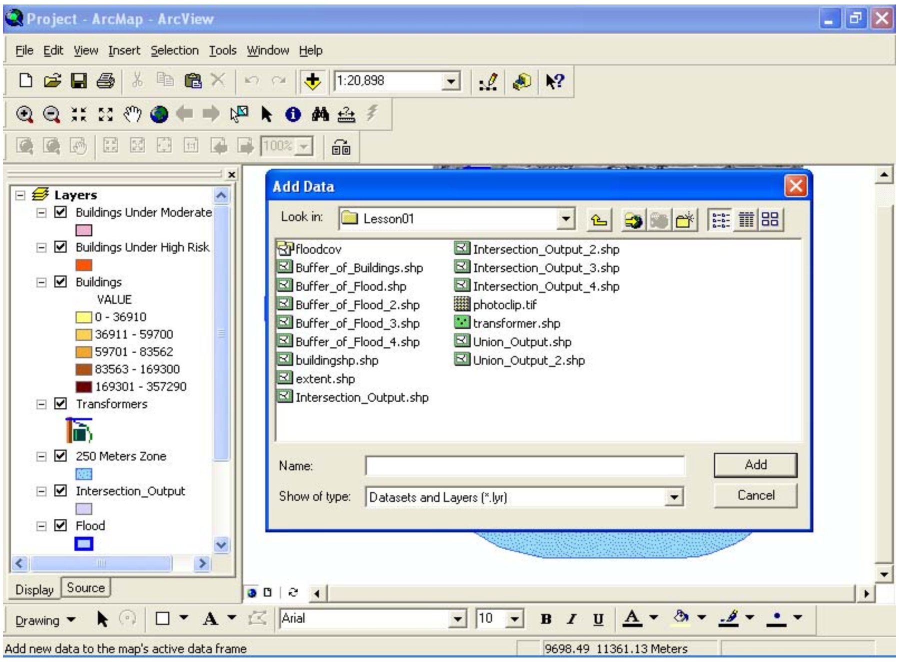
6. ANALYSIS PROCEDURE

6.1 Steps of Analysis

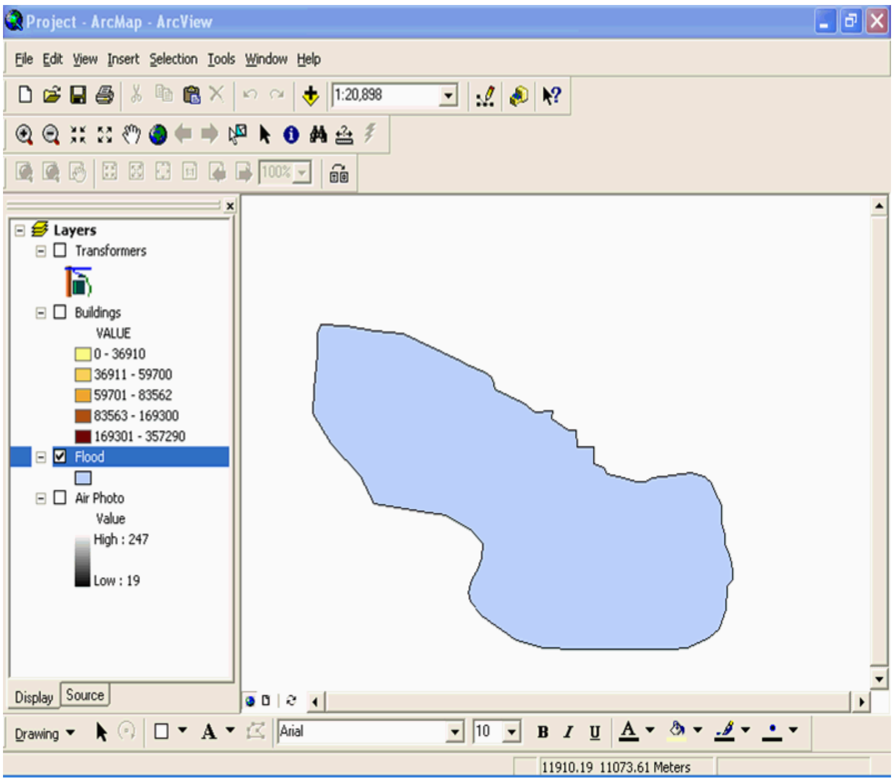
1. Loading Flood Plain, buildings', Aerial Photo and Transformers' layers from ESRI site using ArcCatalog [5].
2. Adding the flood plain layer.
3. Adding buildings' layer to the map.
4. Adding Aerial Photograph layer to the map.
5. Adding the Transformers' layer to the map.
6. The attribute table showing 146 buildings attributes, which is total number of buildings.
7. Classifying Buildings as per their monetary values, using "By Value" classification.
8. Viewing the classification result, with colors.
9. Classifying buildings using Natural Breaks Histograms, as another classification method.
10. Identifying 250 meters zone from flood plain.
11. Identifying buildings that exist within the flood plain, generally.
12. Identifying 38-buildings that exist within the flood plain (under high risk).
13. Attribute table of buildings that exist within the flood plain (under high risk).
14. Identifying 31-buildings that exist within the 250 meters zone (under moderate risk).
15. Attribute table for buildings that exist within the 250 meters zone (under moderate risk).

6.2 Detailed Steps [6]

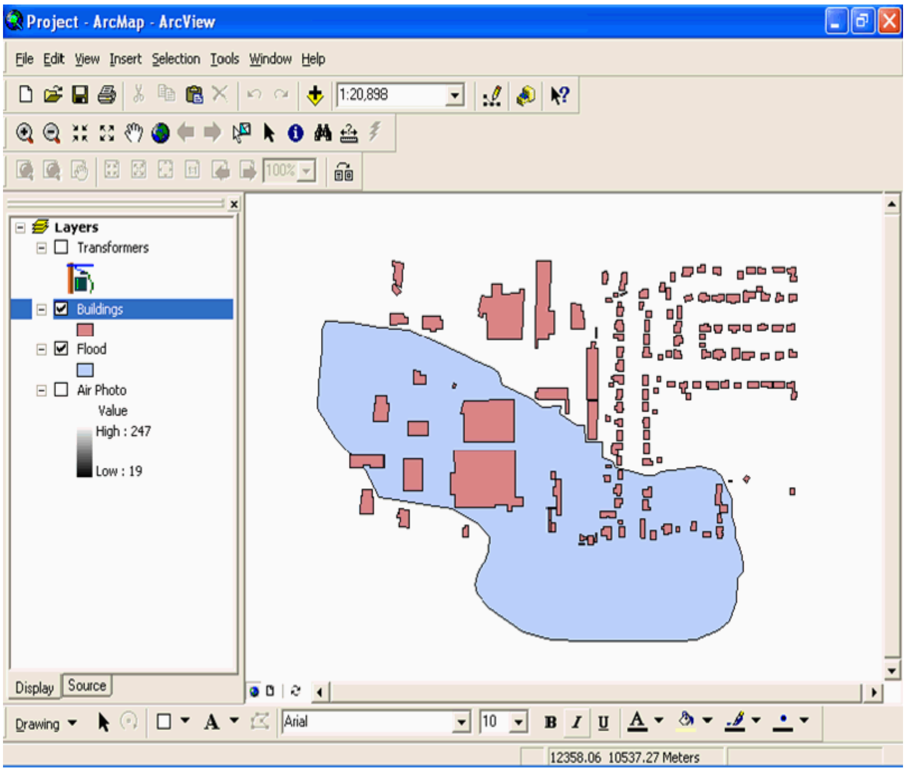
1. Loading Flood Plain, buildings', Aerial Photo and Transformers' layers using ArcCatalog,



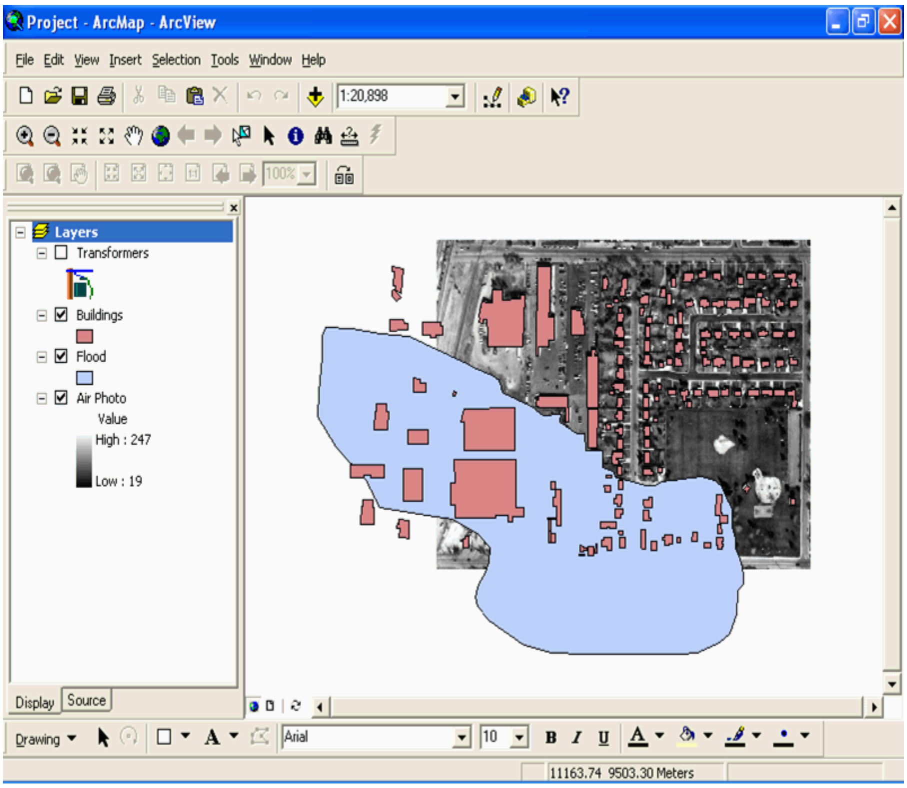
2. Adding the flood plain layer,



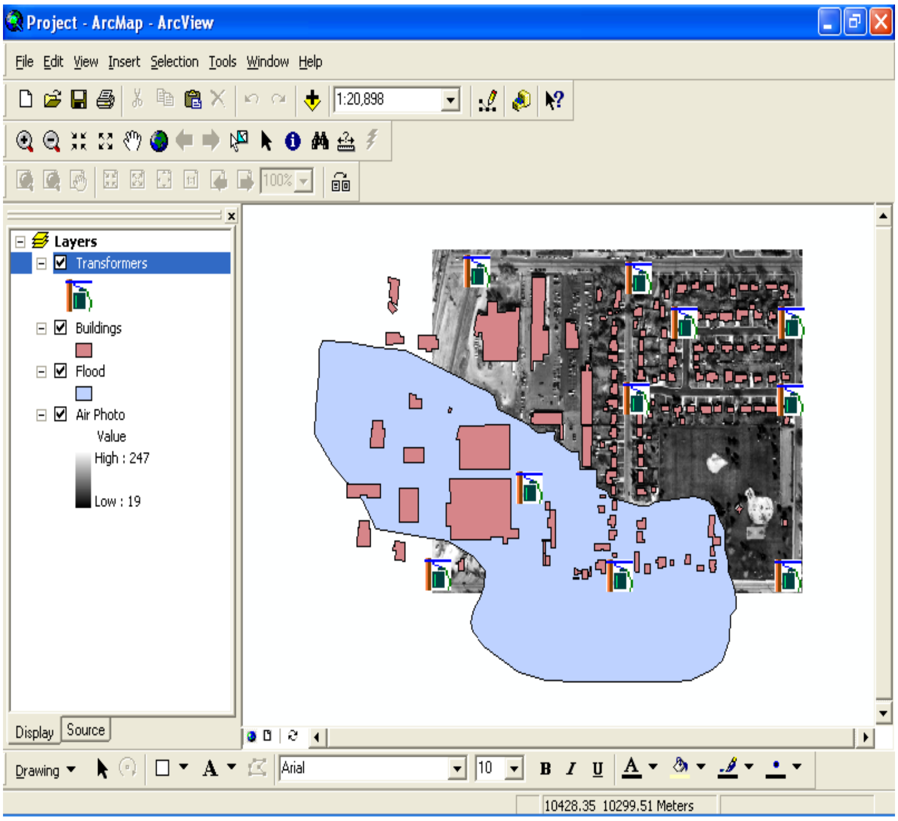
3. Adding buildings' layer to the map,



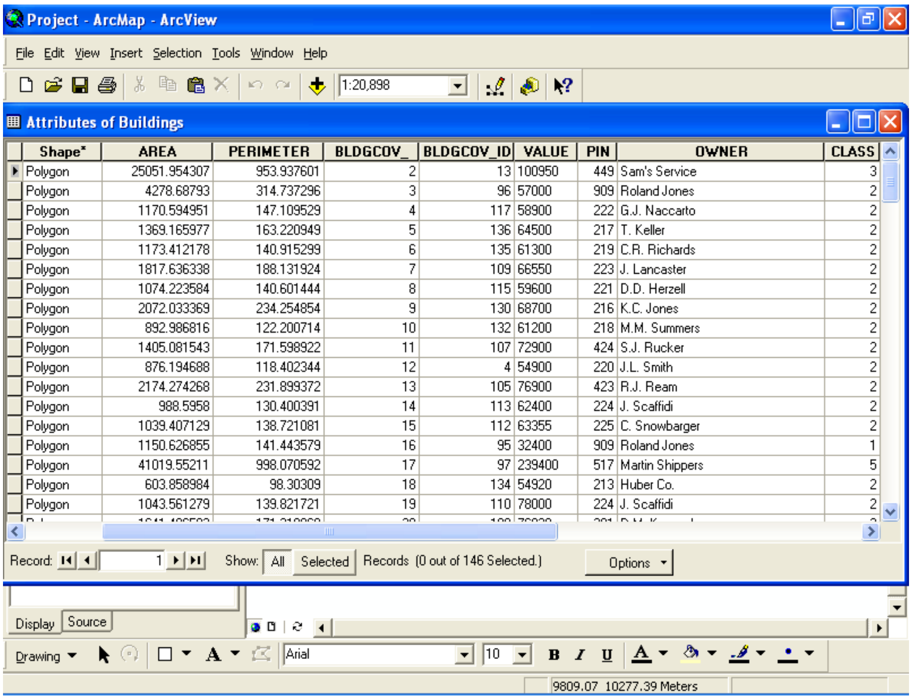
4. Adding Aerial Photograph layer to the map,



5. Adding the Transformers' layer to the map,



6. The attribute table showing 147 buildings attributes,



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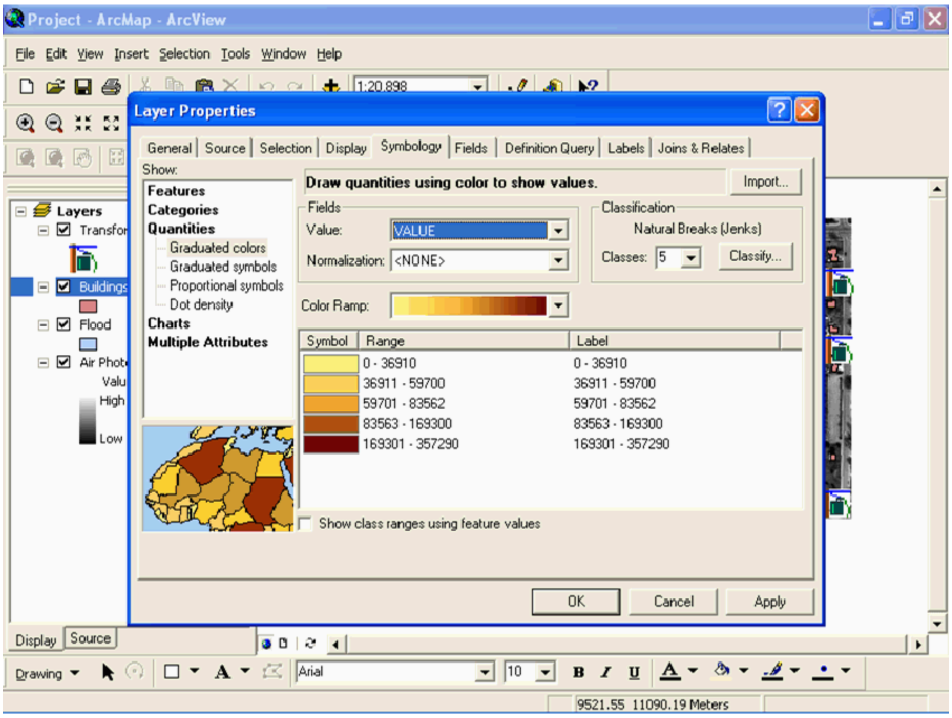
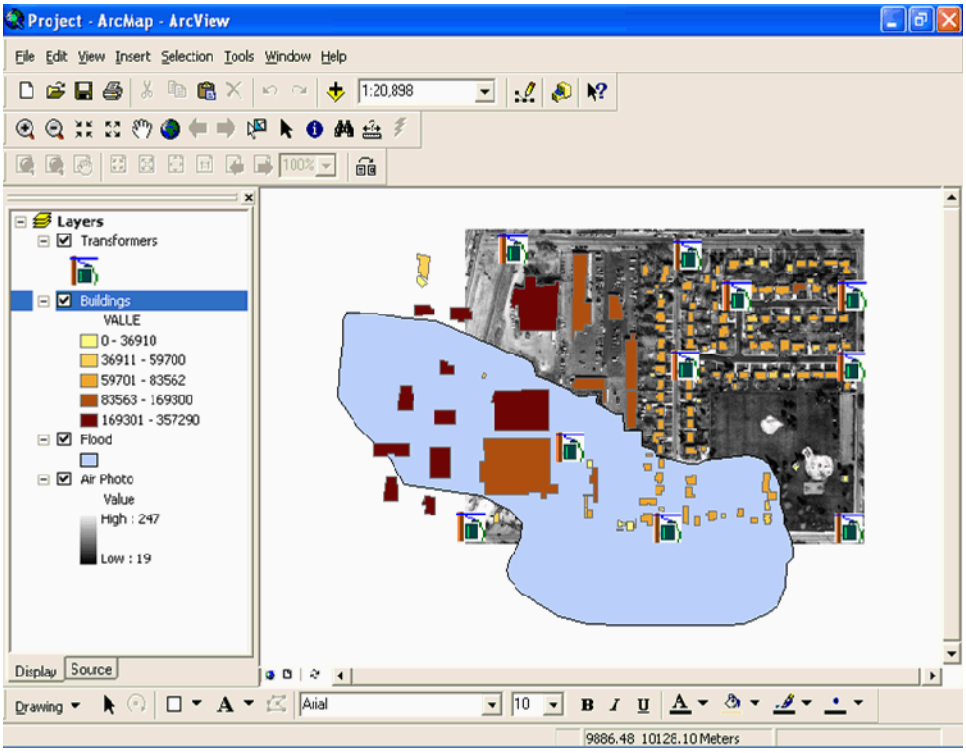
Polygon	4278.68793	314.737296	3	96	57000	909	Roland Jones	2
Polygon	1170.594951	147.109529	4	117	58900	222	G.J. Naccarto	2
Polygon	1369.165977	163.220949	5	136	64500	217	T. Keller	2
Polygon	1173.412178	140.915299	6	135	61300	219	C.R. Richards	2
Polygon	1817.636338	188.131924	7	109	66550	223	J. Lancaster	2
Polygon	1074.223584	140.601444	8	115	59600	221	D.D. Herzell	2
Polygon	2072.033369	234.254854	9	130	68700	216	K.C. Jones	2
Polygon	892.986816	122.200714	10	132	61200	218	M.M. Summers	2
Polygon	1405.081543	171.598922	11	107	72900	424	S.J. Rucker	2
Polygon	876.194688	118.402344	12	4	54900	220	J.L. Smith	2
Polygon	2174.274268	231.899372	13	105	76900	423	R.J. Ream	2
Polygon	988.5958	130.400391	14	113	62400	224	J. Scaffidi	2
Polygon	1039.407129	138.721081	15	112	63355	225	C. Snowbarger	2
Polygon	1150.626855	141.443579	16	95	32400	909	Roland Jones	1
Polygon	41019.55211	998.070592	17	97	239400	517	Martin Shippers	5
Polygon	603.858984	98.30309	18	134	54920	213	Huber Co.	2
Polygon	1043.561279	139.821721	19	110	78000	224	J. Scaffidi	2

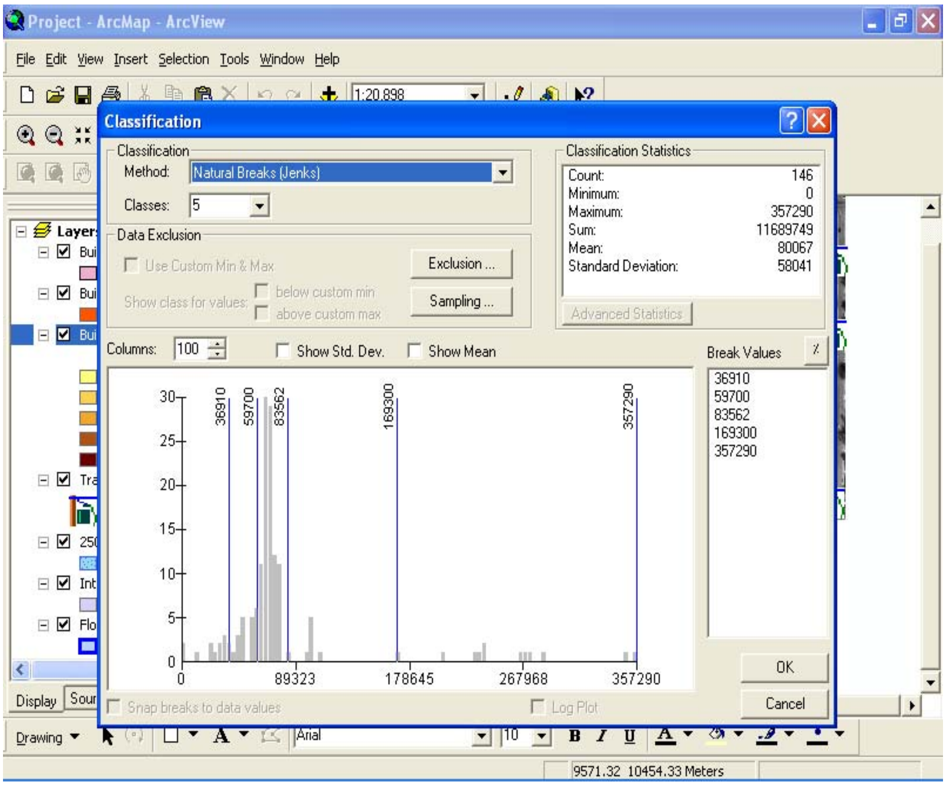
7. Classifying Buildings as per their monetary values,



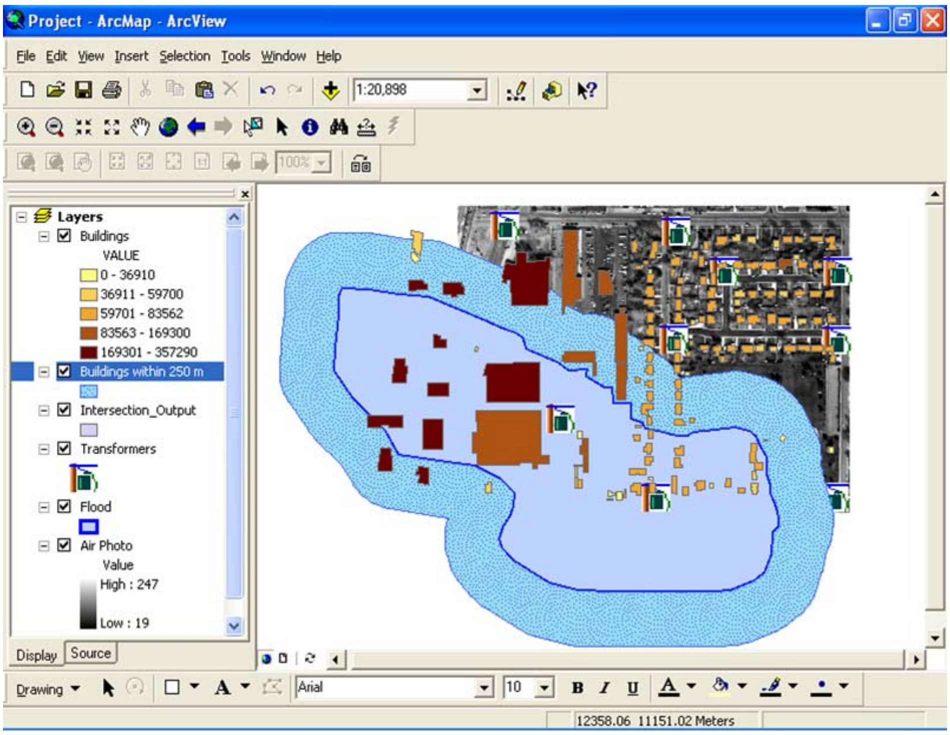
8. Viewing the classification result,



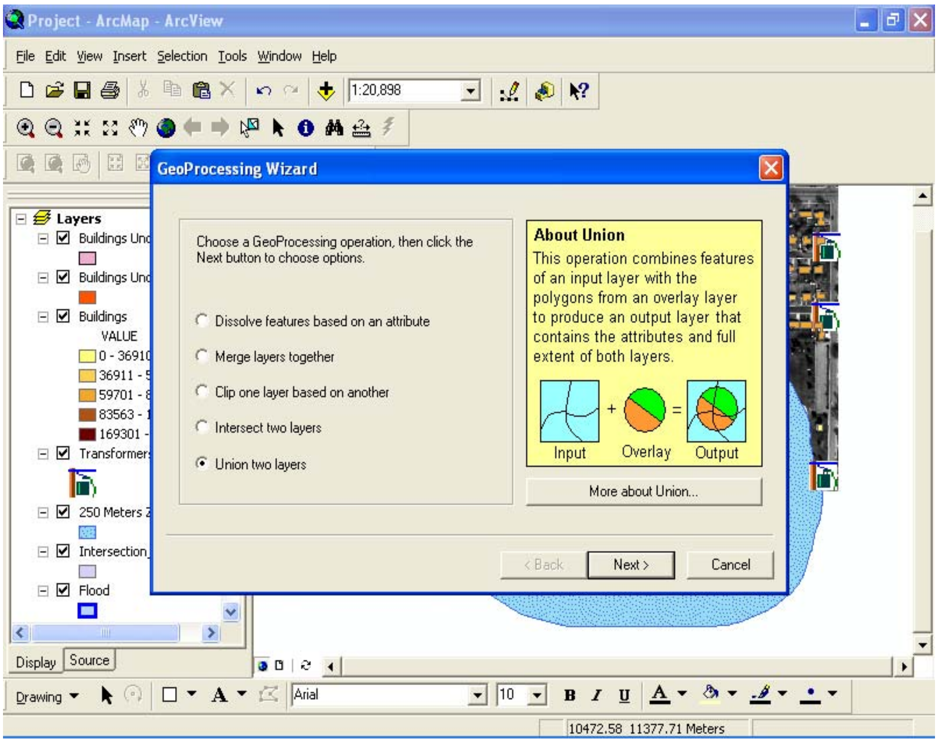
9. Classifying buildings using Natural Breaks Histograms,



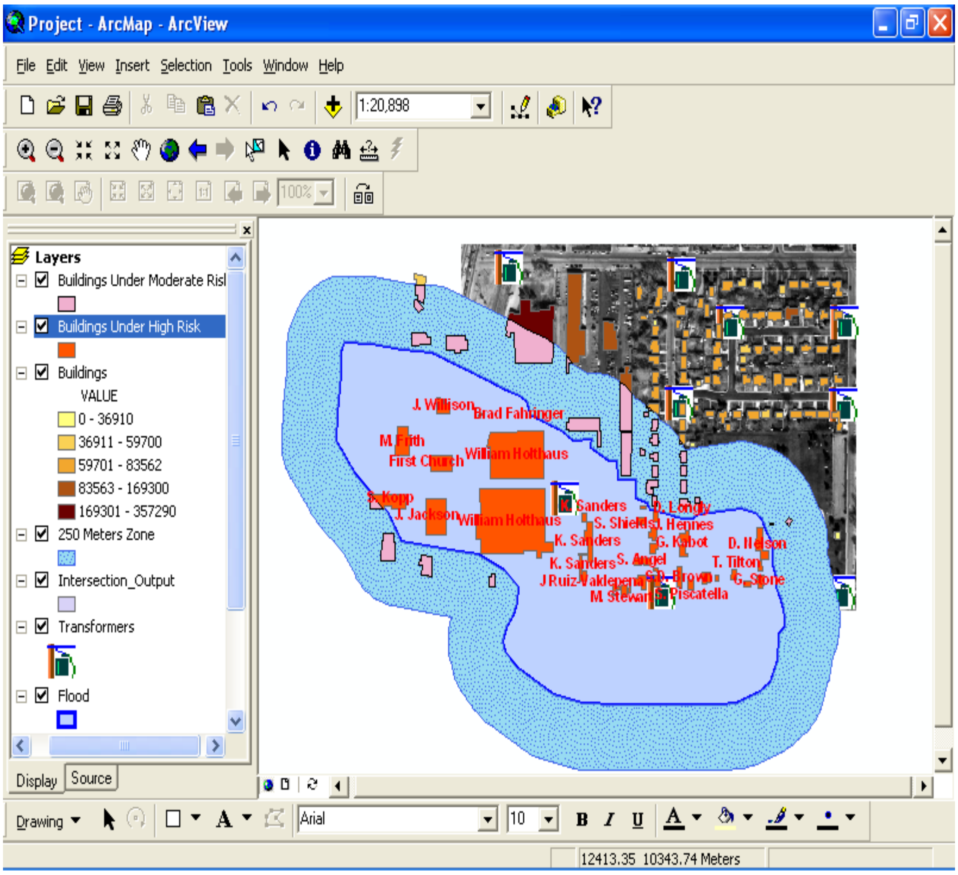
10. Identifying 250 meters zone from flood plain,



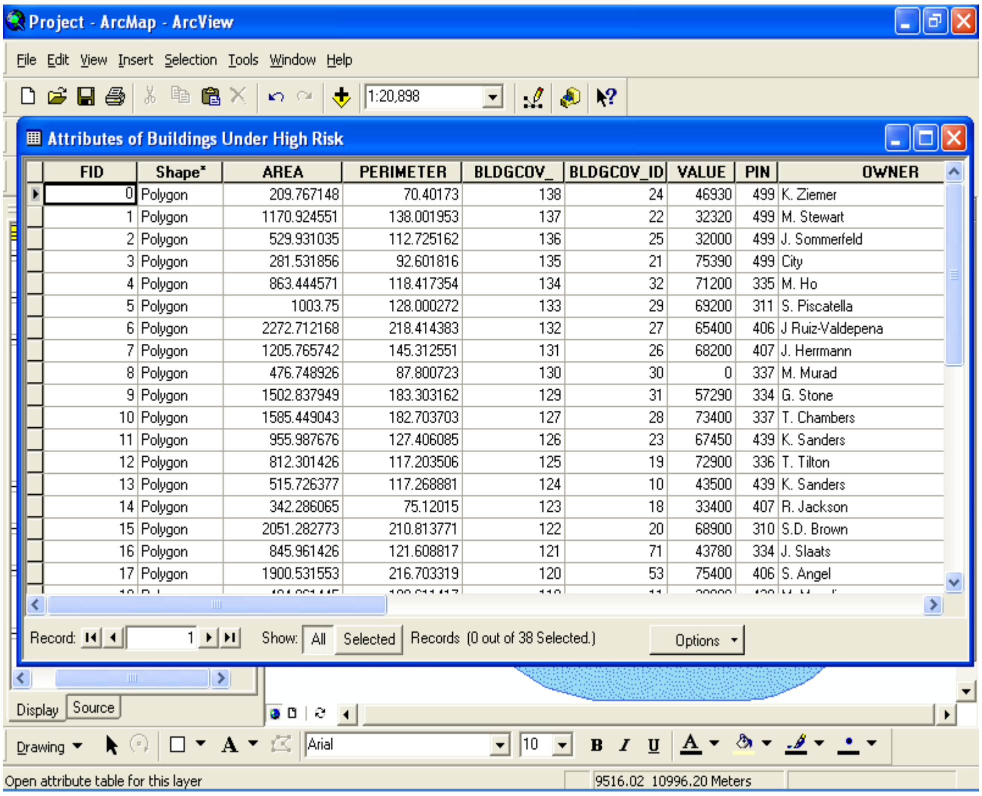
11. Identifying buildings that exist within the flood plain,



12. Identifying buildings that exist within the flood plain (under high risk),

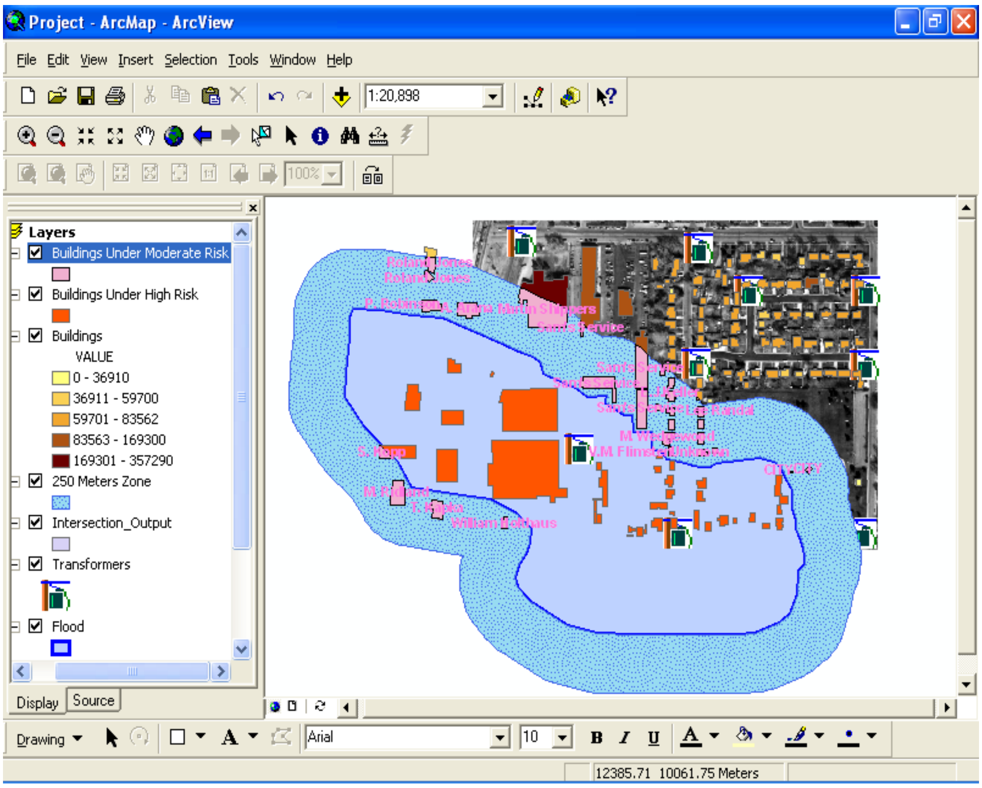


13. Attribute table of buildings that exist within the flood plain (under high risk),

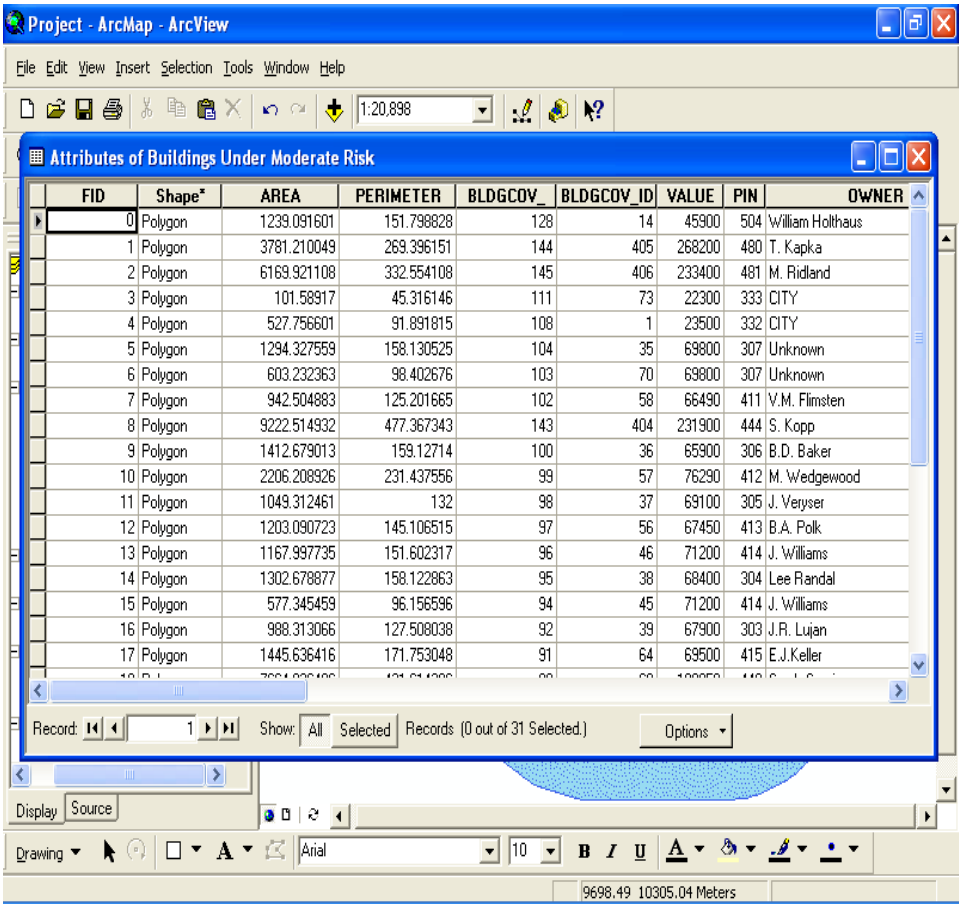


FID	Shape*	AREA	PERIMETER	BLDGCOV_	BLDGCOV_ID	VALUE	PIN	OWNER
0	Polygon	209.767148	70.40173	138	24	46930	499	K. Ziemer
1	Polygon	1170.924551	138.001953	137	22	32320	499	M. Stewart
2	Polygon	529.931035	112.725162	136	25	32000	499	J. Sommerfeld
3	Polygon	281.531856	92.601816	135	21	75390	499	City
4	Polygon	863.444571	118.417354	134	32	71200	335	M. Ho
5	Polygon	1003.75	128.000272	133	29	69200	311	S. Piscatella
6	Polygon	2272.712168	218.414383	132	27	65400	406	J Ruiz-Valdepena
7	Polygon	1205.765742	145.312551	131	26	68200	407	J. Herrmann
8	Polygon	476.748926	87.800723	130	30	0	337	M. Murad
9	Polygon	1502.837949	183.303162	129	31	57290	334	G. Stone
10	Polygon	1585.449043	182.703703	127	28	73400	337	T. Chambers
11	Polygon	955.987676	127.406085	126	23	67450	439	K. Sanders
12	Polygon	812.301426	117.203506	125	19	72900	336	T. Tilton
13	Polygon	515.726377	117.268881	124	10	43500	439	K. Sanders
14	Polygon	342.286065	75.12015	123	18	33400	407	R. Jackson
15	Polygon	2051.282773	210.813771	122	20	68900	310	S.D. Brown
16	Polygon	845.961426	121.608817	121	71	43780	334	J. Slaats
17	Polygon	1900.531553	216.703319	120	53	75400	406	S. Angel

14. Identifying buildings that exist within the 250 meters zone (under moderate risk)



15. Attribute table for buildings that exist within the 250 meters zone (under moderate risk)



FID	Shape*	AREA	PERIMETER	BLDGCOV_	BLDGCOV_ID	VALUE	PIN	OWNER
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1	Polygon	3781.210049	269.396151	144	405	268200	480	T. Kapka
2	Polygon	6169.921108	332.554108	145	406	233400	481	M. Ridland
3	Polygon	101.58917	45.316146	111	73	22300	333	CITY
4	Polygon	527.756601	91.891815	108	1	23500	332	CITY
5	Polygon	1294.327559	158.130525	104	35	69800	307	Unknown
6	Polygon	603.232363	98.402676	103	70	69800	307	Unknown
7	Polygon	942.504883	125.201665	102	58	66490	411	V.M. Flimsten
8	Polygon	9222.514932	477.367343	143	404	231900	444	S. Kopp
9	Polygon	1412.679013	159.12714	100	36	65900	306	B.D. Baker
10	Polygon	2206.208926	231.437556	99	57	76290	412	M. Wedgewood
11	Polygon	1049.312461	132	98	37	69100	305	J. Veryser
12	Polygon	1203.090723	145.106515	97	56	67450	413	B.A. Polk
13	Polygon	1167.997735	151.602317	96	46	71200	414	J. Williams
14	Polygon	1302.678877	158.122863	95	38	68400	304	Lee Randal
15	Polygon	577.345459	96.156596	94	45	71200	414	J. Williams
16	Polygon	988.313066	127.508038	92	39	67900	303	J.R. Lujan
17	Polygon	1445.636416	171.753048	91	64	69500	415	E.J.Keller

7. DISCUSSION OF RESULTS

The flood plain is identified and hence its intersection with the existing buildings is also assessed. Risk of flood is categorized into two categories, high risk and moderate risk. The high risk area is the area that bounded by the flood plain geographic boundaries, while the moderate risk area is the area that extends 25o meters after the flood plain boundaries. Transformers located inside the flood plain are easily identified and they will contribute in the risk as well as their insurance strategy. The 147 buildings, which is the total number of buildings is categorized as 38 buildings that fall at high risk zone, 31 buildings at moderate risk zone and the rest fall out side normal flood plain zone. Hence, the premium of insurance can be dealt with accordingly.

8. RECOMMENDATIONS

- GIS and its powerful tools are highly recommended in order to deal with such problems.
- Buildings fall within flood zone require high insurance value.
- Buildings fall within 250 meters from the flood plain edges can be considered under moderate risk.
- Transformers that fall within the flood plain are identified and hence their risk contribution as well as their insurance can be dealt with accordingly.

9. REFERENCES

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2. O. Evdakov, J. Ihringer, P. Oberle, S. Theobald, "GIS Techniques to Support Flood Plain Modeling in Different Scale Ranges", Europian Geophysical Socity 2003", www.cosis.net.
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