

Development of a GIS Application for seismic vulnerability and earthquake damage studies in Nicaragua

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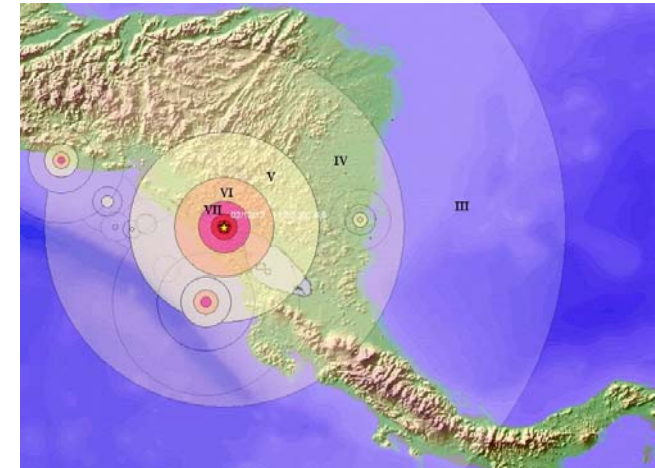


Damages of the 1972 Managua Earthquake

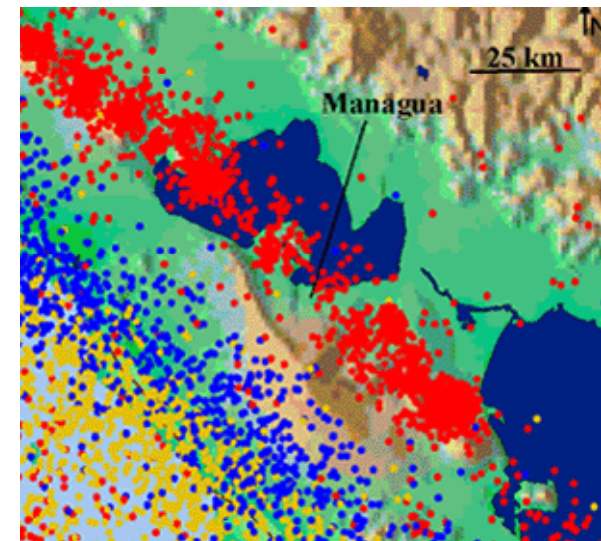
1. INTRODUCTION

Nicaragua is a country with a high seismic activity. Earthquakes have been provoking thousands of deaths and infrastructure destruction. The economic losses and socio-cultural damages complicate the development of the country.

In order to contribute to the prevention and risk mitigation, seismic vulnerability and risk studies have been carried out, in recent years, by several scientific groups applying different methodologies.



Isoseisms of a simulated Earthquake in Managua and its effects in C.A



Managua seismicity



2. OBJECTIVES OF THE DEVELOPMENT OF THE APPLICATION

1. Provide to INETER, Nicaraguan Universities and other institutions with a software tool that implements all the requirements related to earthquake and damage studies.
2. Considering the specific methodology of the seismic vulnerability index.
3. Reducing time and efforts for the accomplishment of seismic vulnerability studies.



What means seismic vulnerability study for a town

- It is to determine the probable response of buildings to the impact of possible seismic events

To do this-

- ... to identify the construction parameters of all the buildings.
- ... but, it cannot be done in a detailed way for all buildings, due to time and cost limitations.
- ... for all houses we have the data of the municipal cadastre which contain certain interesting information for our purposes.
- ... grouping the houses in construction types according certain parameters (adobe, concrete, ..., single floor, two-floors..., type of roof)
- ... the randomly selecting a number of houses for each group, visiting them and their vulnerability determination.
- ... from the mean value of the vulnerability of the visited houses we get a vulnerability index for each group of buildings.
- ... this index is applied to all houses of the group.
- ... at the end we get an estimate of vulnerability fore each house in the cadastre data base.
- Finally We can plot a map of the vulnerability to investigate the spatial distribution.

Types of houses, Leon City, Nicaragua



Adobe, 1 store, before 1972



Concrete, 2 stores, after 1972

3. DISADVANTAGE OF THE TRADITIONAL WAY OF WORK

In Nicaragua, the assessment of seismic vulnerability was carried out through distinct tasks, as:

- * Obtaining database from municipal cadastre.
- * Grouping the houses according to typologies. Software tool: MS ACCESS.
- * For each typology - Selecting a percentage of houses to be visited for getting data for the calculation of their vulnerability index. Software Tool: None (this step was done manually)

The screenshot displays three windows from a Microsoft Access database:

- VulnSisCatJui : Base de datos (Formato d...)**: Shows options for creating tables, including 'Crear una tabla en vista Diseño', 'Crear una tabla utilizando el asistente', and 'Crear una tabla introduciendo datos'. The 'VulnSisCat' table is selected.
- Consulta2 : Consulta de selección**: Contains a complex SQL query with multiple conditional clauses for updating 'VulnerSism' values based on various criteria like 'SIGPARED', 'SIGESTEDIF', 'SIGCUBIERT', and 'ANOCONEDIF'.
- VulnSisCat : Tabla**: A data table view with columns: ID, CODEPARTAM, CODCENTRO, CODISTRITO, CODMANZANA, CODLOTE, NUMEDIFIC, USO, NOMEDIFIC, and SI. It lists 15 rows of data.

ID	CODEPARTAM	CODCENTRO	CODISTRITO	CODMANZANA	CODLOTE	NUMEDIFIC	USO	NOMEDIFIC	SI
1	16	02	U100	001	001	001	OFI	COOPERAT. D	
2	16	02	U100	001	003	001	HAB	SIN NOMBRE	
3	16	02	U100	002	001	001	HAB	SIN NOMBRE	
4	16	02	U100	002	002	001	HAB	SIN NOMBRE	
5	16	02	U100	002	003	001	HAB	REPUESTOS L	
6	16	02	U100	002	004	001	HAB	SIN NOMBRE	
7	16	02	U100	002	006	001	HAB	SIN NOMBRE	
8	16	02	U100	002	009	001	HAB	SIN NOMBRE	
9	16	02	U100	002	011	001	HAB	SIN NOMBRE	
10	16	02	U100	002	012	001	HAB	SIN NOMBRE	
11	16	02	U100	002	013	001	HAB	SIN NOMBRE	
12	16	02	U100	002	014	001	HAB	SIN NOMBRE	
13	16	02	U100	002	017	001	HAB	SIN NOMBRE	
14	16	02	U100	002	015	001	HAB	SIN NOMBRE	
15	16	02	U100	002	016	001	HAB	SIN NOMBRE	

3. DISADVANTAGE OF THE TRADITIONAL WAY OF WORK

* Calculation of vulnerability index for each selected house.

Software Tools:

1) Raven 2002

2) Ms - Excel

* Calculation of damages for earthquakes scenarios

Software Tools:

1) Raven 2002

2) Ms - Excel

PRINCIPAL

METODO DEL INDICE DE VULNERABILIDAD

CODIGO DE LA EDIFICACION

USO DE LA EDIFICACION

1 2 3 4 5 6 7 8 9 10 11

RESISTENCIA CONVENCIONAL

No. DE PISOS Pm (ton/m²)

At (m²) Tk (ton/m²)

A mín x,y (m²) Ps (ton/m²)

B máx x,y (m²)

h (m)

MATERIAL Y AREA

LADRILLO CUARTERON

BLOQUE DE CEMENTO

PIEDRA CANTERA

RESULTADOS

α CATEGORIA

CALCULAR

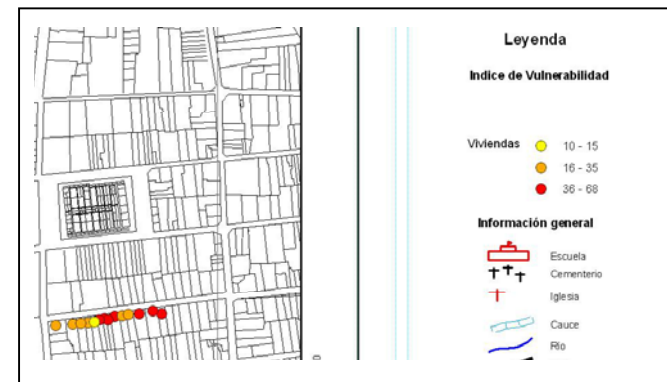
Excel is used for saving the calculation of each house because raven doesn't work with Data Bases, it doesn't have memory, it is just like a calculator.

3. DISADVANTAGE OF THE TRADITIONAL WAY OF WORK

* Placing all the transformed data in a correct format for to be imported to the GIS, for its presentation on maps. Software tool: ms - excel

IV	IVNOR	Niv IV	ID1	Niv ID1	ID2	Niv ID2	ID3	Niv ID3	ID4	Niv ID4	X	Y
91.25	23.86	MEDIA	0.1759	Menor	0.4141	Severo	0.7716	Severo	1.0694	Total	-86.2974629352	12.1528110906
72.50	18.95	MEDIA	0.1549	Menor	0.3746	Moderado	0.7042	Severo	0.9788	Total	-86.2979985097	12.1530195506
77.50	20.26	MEDIA	0.1603	Menor	0.3843	Moderado	0.7201	Severo	1.0000	Total	-86.2980051479	12.1528317177
91.25	23.86	MEDIA	0.1759	Menor	0.4141	Severo	0.7716	Severo	1.0694	Total	-86.2980009298	12.1529376428
146.25	38.24	ALTA	0.2445	Menor	0.5436	Severo	0.9922	Total	1.3660	Total	-86.2979007019	12.1529903394
40.00	10.46	BAJA	0.1201	Menor	0.3142	Moderado	0.6053	Severo	0.8479	Total	-86.2978215523	12.1529882377

* Layouts creation for the presentation of the vulnerability and damages results in several displaying way: houses, blocks and one layout for each damage scenario. Software tool: ArcGIS - ESRI



The creation of spatial-relationships for presenting the resulting vulnerability and damages estimations over a map is always needed.



4. THE NEW APPLICATION “VULNESIS” - FUNCTIONALITIES AND ITS WAY OF WORK

The analysis the previous working way allows us to decide the developing the new software for the assessment of the vulnerability and damages due to earthquakes within the environment of a Geographical Information System (GIS)::

General steps integrated in the new software :

- 1) The support the automatic and interactive grouping of houses in typologies using the municipal cadastre data
- 2) Automatically and randomly selection of a number of houses spatially distributed for each typology house; houses which will be visited to determine its vulnerability index.
- 3) Applying the specific methodologies of seismic vulnerability index.
- 4) Calculation of damages (Scenario) using the vulnerability index.
- 5) Presenting the results over maps at any stage of the work..

With this integrated software system the user has not to care about separated software tools for each part of the studio process, also avoiding translate data for one software to other..

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

Login into the system:

VulneSis - Sistema para el Estudio de la Vulnerabilidad y Daños debido a Sismos

USUARIO: root

CLAVE: [password]

Ingresar Cancelar

Login Window

Creation of a new project:

Vulnerabilidad Sismica (VULNESIS) - Proyectos Accesibles

Entrar al Proyecto Seleccionado Editar Informacion General del Proyecto Seleccionado Registrar Nuevo Proyecto

Nombre	Comentario	Estado	Fecha Creacion
MonseñorLezcano	Monseñor Lezcano (Barrio). Levantamiento de campo de los	3	27/05/2006

Edición de Proyecto

NOMBRE DEL PROYECTO: Alcahulincá

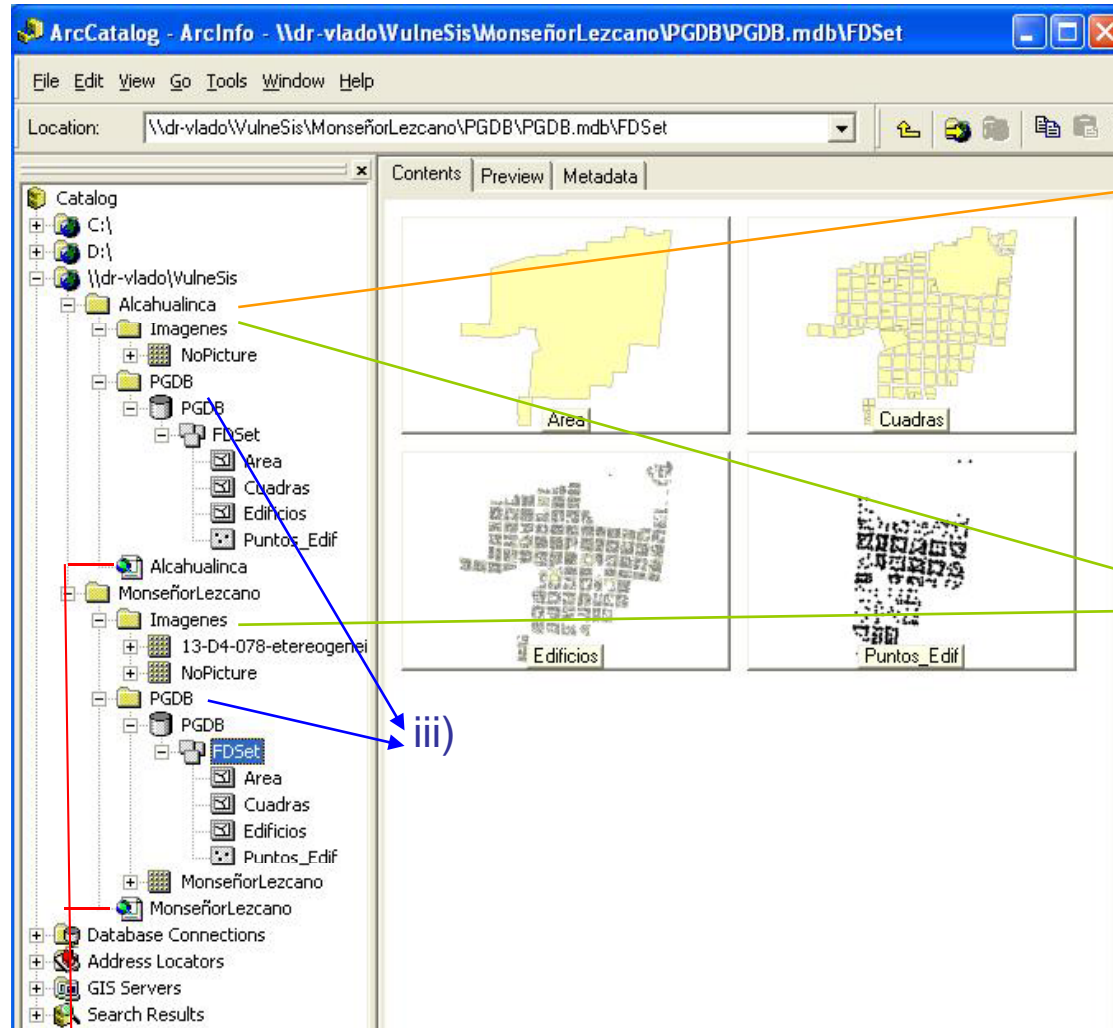
COMENTARIO:
Alcahulincá, barrio popular de Managua.

TADLA CATASTRAL: [prjAlcahulincá]

Aceptar Cancelar Aplicar

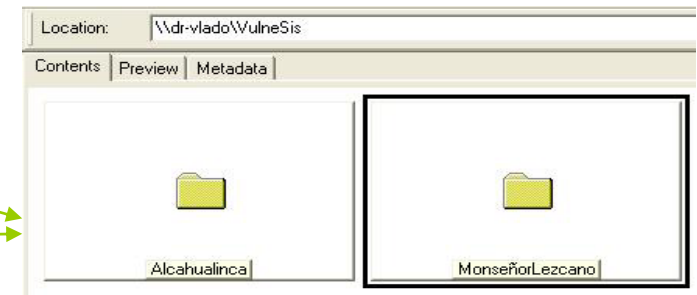
Grid with a list of all vulnerability projects, and dialog for the new project creation

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK



Step 1) Creating of the specific for the new project

i)



ii)

iv) And also the app creates a Map file that hold the layout.

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

STEP 2: The software start the automatic grouping houses in sub typologies using the municipal cadastre data.

This step is made in order to find in the cadastre data for the specific project all the variations of wall, roof, type of use, constructed before or after 1973, these variations are know as SubTypologies.

The houses are marked for to indicate the SubTypology that they are part.

Maestro de Tipos del Proyecto

Codigo	Cantidad	Descripcion
BCO	1576	BLOQUE DE CONCRETO
MIN	604	MINIFALDA
MAR	183	MADERA RUSTICA
RIP	100	RIPIOS O MATERIAL PRECARIO
MAD	88	MADERA ACEPILLADA
CPR	35	LOSETAS DE CONCRETO PREFA
LFC	26	LAMINA DE FIBRO/CEMENTO
CMO	17	CONCRETO MONOLITICO
ADO	16	Parad de ADOBE
TAQ	16	TAQUEZAL
MET	15	LAMINAS METALICAS
LAC	13	LADRILLO CUARTERON
BBA	12	BLOQUE DE BARRO/CERAMICA
PLY	7	PLYWOOD
SIN	6	SIN INFORMACION
PFC	4	PANEL DE FERRO-CEMENTO
PCA	2	PIEDRA CANTERA

SubTipologias del Proyecto

TOTAL DE SUBTIPOLGIAS : 135

CodP	Pared	CodT	Techo	CodU	Uso	CodA	Año	Cant_Viv
BCO	BLOQUE DE CONCRETO	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	654
BCO	BLOQUE DE CONCRETO	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	587
MIN	MINIFALDA	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	373
MIN	MINIFALDA	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	184
BCO	BLOQUE DE CONCRETO	FIC	LAMINA	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	176
MAP	MADERA RUSTICA	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	89
MAP	MADERA RUSTICA	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	64
RIP	RIPIOS O MATERIAL	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	51
MAC	MADERA ACEPILLADA	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	42
MAC	MADERA ACEPILLADA	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	35
RIP	RIPIOS O MATERIAL	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	29
MIN	MINIFALDA	FIC	LAMINA	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	27
CPR	LOSETAS DE	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	22
BCO	BLOQUE DE CONCRETO	FIC	LAMINA	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	17
CMC	CONCRETO	COA	CONCRET ARMADO/LOS.	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	16
BCO	BLOQUE DE CONCRETO	TBA	TEJA DE BARRO	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	16
LFC	LAMINA DE	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	15
ADO	Parad de ADOBE	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	14
RIP	RIPIOS O MATERIAL	PRE	MATERIAL PRECARIO	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	13
MAP	MADERA RUSTICA	TBA	TEJA DE BARRO	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	13
BCO	BLOQUE DE CONCRETO	LZM	LAMINA DE ZINC O	OFI	OFICINAS DE TODO TIPO	72	Edificaciones Construidas	11
TAQ	TAQUEZAL	LZM	LAMINA DE ZINC O	V11	VIVIENDA UNIFAMILAR	72	Edificaciones Construidas	11
CPR	LOSETAS DE	FIC	LAMINA	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	9
BCO	BLOQUE DE CONCRETO	LZM	LAMINA DE ZINC O	EDS	EDIFICIOS SINGULARES	73	Edificaciones Construidas	9
BCO	BLOQUE DE CONCRETO	LZM	LAMINA DE ZINC O	OFI	OFICINAS DE TODO TIPO	73	Edificaciones Construidas	9
BCO	BLOQUE DE CONCRETO	LZM	LAMINA DE ZINC O	EDS	EDIFICIOS SINGULARES	72	Edificaciones Construidas	8
BCO	BLOQUE DE CONCRETO	ZTR	COMBINADO ZINC/TEJA	V11	VIVIENDA UNIFAMILAR	73	Edificaciones Construidas	7

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

Then SubTypologies are grouped interactively in more general classifications called Typologies, this classification is commonly known for specialists.

SubTypologies are usefully for to know the real type of houses variation and for avoid to classify house by house into a major typology, for example it is easily group 135 SubTypologies into 10 Typologies than 2700 houses into the same 10 typologies.

ii) Selected the SubTypologies that will be assigned to a general typology

iii) ... the command that assign the select SubTypologies into the selected Typology.

i) General typology: The major way of houses grouping.

ID	Pared	Techo	Uso	Año	Cant_Viv
136	BLOQUE DE CONCRETO	LAMINA DE ZINC O	VIVIENDA UNIFAMILAR	Edificaciones Construidas	10
137	MINIFALDA	LAMINA DE ZINC O	VIVIENDA UNIFAMILAR	Edificaciones Construidas	4
138	RIPIOS O MATERIAL	LAMINA DE ZINC O	VIVIENDA UNIFAMILAR	Edificaciones Construidas	2
139	MADERA ACEPILLADA	LAMINA DE ZINC O	VIVIENDA UNIFAMILAR	Edificaciones Construidas	2
140	MADERA RUSTICA	LAMINA DE ZINC O	VIVIENDA UNIFAMILAR	Edificaciones Construidas	1
141	BLOQUE DE CONCRETO	LAMINA DE ZINC O	FABRICAS O INDUSTRIAS	Edificaciones Construidas	1
142	BLOQUE DE CONCRETO	LAMINA DE ZINC O	OFICINAS DE TODO TIPO	Edificaciones Construidas	1

Nombre de la Tipología	Descripción	#SubTipologías	#Viviendas
Pared de Concreto y Techo de Peso	Pared de Concreto y Techo de Peso Ligero	0	0

ID	CodP	Pared	CodT	Techo	CodU	Uso	CodA	Año	Cant
----	------	-------	------	-------	------	-----	------	-----	------

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

When all the subtypologies are assigned to general typologies, or in other words when all the houses are grouped into general typologies then the software allows to define the number of houses that will be selected for to be visited to collect its vulnerability information that the software will calculate.

The screenshot shows the 'Vulnerabilidad Sismica (VULNESIS)' application window. The main window title is 'Creación de Tipologías del Proyecto y Asignación de SubTipologías'. It features a toolbar with icons for file operations and a table for 'Sub Tipologías NO Asignadas a alguna Tipología'. The table has columns for ID, Pared, Techo, Uso, Año, and Cant_Viv. Below this is a summary table for 'TIPOLOGÍAS' with columns for Nombre de la Tipología, Descripción, #SubTipologías, and #Viviendas. The summary table shows two typologies: 'Pared de Concreto y Techo de Peso' and 'Pared ligera techo pesado'.

TIPOLOGÍAS		Tipologías : 2	SubTipologías : 28	Viviendas : 89
Nombre de la Tipología	Descripción	#SubTipologías	#Viviendas	
▶ Pared de Concreto y Techo de Peso	Pared de Concreto y Techo de Peso Ligero	18	75	
Pared ligera techo pesado.	Pared ligera techo pesado.	10	14	

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

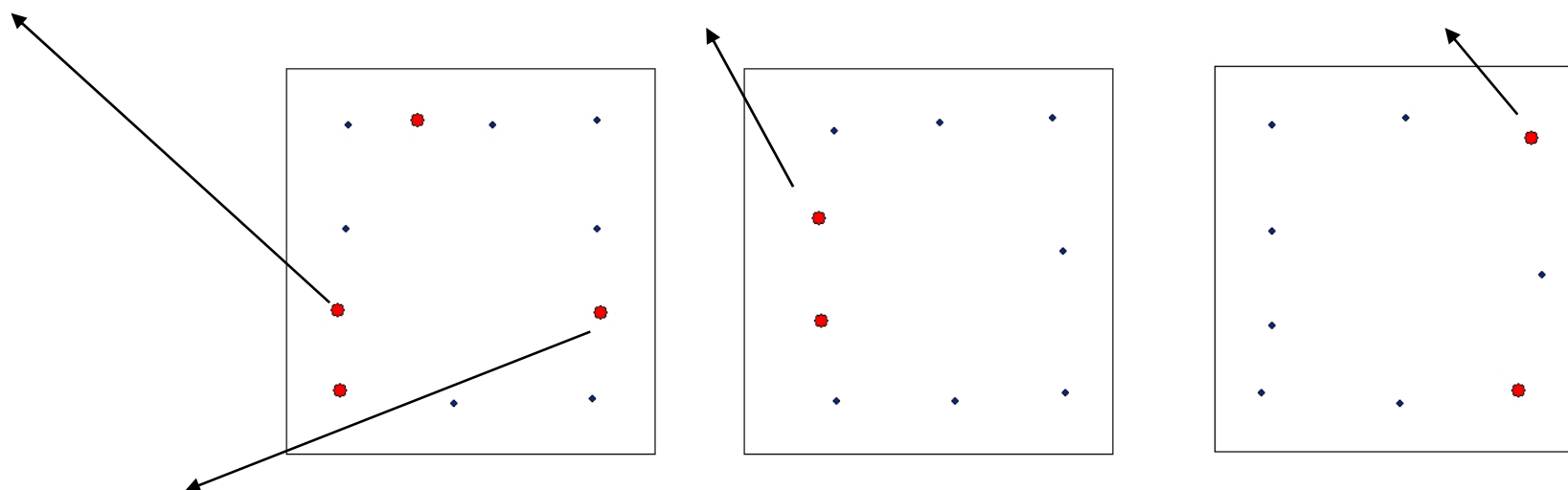
... then the software define the number of houses for each typology that will be randomly and spatially distributed selected:

Definicion de las Cantidades a Muestrear.

TOTAL DE VIVIENDAS : 89 CANTIDA DE VIVIENDAS A MUESTREAR : 9 Aplicar PORCENTAJE DE VIVIENDAS A MUESTREAR : 10 %

TOTAL (Repartir el Total a muestrear de forma proporcional a la cantidad de cada tipologia) INDIVIDUAL (Definir la cantidad a viviendas a muestrear por cada tipologia)

TIPOLOGIAS							
	CantidadMuestrear	%	Margen Error %	#Viviendas	#SubTipologias	Nombre de la Tipologia	Descripcion
	8	11	10	75	18	Pared de Concreto y Techo de Peso	Pared de Concreto y Techo de Peso
▶	1	7	10	14	10	Pared ligera techo pesado.	Pared ligera techo pesado.





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4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

After the selection of the houses the software presents its reports with the format that will be used for fill in the vulnerability information over the field.

ViviendaID : 2726 Codigo Catastral: **10 - 03 - J206 - 005 - 004 - 001** Observador : _____

Fecha (dd/mm/aa) : _____ Dirección : _____

1. Organización del sistema resistente : _____	2. Calidad del sistema resistente : _____
3. Resistencia convencional : 1. Número de pisos N : _____ 2. Area Total Cubierta At : _____ m ² 3. Area resistente sentido x Ax : _____ m ² sentido y Ay : _____ m ²	4. Posición del edificio y la sim entación : _____
1. Resistente cortante m am postería tk : _____ Ton / m ² 2. Altura media de los pisos h : _____ m 3. Peso específico m am postería Pm : _____ Ton / m ³ 4. Peso por unidad de área diafragma Ps : _____ Ton / m ²	5. Diafragmas horizontales : _____
	6. Configuración en planta b1 = a/L : _____ / _____ b2 = b/L : _____ / _____
	7. Configuración en elev :  T / H % : _____ / _____
8. Distancia máxima entre los muros L / S : _____ / _____	9. Tipo de cubierta : _____
10. Elementos no estructurales : _____	10. E estado de conservaci

TODAS LAS VIVIENDAS



DEPARTAM	CENTRO	DISTRITO	MANZANA	LOTE	EDIFIC	YA	Foto_ID	flagV	ViviendaID	Nombre Tipologia
10	03	U206	003	001	001				151	Tipologia2
10	03	U206	003	002	001			True	8	Tipologia1
10	03	U206	003	003	001			True	77	Tipologia1
10	03	U206	003	004	001				11	Tipologia4
10	03	U206	003	005	001				63	Tipologia2
10	03	U206	003	006	001			True	35	Tipologia2
10	03	U206	003	007	001			True	59	Tipologia3
10	03	U206	003	008	001				10	Tipologia2
10	03	U206	003	009	001				83	Tipologia2
10	03	U206	003	010	001				96	Tipologia2
10	03	U206	003	011	001				85	Tipologia4
10	03	U206	003	012	001			True	7	Tipologia4
10	03	U206	004	002	001			True	55	Tipologia5
10	03	U206	004	003	001				1	Tipologia3
10	03	U206	004	004	001			True	22	Tipologia1
10	03	U206	004	004	002				44	Tipologia1
10	03	U206	004	004	003				16	Tipologia2
10	03	U206	004	005	001				64	Tipologia2
10	03	U206	004	006	001				153	Tipologia3
10	03	U206	004	007	001				42	Tipologia2
10	03	U206	004	008	001				9	Tipologia4

ViviendaID : 2727 Codigo Catastral: **10 - 03 - J206 - 003 - 012 - 001** Observador : _____

Fecha (dd/mm/aa) : _____ Dirección : _____

1. Organización del sistema resistente : _____	2. Calidad del sistema a res
3. Resistencia convencional :	



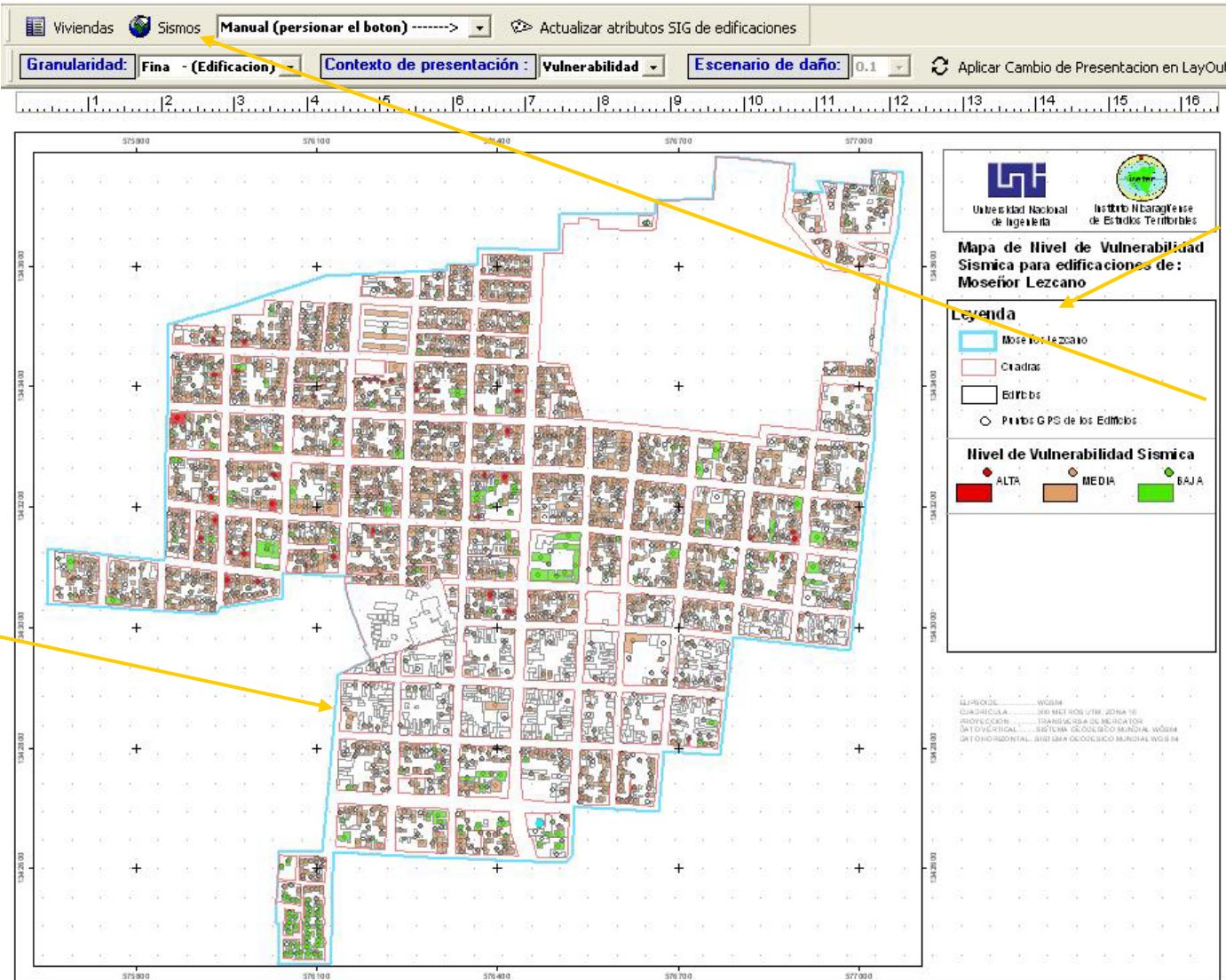
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4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

Programmed GIS extensions (VulneSIs) in Visual Basic program language with ArcObjects and Sql-Server like RDMBS (Relational Database Managed system)

Geographical layer of the current project, Area, Blocks and Parcels, but the app can work without these, it can work with only the points taken for the data field collection work



Context of the current project and user (some user have not access to all the functionalities)

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK



The “Viviendas” Button display a dialog (next image) for the selection and finding of houses, depends of certain parameters of search. Also the user can mix between several parameters or don't use parameters -> (all houses are showing)

Parameters of houses searching

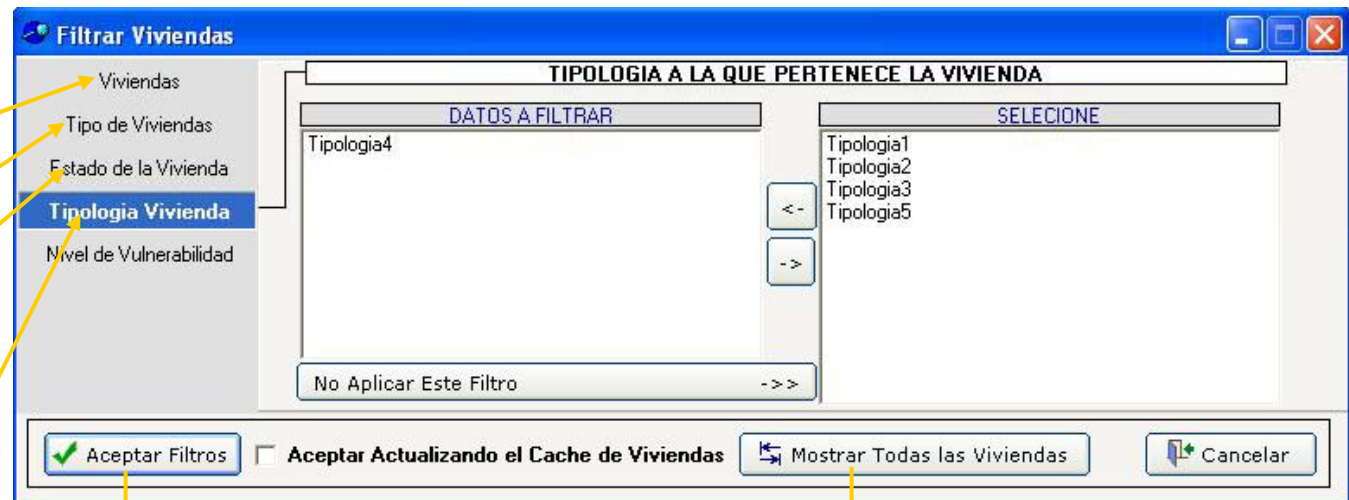
1) Intervals of houses Ids.

2) Houses selected for the vulnerability work field.

3) Edited or not edited houses.

4) Houses members of certain typologies.

5) Houses that had certain vulnerably levels.



This option show all the houses without apply any parameter.

After clicking the “Aceptar” (Accepted button) are presented the houses who have true for the selected parameters.

The example say “Sow me all the houses of the certain typology”

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

The screenshot shows the 'Viviendas' application window. At the top, there are icons for file operations and a toolbar. Below the toolbar, there are filter controls: 'CANTIDAD TOTAL DE EDIFICACIONES' (2720), 'EDIFICACIONES ENCONTRADAS (FILTRADAS)' (266), and checkboxes for 'Filtros aplicados' and 'Filtros NO aplicados'. There are also checkboxes for 'Viviendas', 'Tipo de Viviendas', 'Estado de la Vivienda', 'Tipologia Viviendas', and 'Nivel de Vulnerabilidad'. A 'Nivel de Zoom' dropdown is set to 500. Below these controls is a data table with the following columns: ViviendaID, Vulnerabilidad, Editada, Tipo, Tipologia, Departam, Centro, Distro, Manz, Lote, and Edific.

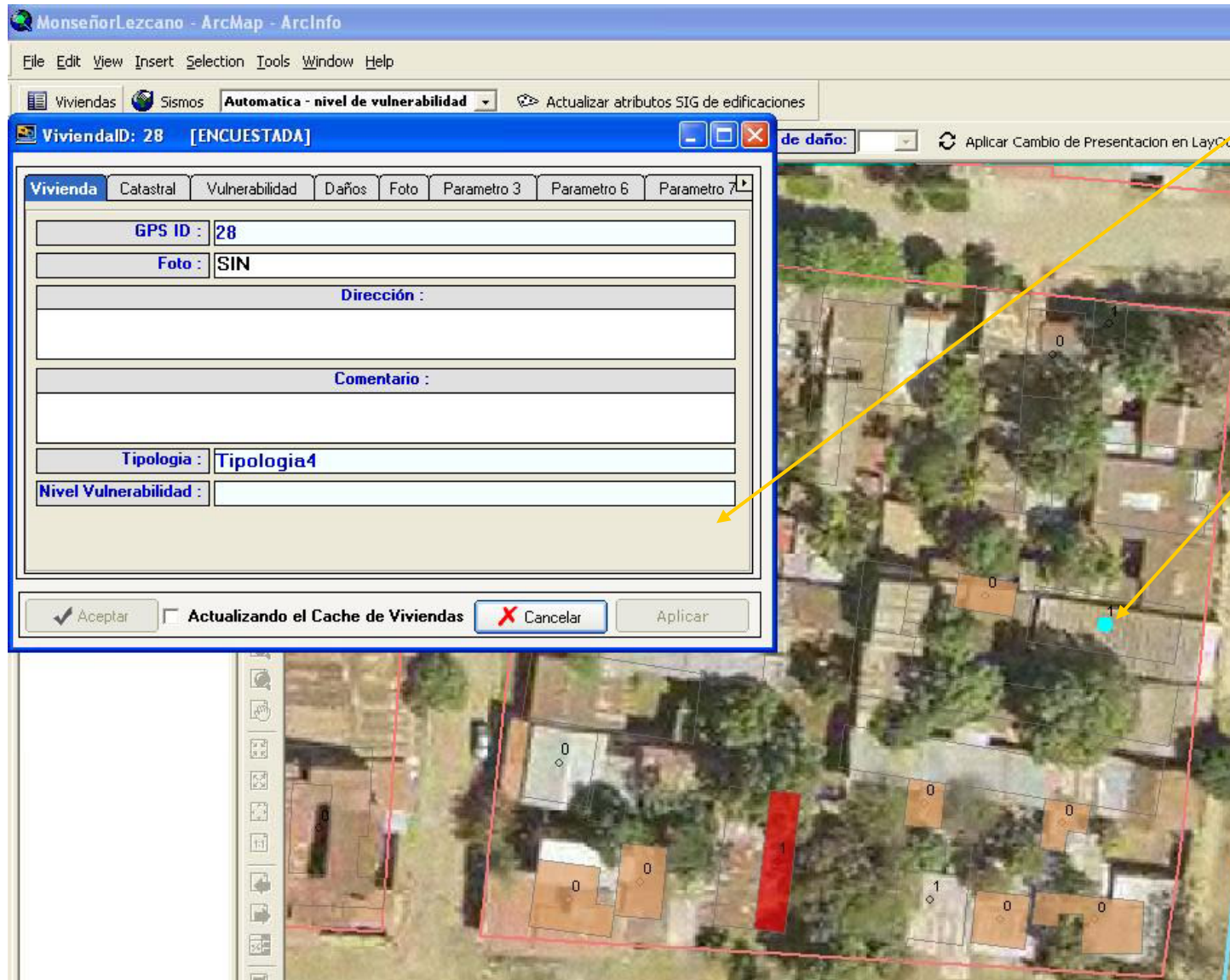
ViviendaID	Vulnerabilidad	Editada	Tipo	Tipologia	Departam	Centro	Distro	Manz	Lote	Edific
7	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	003	01	
9	SIN	Falso	NO_Encuestadas	Tipologia4	10	03	U206	004	00	
11	SIN	Falso	NO_Encuestadas	Tipologia4	10	03	U206	003	00	
14	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	005	00	
25	SIN	Falso	NO_Encuestadas	Tipologia4	10	03	U206	004	01	
28	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	012	01	
31	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	004	01	
82	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	014	00	
85	SIN	Falso	NO_Encuestadas	Tipologia4	10	03	U206	003	01	
116	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	027	01	
117	SIN	Falso	NO_Encuestadas	Tipologia4	10	03	U206	015	02	
166	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	021	00	
174	SIN	Falso	NO_Encuestadas	Tipologia4	10	03	U206	027	01	
187	SIN	Falso	ENCUESTADAS	Tipologia4	10	03	U206	015	01	

Then, (from the before example) this windows show the 266 houses for the total of 2,700 that are members of the 4th typology.

At this point we can select the house that will be edited.

For example if the user select the house number 28 and then the option of “Editing the selected house”, the software will automatically bring a specialized windows for the vulnerability index purpose, that show the information about the selected house and also de software make a zoom to the house in the map.

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK



Alphanumerical information of the house 28, stored in the RDBMS (Relational Database Managed System).

Graphical information of the house 28, stored in the GIS and the attribute table

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

ViviendaID: 28 [ENCUESTADA]

Vivienda **Catastral** Vulnerabilidad Daños Foto Parametro 3 Parametro 6 Parametro 7

Codigo Catastral :	10 - 03 - U206 - 012 - 011 - 001
Pared :	BLOQUE DE CONCRETO
Techo :	LAMINA ASBESTO/FIBROCEMEN
Uso :	VIVIENDA UNIFAMILAR URBANA
Año Construcción :	Edificaciones Construidas Despues de 1972
Estado :	Estado BUENO
Pared (T.Campo) :	
Techo (T.Campo) :	
Uso (T.Campo) :	

Aceptar Actualizando el Cache de Viviendas Cancelar

Cadastral information for the house

ViviendaID: 28 [ENCUESTADA]

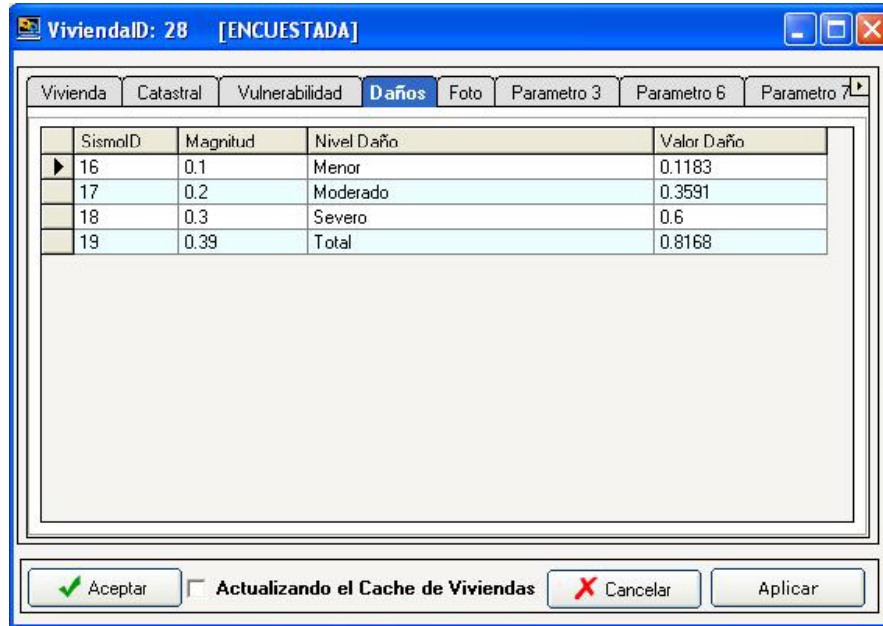
Vivienda Catastral **Vulnerabilidad** Daños Foto Parametro 3 Parametro 6 Parametro 7

Parametro 1 : Organizacion Sistema Resistente :	A	Indice de Vulnerabilidad
Parametro 2 : Calidad Sistema Resistente :	A	
Parametro 3 : Resistencia Convencional :	C	Indice de Vulnerabilidad Normalizado
Parametro 4 : Posicion Edificio Cimentacion :	A	
Parametro 5 : Diafragmas Horizontales :	A	Nivel de Vulnerabilidad
Parametro 6 : Configuracion Planta :	A	
Parametro 7 : Configuaracion Elevacion :	A	
Parametro 8 : Distancia Maxima entre Muros :	A	
Parametro 9 : Tipo de Cubierta :	A	
Parametro 10 : Elementos No Estructurales :	A	
Parametro 11 : Estado de Conservacion :	A	

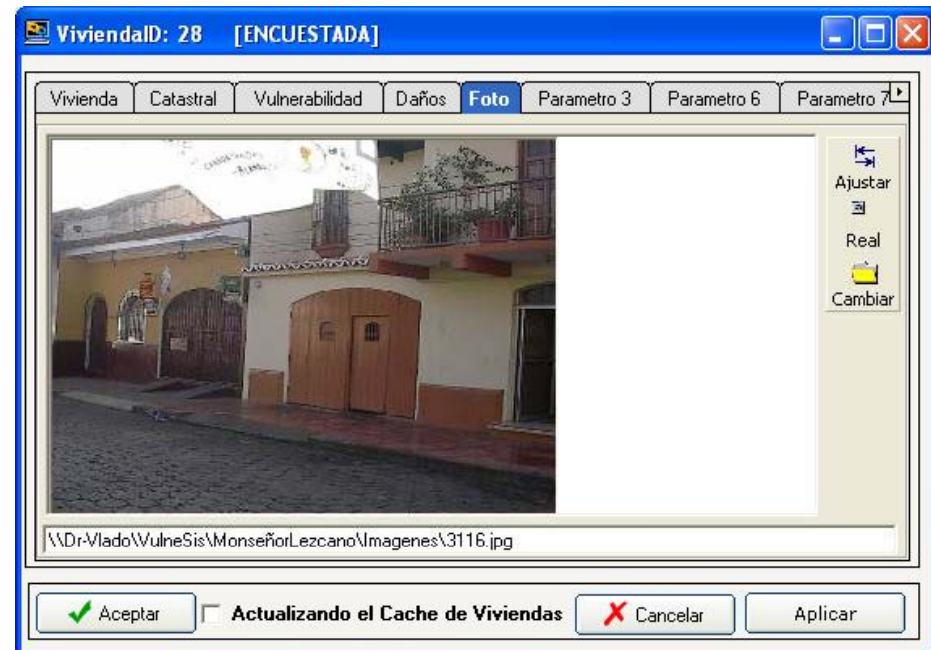
Aceptar Actualizando el Cache de Viviendas Cancelar

Vulnerability base information collected from the field work and the automatically calculation of the index for the software

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

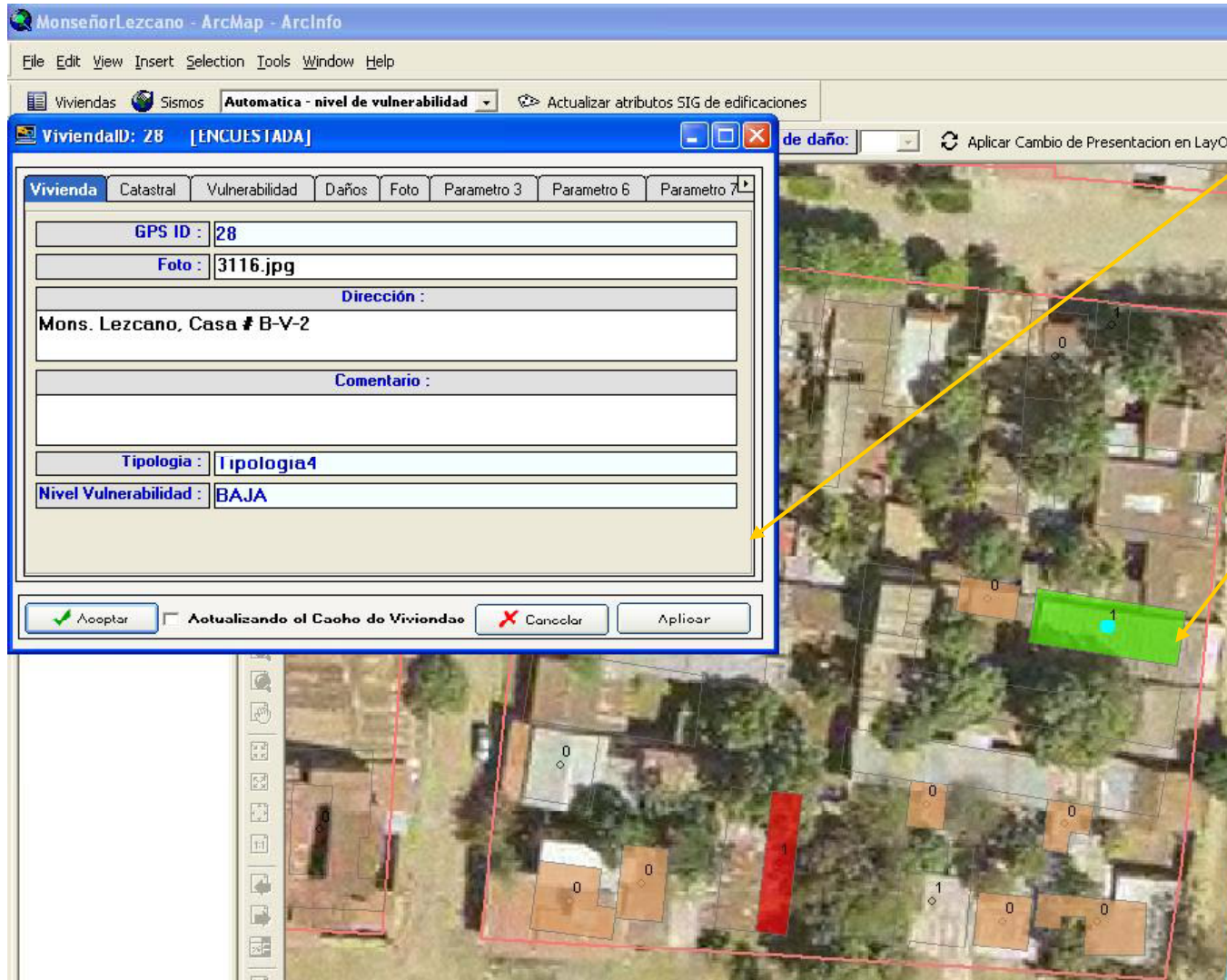


Damage values for the distinct defined scenarios.



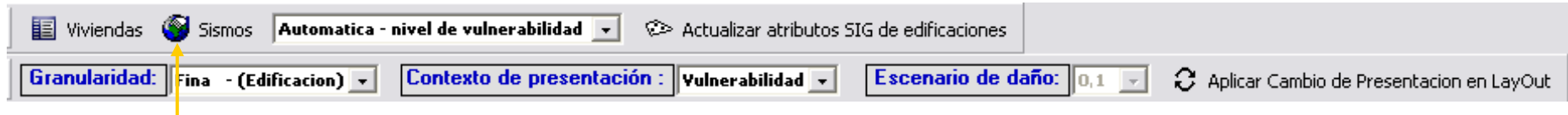
Picture of the house, took in the field work.

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

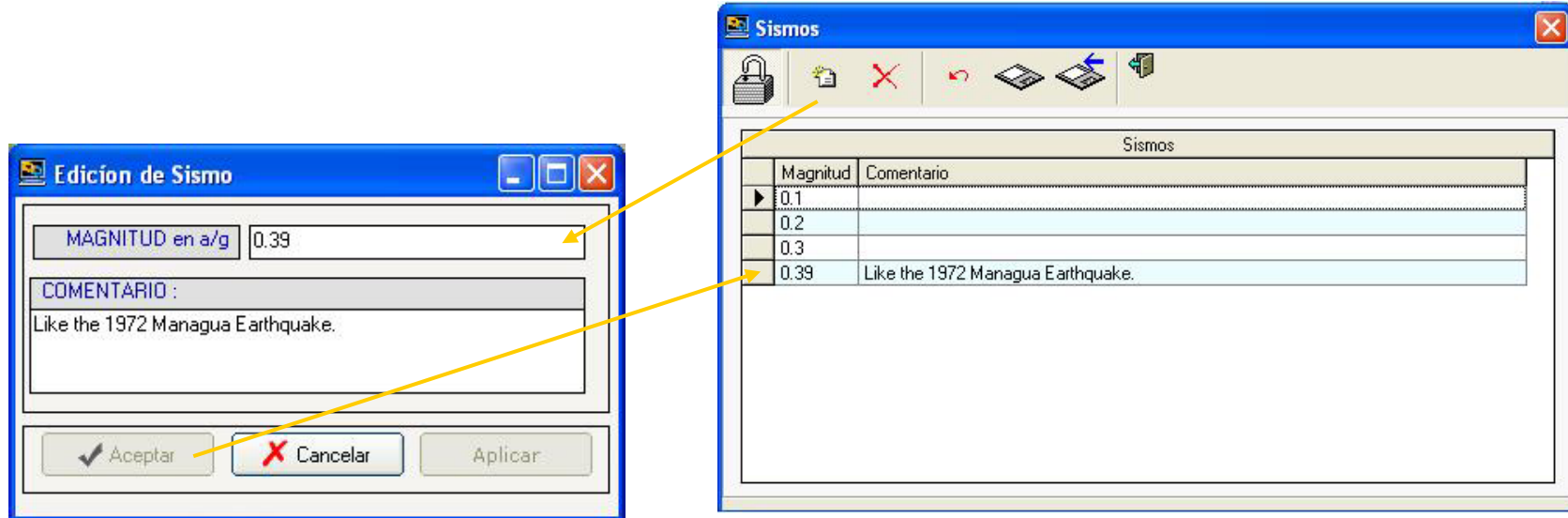


House 28 After save the collected field information. We can see the automatically synchronization between the Graphical information (Behind de GIS) and Alphanumerical information (Behind the RDBM).

4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

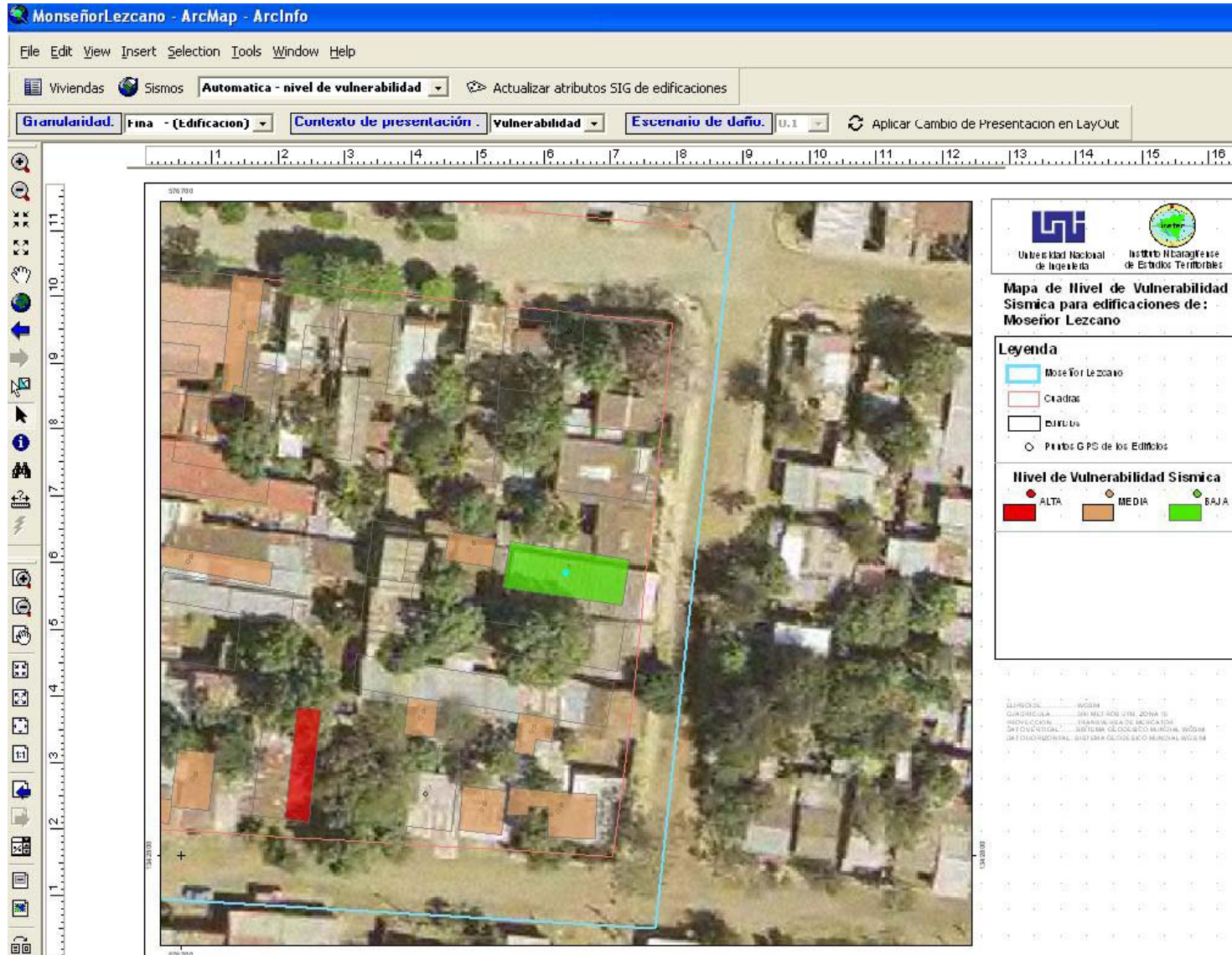


The software also allow us to create several earthquake scenarios, through the “Sismos” bottom, calculating the damages that produce the earthquake in function of each house’s vulnerability index value.

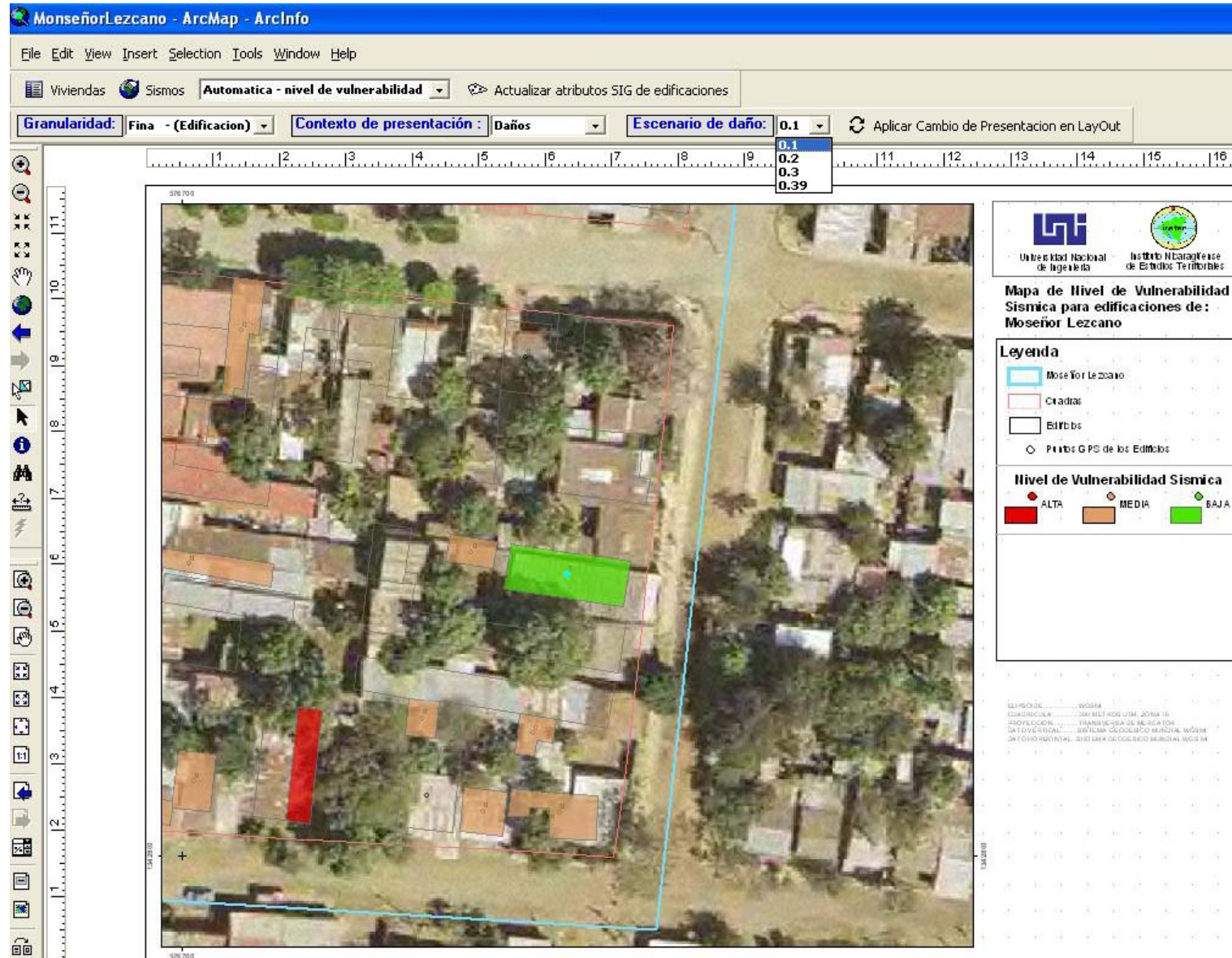


The example say “Sow me all the houses of the certain typology”

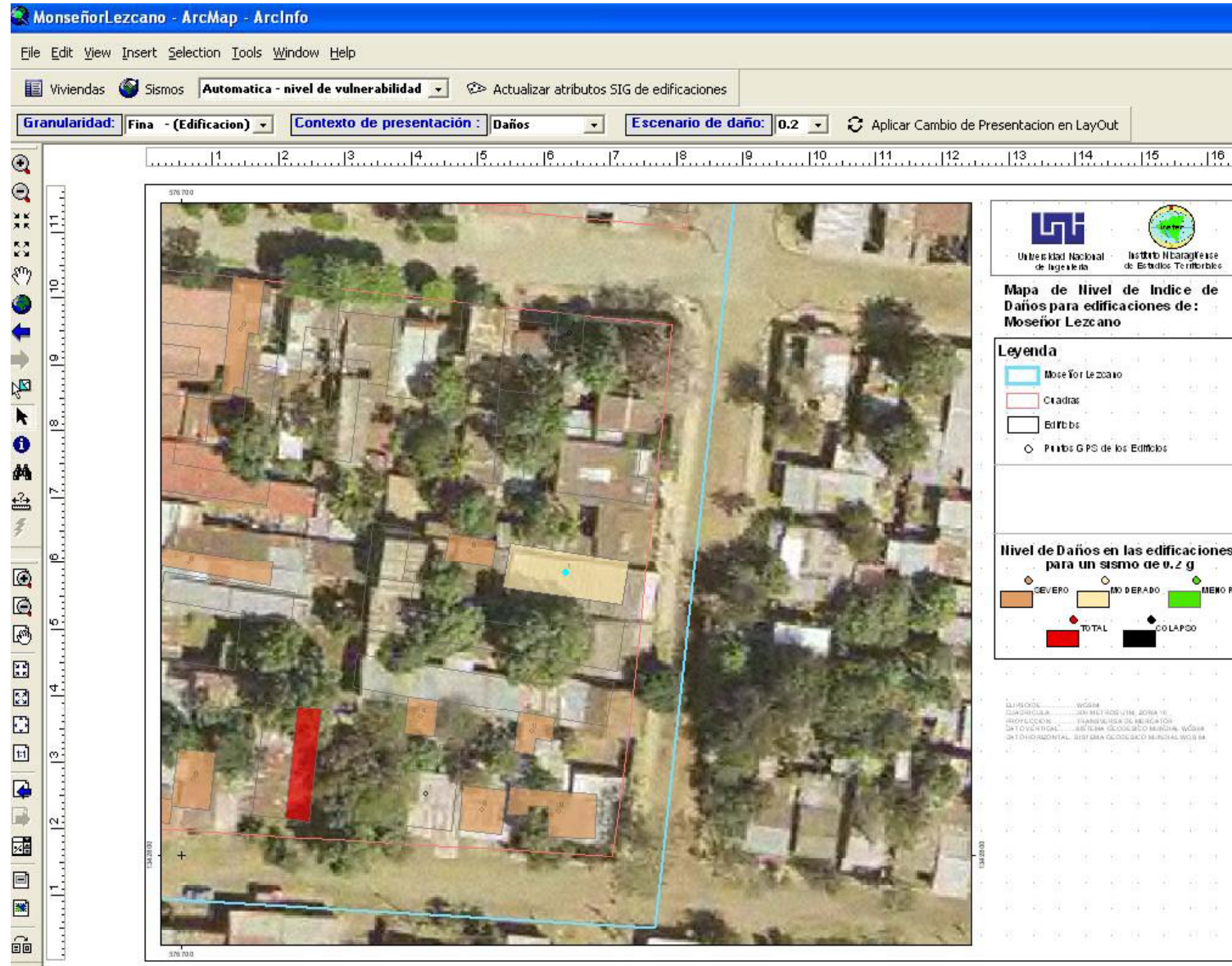
4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK



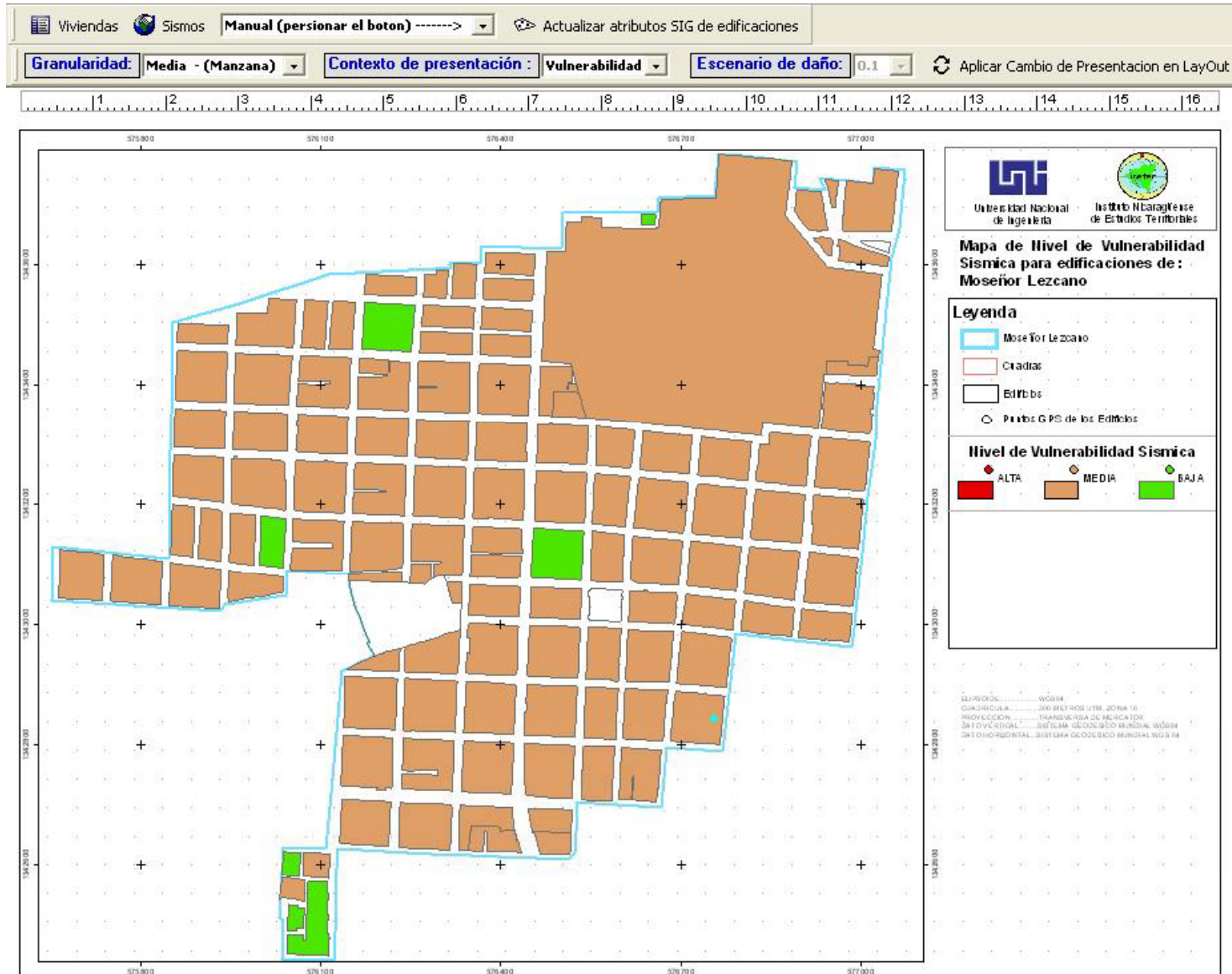
4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK



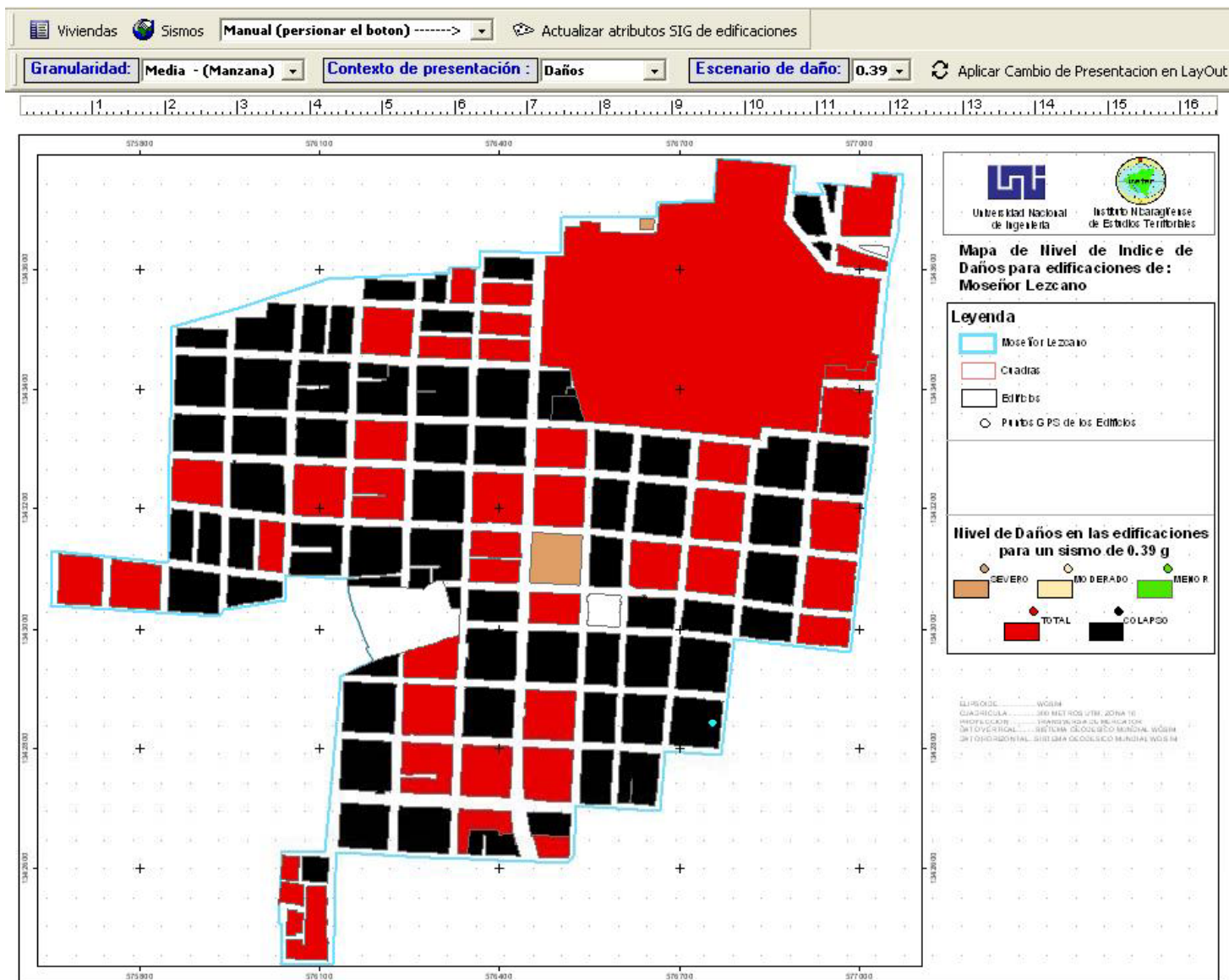
4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK



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4. THE APPLICATION FUNCTIONALITIES AND ITS WAY OF WORK

CONCLUSIONS:

The new developed software reduce the amount of steps and time required for the calculation and presentation of the results on maps.

With all project data inside one program environment, the problem of make mistakes due to the translation of data between several software tools is avoided.

The program work like a Database of vulnerability due to earthquake studies.



- THE END

- *THANK YOU*

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