

## FREE GIS PLUS DATABASE SYSTEM FOR DISSEMINATION ACTIVITY OF EARTHQUAKE DISASTER MITIGATION

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### ABSTRACT :

A free Geographic Information System plus free Database system working on MicroSoft Windows is targeted on to facilitate dissemination activities of earthquake disaster mitigation of non-engineered dwellings for so called developing countries. The free software aimed to promote selling commercial ones, however, have been eliminated at selection. For GIS engine, Geographic Resources Analysis Support System (GRASS) and Quantum GIS (QGIS) are selected for that they cover their weak points mutually. The former is good at handling raster layers including projection conversion and the latter is advantageous over its easiness at connecting to database and operability. For Database engine, PostgreSQL is selected with PostGIS that can store the geometry of vector data together with their attributes in tables of database. For BaseMap, usage of satellite images of resolution enough high to identify individual dwellings is considered for regions where maps of big scale are not yet available. A way to rectify free satellite images also is considered. The instructions on MicroSoft PowerPoint slides are prepared for education and non-commercial activities by NGO, NPO and inhabitants themselves.

**KEYWORDS:** Free ware, GIS, DataBase, Satellite Image, Dissemination, Community Based Disaster Mitigation Activities

## 1. INTRODUCTION

Needless to say, the efficiency of Geographical Information System (GIS) for earthquake risk management has been world widely recognized. The necessary investment for computer, software and geographic data, unfortunately, is still so high that small communities and NGOs may feel difficulties to introduce it. This study is attempting to overcome this difficulty by introducing free software and free satellite images for that small group of inhabitants who works on community based earthquake disaster mitigation in small areas with NGOs that support them can receive benefit from the most recent advanced technologies with much reduced cost.

## 2. SYSTEM DESIGN

The system is composed of Geographic Resources Analysis Support System (GRASS), Quantum GIS (QGIS) and PostGIS that are under GNU General Public License (GPL) and PostgreSQL under BSD license (Visit their official home pages listed in **REFERENCE**). Users do not have to pay to use them. All these four can work on various platforms including MicroSoft Windows and Linux. There is redundancy among the functionalities of GRASS and QGIS that are full GIS engines (Figure 2.1).

### 2.1 GRASS

GRASS is good at handling raster and vector layers including projection conversion, geo-referencing, rectifying and import/ export raster data of various formats (Ref: <http://grass.itc.it>). However, this software is heavy and its way of data management based on LOCATION-MAPSET configuration is different from that of other GIS engines such as ESRI ARCGIS. Although it has the functions to connect to database and handle the data in it, the procedure is not easy to perform for beginners. Therefore, GRASS is expected to be used for preparing the basic information on digital maps like BaseMap or earthquake hazard map by professionals or semi-professionals who support community based activity. GRASS works on Cygwin that is Unix emulator on MicroSoft Windows

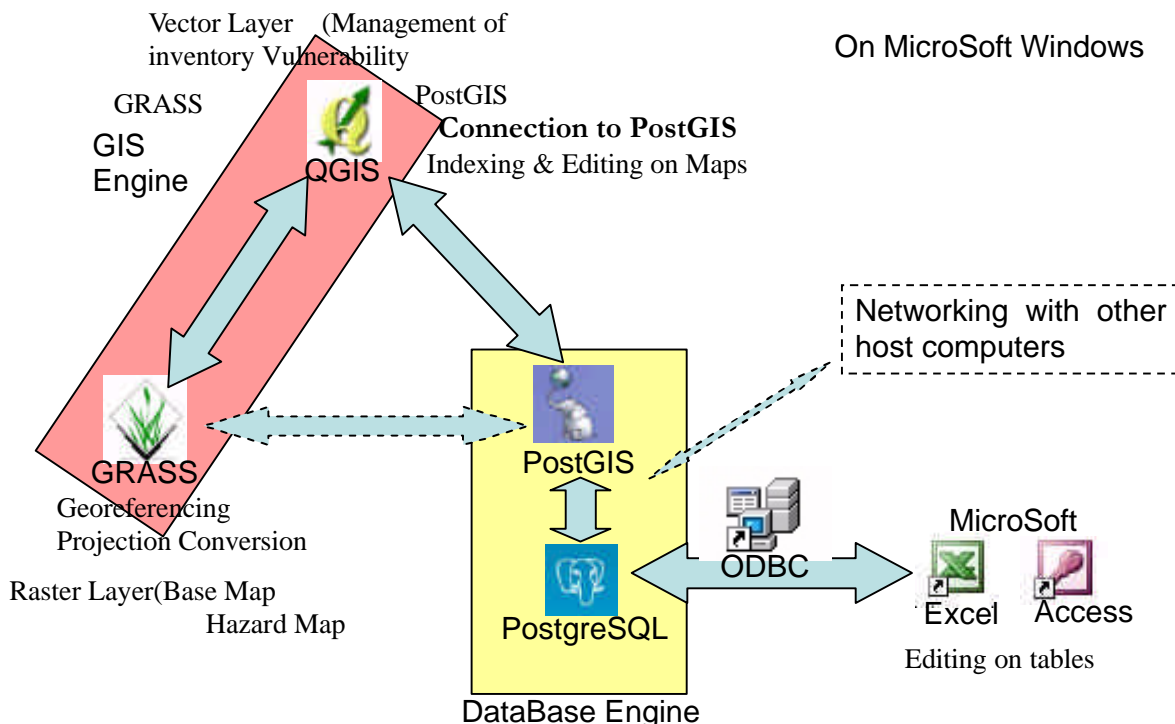


Figure 2.1 Out line of the Management System composed of the selected Free Software.

## 2.2 QGIS

QGIS is lighter GIS engine than GRASS and good at browse the prepared raster layers in GRASS. For vector data, QGIS can process them in GRASS and convert their projection system automatically (On the fly projection). For raster layers, QGIS has function to make Pyramid structure to speed up zoom and pan them. The most advantageous feature is that to connect to PostgreSQL through PostGIS. Moreover, QGIS can directly access to layers stored in GRASS. Therefore, QGIS is expected to be used to browse raster layers, digitize (pick up) information on them and store them as vector layers into Database. Additionally, QGIS can import the data from handy GPS equipment. Namely, QGIS is used as the graphic front end.

## 2.3 PostGIS

PostGIS is a socket between PostgreSQL and GIS engine. This *spatially enables* PostgreSQL server, namely, makes it a backend spatial database for GIS. Through PostGIS, users can manipulate the information in tables of PostgreSQL from QGIS.

## 2.4 PostgreSQL

This is already world widely famous free DataBase engine of which handbooks can be found easily in bookstores. Through Post GIS, this can be connected to QGIS. PostgreSQL itself has networking functionalities through LAN and InterNet. Moreover the data of PostgreSQL can be retrieved through by Open DataBase Connectivity (ODBC) of MicroSoft Windows into MicroSoft Excel and Access. The import/export of data can be done also using files in CSV format. This gives alternative front end with that users can edit data tables directly.

## 2.5 Other freeware

Other freeware: FWTools136 and AVCE00-2.0.0-win32 are also used together with above mentioned software. They are used, e. g., for converting Map Info Tab to Shape file, importing Shape file directly to PostGIS.

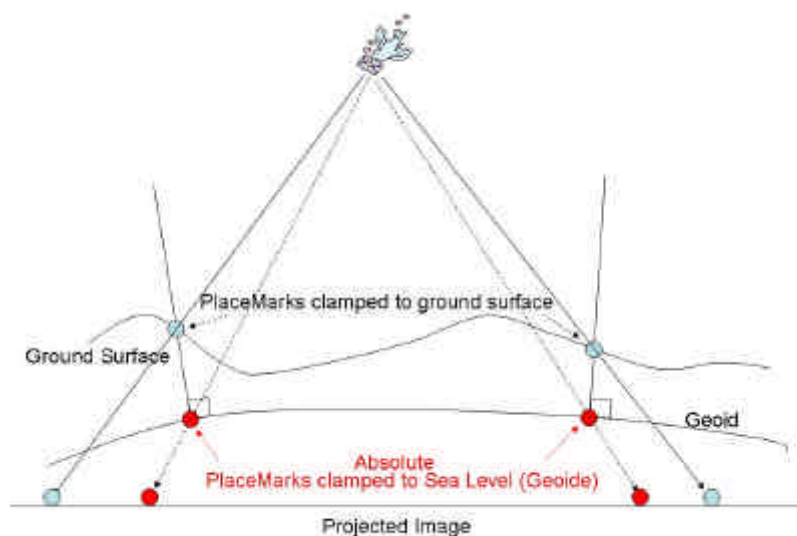


Figure 3.1 Schematic Illustration to understand the relation of PlaceMarks *clamped to the ground* and those of “*Absolute*” with mapping rule for the image of ground surface to the geoid.

## 2.6 System requirement

Unfortunately, it is not clear what specification is required for them. The followings are known at least. Cygwin on that GRASS works does not work on MicroSoft Windows Vista. Available space in HD more than few Gbyte is required to handle the several raster layers together.

## 3. SATELLITE IMAGES USED AS BASEMAP

To manage the inventory at earthquake hazard a big scale map on that individual dwellings can be identified is indispensable. It, however, is not always available all over the world. For the capitals it neither available for all countries. Recently, satellite images of high resolution are available (*e. g.*, Quick bird) and can be used in place of big scale map although their precision is not enough for the geodetic usage due to lack of survey on ground surface. They, however, can be used for various purposes including making earthquake risk map.

Recently, the services of free satellite image provision has been started, *e. g.*, Google Earth, and attract us because it is expected that these images may be able to be used where any big scale map is not available. Of course, it is necessary to follow the requirements that the providers set to protect their rights if we want to use images downloaded from these services. In general, personal and non-commercial use are allowed fortunately (visit the corresponding web pages of each services and confirm the policy and regulation). Therefore, they can be used for community based disaster mitigation activities by the inhabitants themselves.

Deformation of the image due to bird eye view does not matter for this purpose targeted on a small area. Neither, error of absolute value of coordinates. It, however, is sometimes preferred to use geographical coordinates or the projection system that is usually used, if the education of geography or geodesy is included among the aims of the activities. This can be realized semi-manually using PlaceMarks that are available on Google Earth Browser, however time consuming (Figure 3.1).

## 4. INSTRUCTIONS FOR BEGINNERS

The official technical documents for the above mentioned free software are not easy to understand for beginners in comparison with those of commercial ware. Moreover, two or three software have to be used together in “synchronized” way, solutions can not be found in the manuals of individual ones. Therefore, the following instructions have been prepared in files of MicroSoft PowerPoint for convenience of beginners.

### 4.1 Installing and Setting up Software:

- 1) How to install GRASS6.2.2 together with Cygwin and FWTools136 and AVCE00-2.0.0-win32 (Install of GRASS is often failed due to unknown cause. We have detected a tendency that this difficulty occurs with PC that has many free softwares installed. With PC newly used we have not had this difficulty.),
- 2) How to install qgis0.8.1,
- 3) How to install PostgreSQL-8.1.4 with PostGIS (As shown in Figure 4.1, PostgreSQL is installed and works as a service of an independent account.),
- 4) How to set Open DataBase Connectivity of MicroSoft Windows.

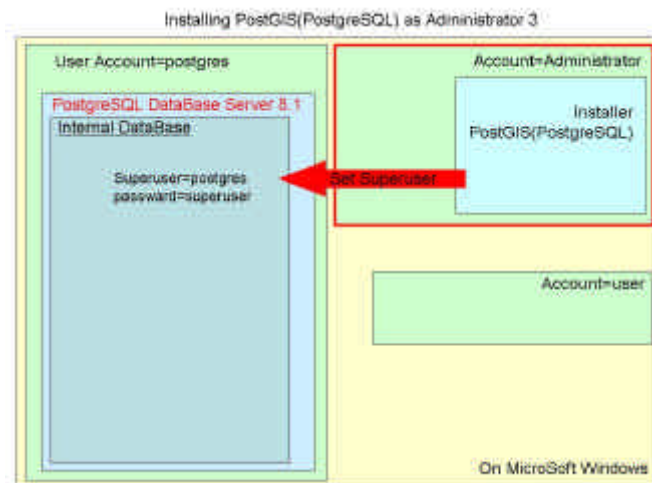


Figure 4.1 Schematic illustrations about PostgreSQL on MicroSoft Windows. PostgreSQL is installed and works as a service of an independent account.

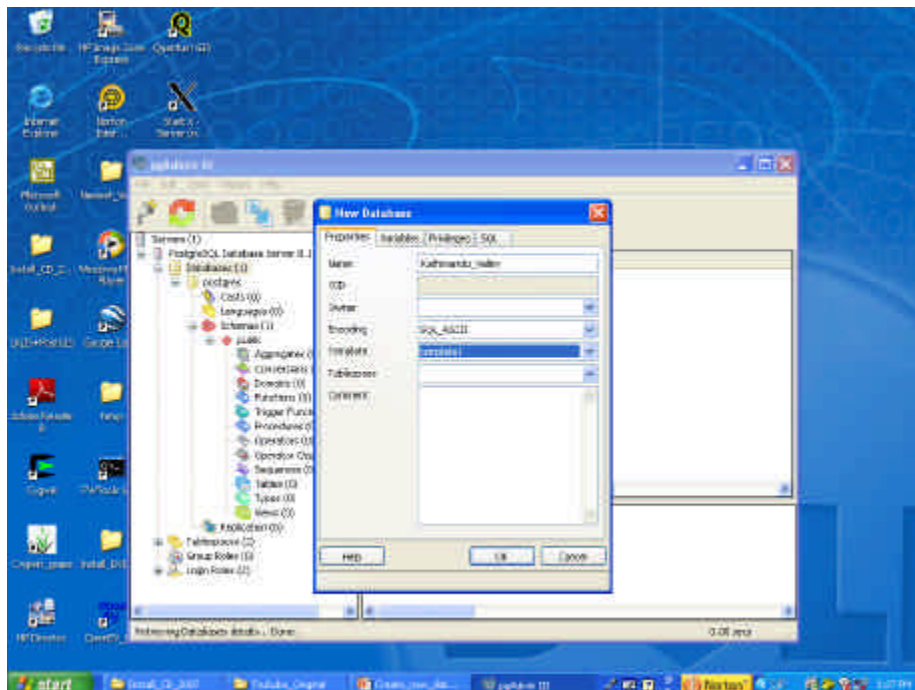


Figure 4.2 Creating a new database from pgAdminIII of PostgreSQL.

#### 4.2 Preparation for tasks on GIS:

- 5) How to create a new database on PostgreSQL using pgAdminIII (Figure 4.2),
- 6) How to create a new LOCATION-MAPSET for latitude – longitude system on GRASS (LOCATION - MAPSET structure is the core concept of data management of GRASS (Neteler and Mitasova (2008)),
- 7) How to geo-reference, rectify and merge satellite images using GRASS semi-manually and convert it from latitude-longitude system to other projection system, *e. g.*, Universal Transverse Mercator,
- 8) How to make Pyramid structure of raster layer on QGIS to speed up panning and zooming.

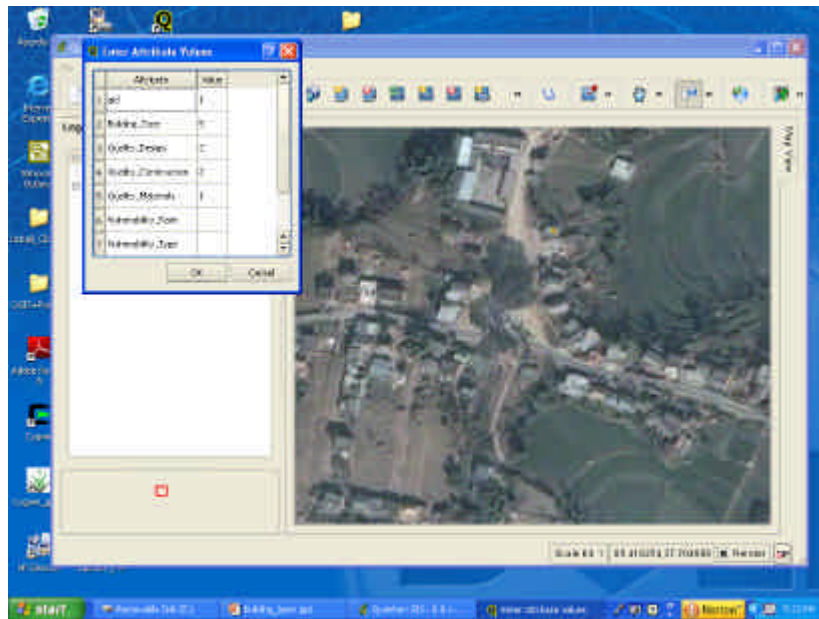


Figure 4.3 Typing in the information corresponding to a captured point data. These data are stored into tables of PostgreSQL through PostGIS. Background Image taken from Google Earth.

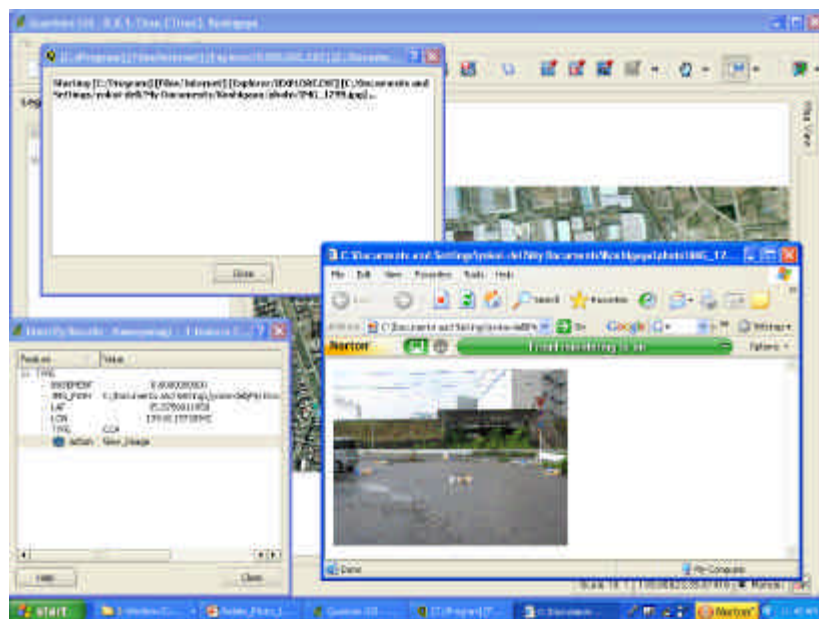


Figure 4.4 Example of Action attributed to Point data. Action “View\_Image” related to *aexplorer.exe* is launched by clicking the icon of Action using the input image (photograph in this case) registered in a table of PostgreSQL. Background Image taken from Google Earth.

**4.3 Tasks for loading existent GIS data:**

- 9) How to convert Map Info Tab to Shape file,
- 10) How to load Shape file into PostgreSQL through PostGIS,

#### **4.4 Tasks for creating new GIS data:**

- 11) How to create vector layer and capture Point Data and give attribute values on QGIS and store them in PostgreSQL (Figure 4.3),
- 12) How to create vector layer and capture Line data and give attribute values on QGIS and store them in PostgreSQL,
- 13) How to create vector layer and capture Polygon data and give attribute values on QGIS and store them in PostgreSQL,

#### **4.5 Task for ordering information in Tables of PostgreSQL:**

- 14) How to extract the coordinates values from the geometry data and store them in PostgreSQL (they are necessary if used in data processing afterward because the geometry data can not be read directly without this process),
- 15) How to extract attribute values of other vector/raster layers at the location of Point data and store them in the table of PostgreSQL.

#### **4.6 Miscellaneous tasks:**

- 16) How to export table from PostgreSQL to CSV file. Then, import CSV file to PostgreSQL after processing. It is expected that the data processing by calculation, simulation and evaluation are conducted not in GIS engine, not in DataBase although they have corresponding functionalities, but in Microsoft Excel spread sheets or by custom made programs that can read files in CSV format.
- 17) How to launch other programs from QGIS through PostGIS (Figure 4.4). This functionality allows to relate Vector data easily to information in files of various forms, *e. g.*, images, lists, tables, slide sets, zipped files etc..

The abundant functionalities of GRASS, QGIS and PostgreSQL have not yet been explored yet by these instructions but only few necessary for beginners. It is expected that users explore more advanced way of usage.

## **5. EXPECTED USAGE**

Education and dissemination of knowledge are the first target of the free GIS – DataBase system explained above. This can be a good educational material to motivate students, because not advanced but basic knowledge of various related fields is required, *e. g.*, Geography for geo-referencing. This also can be an entrance to the Information Technology: GIS, DataBase and Space Technology. The costless feature can be convenient for education and also for the second target that is Community Based Activities, namely collaborative Do It Yourself supported by NGO or NPO.

QGIS-PostgreSQL combination can make note a PC work as a mobile data collector for field work assuming that the BaseMaps are prepared using the full set: GRASS-QGIS-PostgreSQL in central office. Data transfer can be conducted using interim files, *e. g.*, in Shape format. Of course, this mobile collector can work with other free or commercial GIS systems via interim Shape files.

## **ACKNOWLEDGEMENT**

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## **REFERENCES**

- AVCE00-2.0.0-win32: Available at <http://avce00.maptools.org/avce00/>  
BSD Public License: <http://www.opensource.org/licenses/bsd-license.php>  
Dassau, O., S. Holl, M. Netler and M. Redlob (2005), GRASS GIS 6.0, GDF Hannover.  
FWTools136: Available at <http://fwtools.maptools.org/>  
GNU General Public License: <http://www.gnu.org/licenses/licenses.ja.html>  
Google Earth: <http://earth.google.com/intl/en/>  
GRASS: Available at <http://grass.itc.it/>  
Neteler, M. and E. Mitasova (2008), Open Source GIS: a GRASS GIS Approach, Springer.  
PostGIS: Available at <http://postgis.refractor.net/>  
PostgreSQL: Available at <http://www.postgresql.org/>  
QGIS: Available at <http://www.qgis.org/>