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THE PRELIMINARY USE OF MAPINFO PROGRAMME TO EARTHQUAKE HAZARD ASSESSMENT IN THAILAND AND MAINLAND SE ASIA

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SUMMARY

MapInfo provides a complete toolset for a widespread, cost-effective deployment of desktop mapping for earthquake studies in Thailand and mainland SE Asia (92° – 100° E longitudes and 0° – 25° N latitudes). The program with the combination of the database software can give rise to the leverage of desktop mapping and the power of geography to correlate, visualize and analyze data. As a result varieties of patterns and trends can clearly highlight the earthquake-prone area and related situation for seismic hazard zoning as well as help improving decision making of regional and urban planners.

The MapInfo stores information about an object's location (spatial data) and type (attribute data). Data within the MapInfo are characterized into a number of separated layers, each dedicated to a specific theme. These data are stored in a vector or raster format. Vector data may comprise polygons within SE Asia region, such as geologic units, lines such as faults and national boundaries, and points such as locations of earthquake epicenters and cities. Therefore, once an object is stored as vector data, a number of attributes describing that object are also stored. Raster data are herein remote-sensing information, such as the 1993 NOAA-11 space-borne enhanced images.

The MapInfo has demonstrated that digital data are easily overlain by the vector data into a raster form. Buffer zones around the mapped position of specific features can be created allowing the more realistic modeling of an earthquake hazard. Consequently, active fault traces that are the lines on the ground surface where ruptures occurred during earthquake events, are specified and delineated. Accurate mapping of such fault traces forms the very essential information and is represented as the lines highlighted in MapInfo. Since future ruptures along the fault traces may take place along the same line, and ground-shake may occur at about 20 km or so on either of the line. Thus, in order for the optimum uses of precise site investigation and detailed land-use planning, an active-fault database of MapInfo should contain the accurate locations of the known active faults within the region.

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INTRODUCTION

Earthquake hazard is the most serious damage that people have to face. Annually throughout the world, more than 300,000 earthquakes occur but fortunately, the greater parts of these are of slight intensity or take place in uninhabited areas. However, since the population is growing, industries and transportation are developing, and structures are being built, then the probabilities of earthquakes in the more populated area are increasing. In Thailand, there are more than 4,000 earthquakes that have been detected after the installment of the world-wide seismograph network since 1902. Although these earthquakes are relative minor to moderate in global norm, they appear quite essential for Thai and SE Asian people. The largest earthquake in Thailand, ever recorded historically, was the one which destroyed the whole ancient Chiang Saen City in A.D.1015.

The most destructive earthquake of mainland SE Asia ever recorded in the recent period happened in Myanmar on 5 May 1980 with magnitude of 7.3 and almost entire destroyed Pegu township with a few hundred injured and killed people. It was also reported that the biggest tremor instrumentally recorded at ML 8.7 tooth place on 26 June 1941 in Andaman sea (Nutalaya and others, 1985). Therefore, the necessity in acquiring data-base for earthquakes is arbitrarily essential, not only for the national scale but also the more regional and global ones.

MapInfo, a variety of a geographic information system (GIS), is computer-based system designed to allow storage, manipulation, analysis and output of all geographic information. Thus, the prime advantage of MapInfo can lead us to identify the spatial relationships between map features. Therefore, we present in this paper the application of MapInfo to carry out several operations or activities related to earthquake-hazard accessment (EHA) based upon currently multidisciplinary information.

COMPONENTS OF MAPINFO

Both hardware and software computer systems are inevitably required for the EHA. The hardware system comprises a set of PC-pentium 133 with the RAM of 32 Mb, 2 Mb display colour monitor (15 inch), table digitizer and a A4-size colour inject printer. MapInfo version 4.0, or MapInfo Professional, forms a major part of software our analysis. It provides a complete toolset for widespread, cost-effective deployment of desktop mapping. Thus MapInfo can assist us to produce maps with a great variety of many variegated displays, and capabilities of viewing and editing. Main tasks of MapInfo includes opening multiple layers at once, controlling individual layer properties with display and labeling, creating and modifying thematic maps, manipulating the map window view, finding information associated with a map layer, and controlling map projection and units.

DATA GATHERING

In our study, we limit the region within the longitudes between 92° and 110° E and latitudes between 0° and 25° N (see Fig.1). Since MapInfo can store information on both spatial and attribute data that are characterized into a number of separate layers, each of which is dedicated to a specific theme.

For the spatial data, MapInfo data can represent them on maps, or in a GIS, as either point, line or area features in both vector and raster format. Currently available information related to EHA can be afforded from several agencies in Thailand. For the data input, the main sources of information are applied from Thailand Meteorological Department (TMD), CCOP (UNDP), Thailand Military Cartography Department (TMCD), Department of Mineral Resources (DMR), and Electricity Generating Authority of Thailand (EGAT). Among these, data available from TMCD is most practically accurate.

One of the most important data difficult to access is geoscientific information, such as precise locations of active faults, rupture length, and paleoearthquake magnitudes. The two latter involve mathematics equations and models which can be calculated using the normal softwares (in our study we use the LOTUS 123 program).

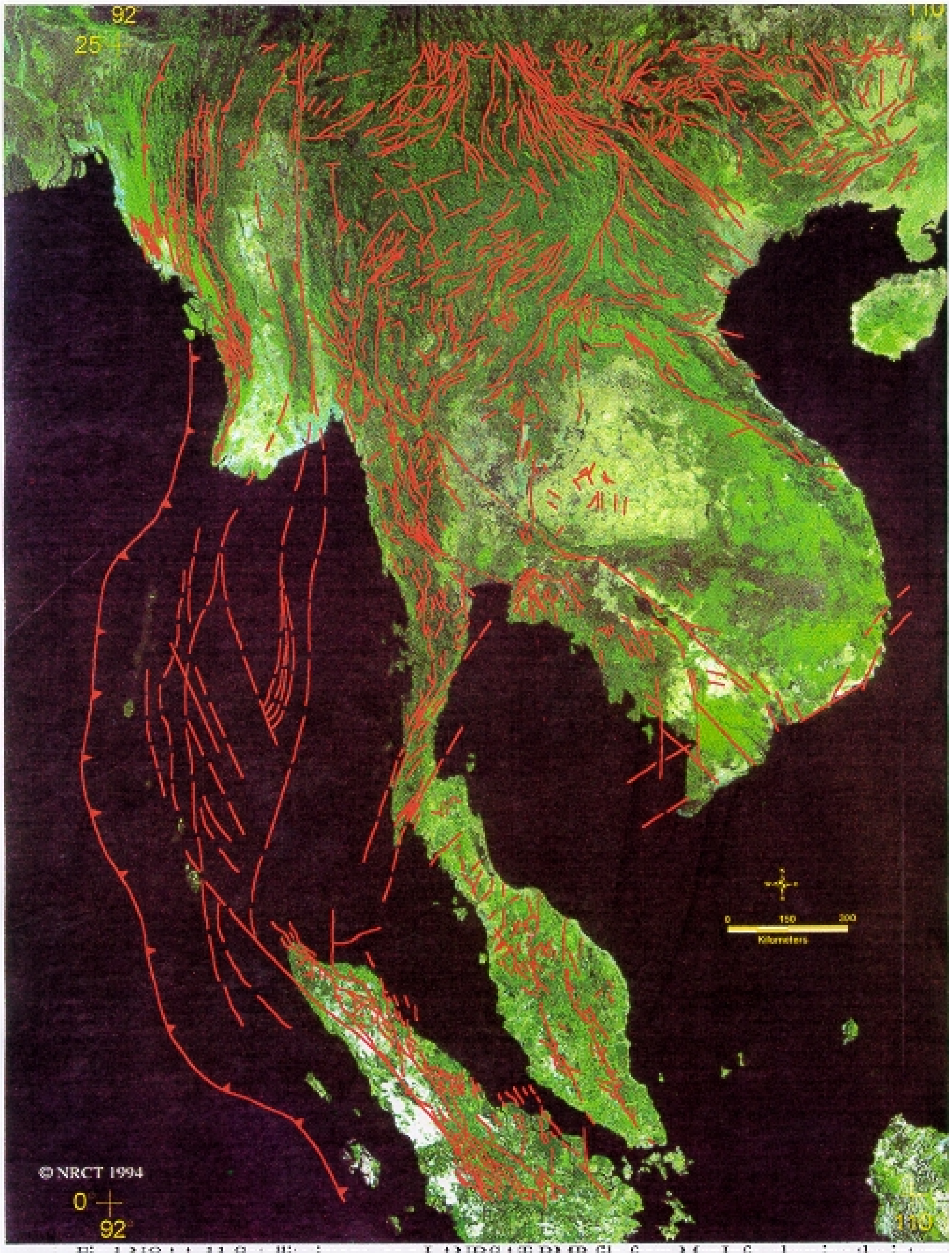

Fig. 1 NOAA-11 Satellite image, as a LANDSAT.BMP file from MapInfo, showing the interpreted fault traces (red lines).

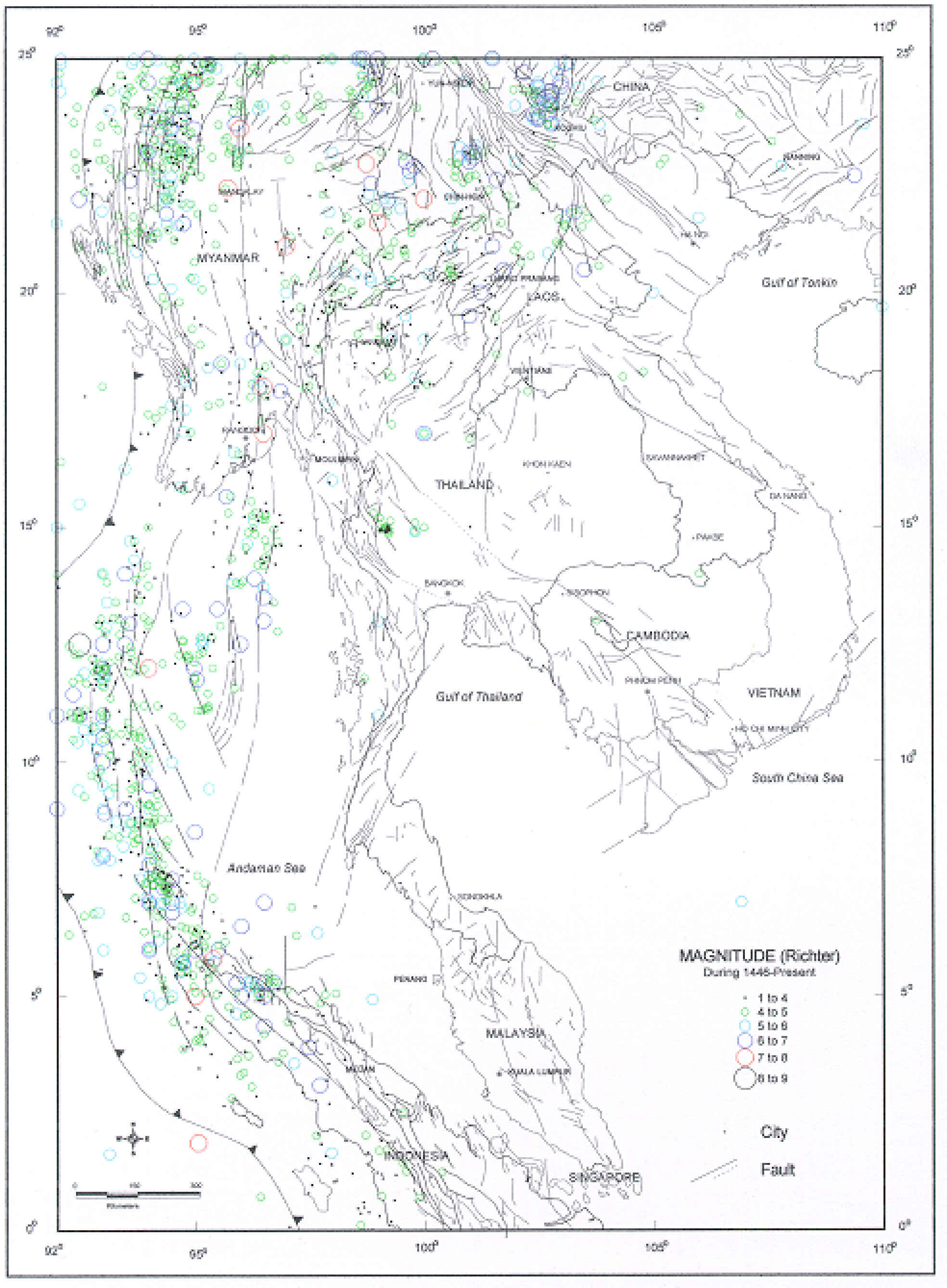

Fig.2 The overlay of variable earthquake local magnitude with the fault traces used for producing seismotectonic map (present = April, 1999).

Three categories of points are applied to represent locations of earthquake epicenters, locations of city and town and hot spring locations. The last category is in progress at present. A line feature consists of an ordered set of connected points such as Thailand and SE Asia country boundaries, and faults which in our case use the ones proposed by Charusiri and others (1998) for Thailand and by our NOAA image interpretation in conjunction with that of DMR (1980). An area feature (a region enclosed by line features) including geologic units, could be represented by an area element which is frequently represented in MapInfo by polygons. When an object is stored as vector data, any number of attributes describing that object is also stored. Raster data consist almost entirely of satellite-borne images, covering the whole SE Asia. In this study, the images were obtained by NOAA-11 in late 1992 to early 1993.

METHODOLOGY AND RESULTS

Once earthquake data are acquired, then they are assigned and arranged into a number of separate layers with specific themes. The data of MapInfo are in the DAT extension (.DAT) file and include all information involving in the beginning, e.g. fault from created by a tablet digitizer. If data are imported from the other file formats and the input of individual layers were accumulated, MapInfo files were subsequently saved sequentially as .DAT, .TAB, .MAP and .ID, respectively. Therefore one can change the data, the MapInfo can automatically modify the concerned files step. It is comparable that if any table in MapInfo (.TAB) acts like a sheet of a clear film, then a composite map (.MAP) is like multiple sheets of this clear film laid one on top of the other. Each of these sheets is like a layer that can be mixed matched to change the appearance of the map, and how the map may be analyzed. It is also demonstrated that when MapInfo redraws a map, it redraws from the bottom layer up, but when it is selected information, it selects from the top layer down.

Although, MapInfo allows one to add, delete and reformat data very easily and swiftly, the input data were herein arranged in sequential order, of which the one is rarely changed were stored first. In this study, we input satellite-borne image (or raster data) into the first (or bottom) layer, then country boundaries of SE Asia (polyline) with names were added to the next layer. AutoCAD (R12) program was used to digitize SE Asia administrative boundaries as polyline in UTM coordinate and saved as .dwg file format. Polylines of each country were hatched in the same layers, and were saved as data exchangeable format (i.e. DXF extension). Since MapInfo software should be compatible and acceptable with DXF file format. Locations of cities and main towns with their names as well as locations of hot springs (in Thailand and Myanmar are available only) with their descriptive information, were added and acted as subsequent separate layers.

Geologic and geotectonic units (polygons in Figs.3 and 4) formed the succeeding layer in conjunction with legend or explanation and age (attribute data). Geologic boundaries were interpreted, grouped and expanded according to the lithological and age (era) data from currently available geologic maps of DMR (1987), United Nation (1990, 1993), Nutalaya and others (1985) and CCOP (1993). Tablet digitizing of MapInfo program was used to delineate rock unit boundaries as polygons in latitudes/longitudes coordinate in reference to the Indian datum. Polygons of each rock unit were hatched in different colours and separate layers. Seismotectonic zones (polygons) with their names were stored next. The fault traces (lines) are denoted with their latitudes/longitudes at both ends. Fault lines were also digitized as polylines connected in the same coordinates and were saved as data MapInfo format (.TAB).

Earthquake epicenter is the next layer name and its spatial data or points with varying sizes depending upon earthquake magnitude. The stronger the magnitudes, the larger the points. In our study, the earthquakes with magnitude (ML) > 8 are assigned as black circle, and those with ML > 7 - 8, > 6 - 7, > 5 - 6, > 4 - 5 and < 4 are assigned as red, blue, light blue, green and black respectively, with decreasing in size. As illustrated in Fig.2, individual ranges of earthquake magnitude are symbolized along with numbers of earthquake events displayed in bracket. The earthquake parameters are contributed by U.S. National Earthquake Information Service (NEIS), International Seismological Center (ISC), TMD, and Nutalaya and others (1985) as collection data. The coordinate range of basic earthquake data in the study area from 0° to 25° north latitudes and 92° to 110° east longitude, which covers the whole mainland of SE Asia data for historical and instrumental earthquake data input during 1446-1999 (present) A.D. The pre-instrumental locations could be in error by as much as 100 km. In our study, raw data of earthquakes, e.g. foreshock, mainshock, and aftershock, were stored in LOTUS 123. However, to produce the map with more significant meanings, some of the stored data had to be eliminated (foreshock, aftershock and incomplete data) and saved as worksheet data. Record of earthquake epicenters were directly imported from the LOTUS 123 program as worksheet to MapInfo program and were designated field names for individual columns (e.g. latitude, longitude, magnitude, intensity, sources, year etc.). At this stage, the

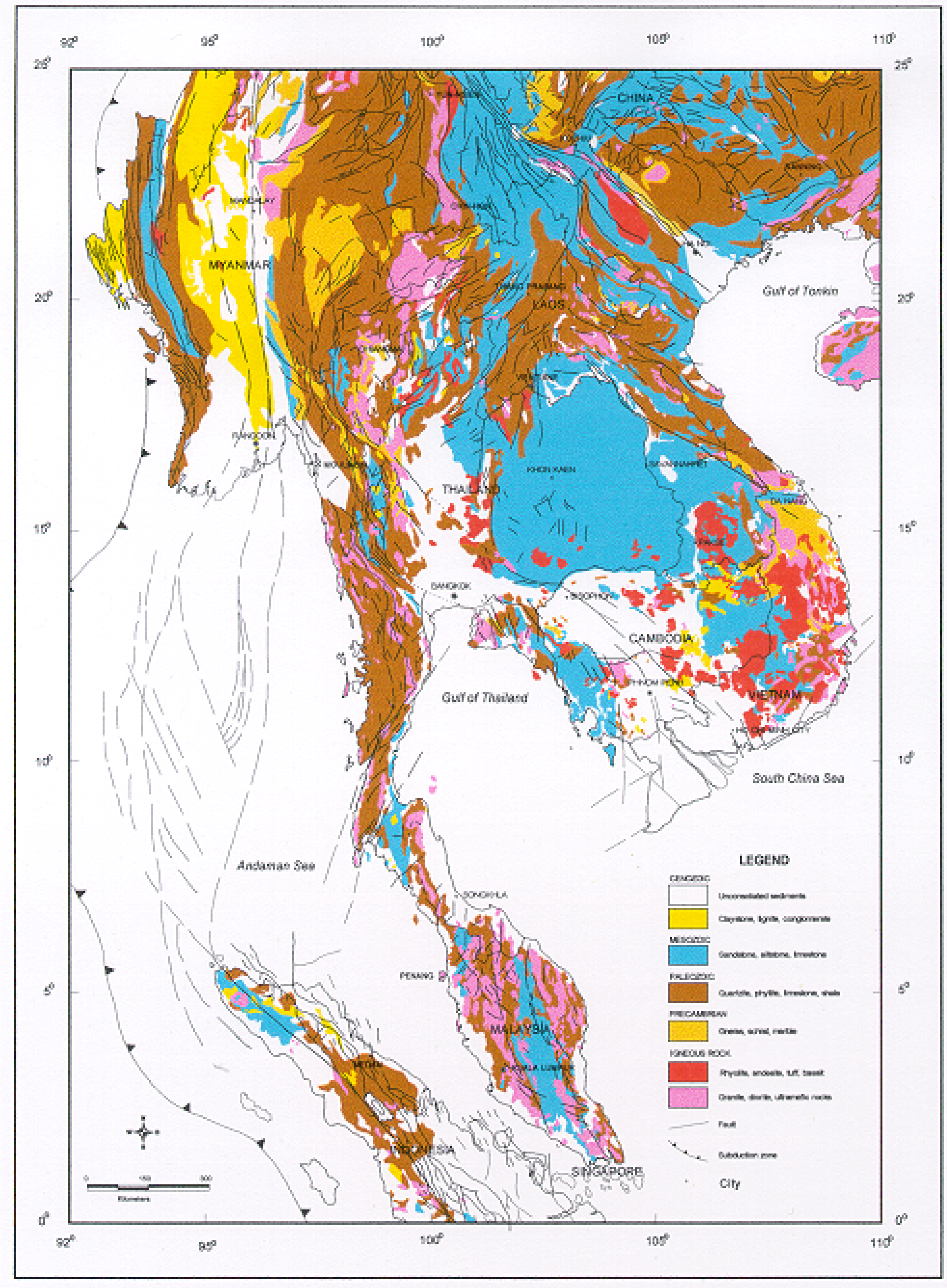

Fig.3 Geologic map of Thailand and mainland SE Asia (see text for references).

MapInfo, locally stored data of earthquake epicenters (in the LOTUS 123 file format), can be easily accessed and combined into a map view of SE Asia boundaries, geologic units and fault lines. The epicenters can reveal points and trends in data that otherwise go unnoticed. The MapInfo has demonstrated that digital data are most easily overlain by the vector of earthquakes and fault traces into a raster form of satellite-borne image. It is anticipated that when all the available data are successfully input in the MapInfo, the more appropriate EHA map will be then produced digitally. With the combination with the PGA-dominated seismic zones (Warnichai and others, 1996), we are able to redraw the new proposed map shown in Fig. 4 more effectively and accurately, Since the pioneer map by Warnichai and others (1996) was drawn with the statistical input and without essential application of geotectonic parameters.

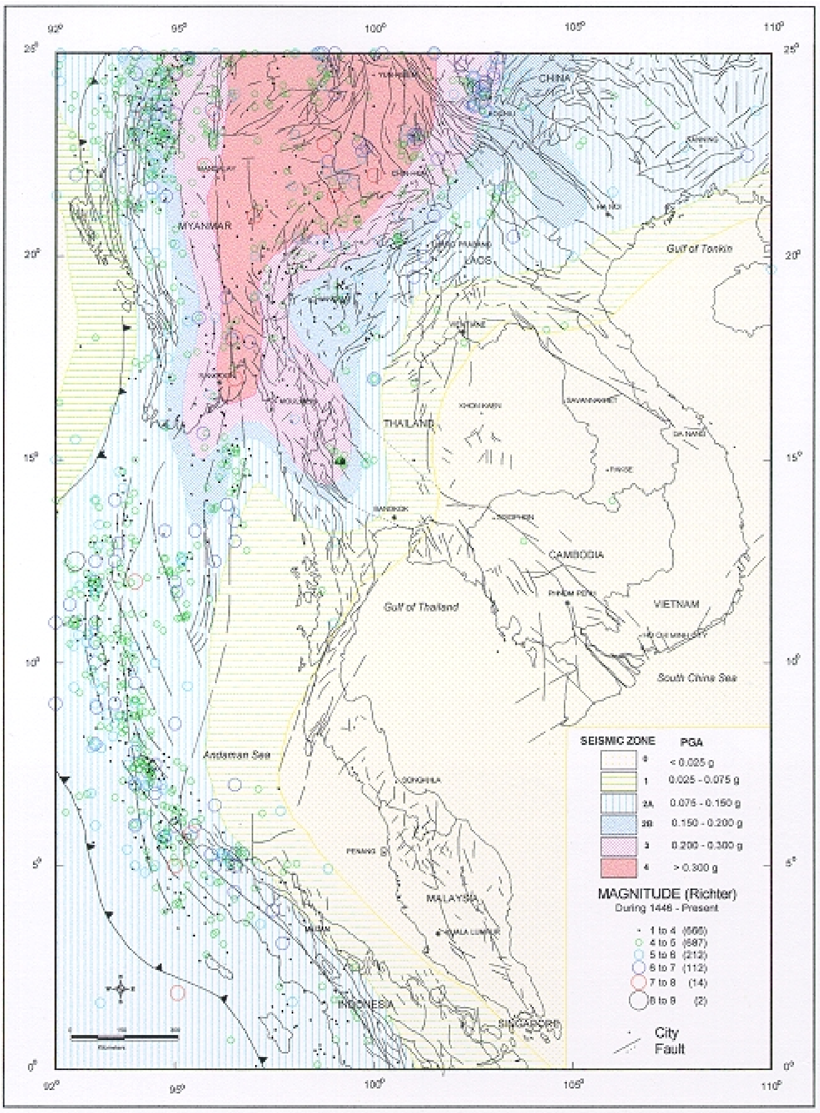

Fig.4 Seismic zone according to fault trace analyses, earthquake epicenter, and peak ground acceleration (PGA, Warnitchai and others, 1996), when g is acceleration of gravity.

Table 1. Analysis produce for MapInfo data chart for Thailand and mainland SE Asia earthquake hazard accessment.

Spatials	Types	Attributes	File Name
Earthquake epicenters	Point	Latitude/Longitude Magnitude Year/Month/Day/Hr/Min/Sec Intensity	Center
City	Point	Name	SE_city
Fault	Polyline	Name	Tec_line
Geologic units	Polygon	Type Age	Geol
Seismotectonic zone	Polygon	Uniform Building Code	Seismo_zone
SE Asia country boundary	Polyline	Name	Asia_map
SE Asia Landsat image	Raster	Date	Landsat

CONCLUSION AND RECOMMENDATION

The MapInfo programme to the study of earthquakes used in this paper seems to be a complicated method, but the computerized mapping techniques are simple and easy to operate. The advantage of this method is input data that can be easily corrected and added to the base map and the database system. Geologic map compilation and digitization are among the most time-consuming parts but need to be performed only once and will be considered as constant, because the map does not so much vary with time. The only changing parameters include earthquake epicenters and fault traces which can be redrawn using PC computer in a few minutes.

It is further recommended that buffer zones around the mapped position of earthquake epicenters and associated fault lines can be created, allowing for more realistic modeling of a particular seismic hazard. Taken into account the active fault traces that are the lines on the ground surface where ruptures and movements have occurred during an earthquake, accurate mapping of the traces is represented as the polylines in a MapInfo. While experience has shown that rupture on the fault trace will be along the same line or continue, ground-shake might happen out to 20 km or more on either side of the line. Seismic zoning is therefore capable defining as the process of accessing the earthquake hazard (EHA) in Thailand and mainland SE Asia region for the purpose of delineating seismic zones in which seismic engineering design (e.g. value of peak ground acceleration and returned period of tremendous earthquake) is required. Thus an active-fault database would contain the accurate location of the known faults in a region, since the previous maps were treated by seismological parameters rather than the combined seismological and geological ones.

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