A Critical Appraisal for the Use of GIS Software and its Applications

Manan Desai[1]

Post Graduate Student

Department of Civil Engineering

Amity school of Engineering and Technology

Amity University, Gurgaon, Haryana

Abstract - **Nowadays GIS has become very popular tool for the study of environmental planning and management, town planning, and geography etc. Although there are many implementations in GIS has been developed and that's why now it becomes very easy to use. Sometimes it becomes quite complicated because of its wide range of requirements of data for the decision making and its outputs. Many studies shown that results shown by GIS can depends upon the input that is done by users. Moreover GIS has also advantage to show both 2 dimensional and 3 dimensional outputs whereas disadvantage is that it is quite expensive software. The review of past studies related to GIS software and its functions and applications aims to find out best way to reach the results using its different kind of applications and also helps to solve users' problems that what type of applications or functions required for their study. This would help to give solution for the problems regarding GIS software.**

Key words: GIS, Mapping, Spatial Analysis

I INTRODUCTION

GIS (Geographic Information System) has capability to capture, store, manipulate, analyze, manage the data and give output of current spatial geographic data. It allow user to develop interactive queries and summaries spatial information, editing data in maps as per requirement of the research. GIS is tool which has many different technologies, processes and methods. Disciplines like engineering, management, planning, business and telecommunication, there are many applications of GIS that can be used. Location intelligence applications in GIS are widely used for location-enabled services and that is depends on two categories analysis and visualization. Nowadays, there are many different digitized data creation methods are there used for digital information in GIS software. Digitization is the most common method of them. This software can be used in many different disciplines like agriculture, archaeology, architecture and design, business, education, engineering, environmental studies, forestry, law and crime, medicine and public safety, public policy, real estate etc. GIS can show us geographical patterns, changes occurred in given period of time, spatial implications. Here there is an example for visualize data by making spreadsheets in which the longitude latitude coordinates are given and how GIS shows its figure when you added these positions on a map.

name	latitude	longitude	pop_min	pop_max
Seattle	47.570002	-122.339985	569369	3074000
New York	40.749979	-73.980017	8008278	19040000
Miami	25.787611	-80.224106	382894	5585000
Los Angeles	33.989978	-118.179981	3694820	12500000
Dallas	32.820024	-96.840017	1211704	4798000

Figure 1: Attribute table

Figure 2: latitude and longitude on a map

In this paper uses of GIS software for the different kind of purposes are reviewed. This would in help for the GIS software related researches.

II PAST STUDIES

Palaniyandi Masimalai (2014) studied about the rapid epidemiological mapping and health care management for the filariasis in india. She used GIS software for mapping of vertical and horizontal structure of particular dieses. The aim of the study was mapping of infection rate, occurrences, sex, age group, dieses transmission, virus load etc. she also studied the spatial trend of dieses transmission and spatial modeling. Her study lead to the conclusion that GIS has become most important decision making tool fr the health-care management in all over the world particularly in india. She also added that GIS was not only used for the mapping of geographical distribution for the particular disease but it can be also used for surveillance, investigation or for the ongoing program to control the disease.

Dimitris Potoglou, Pavlos S. Kanaroglou (2005) creates a model to estimate the air pollution and mapping for the vehicular pollution. They also have done dispersion model and spatial data analysis in their study. They studied that how carbon monoxide concentration can be mapped through the application in GIS. They showed patterns of pollutants, emissions, traffic flows etc in their research.

Their research was concluded that traffic pollution is the major contributor in emissions in both developed country and developing country. Application CALINE-4 shows the estimation of air pollution and mapping. Model showed the concentration level of carbon monoxide under the base-case scenario of 2006.

Younkook kim et al. (2010) developed a GIS based urban air quality model for the NO_2. They have showed the concentration of NO_2 for all seasons like spring, summer and fall. They also have done the elasticity analysis for both WVKT and solar radiation for every one hour. It have seen that mostly NO_2 is emitted by vehicular flows and also generated by the chemical reactions in the atmosphere the $OH-$ radicals reacts with the NO_2 which is produced under the UV radiation. They also stated that the model has limitations for the use of urban areas because of the large data requirement and computation work over the model.

Farzana Danish (2013) studied the dispersion pattern of pollutants in the atmosphere. His main aim of the research was to visualize and assess this kind of patterns so that people can understand about the changes occurs in atmosphere. He has done this research in Lima Ohio for SO_2 only. He showed the comparison between predicted concentration and observed concentration for 1 and 24 hour respectively as a conclusion.

Robert A. Rohde, Richard A. Muller (2015) used interpolation method and four month pollution data to derive maps in eastern china because of the heavy traffic rush in some particular area. They have chosen the real time monitoring station for hourly data in their study. They have concluded that the $PM_{2.5}$ concentration in Beijing was too high due to the heavy vehicular pollution. They noted that 37% of the study area had $PM_{2.5}$ fluxes >0.5 $\mu g/m^3/hr$.

Marzena Wicht et al. in their study they talked about main methods for mapping the urban ventilation corridor they have also mentioned that if they are properly designed it will increase the air quality and also reduce the heat stress. They have talked about warsaw which located in temperate zone where, two concept of morphometric analysis were used. In this method firstly used the roughly mapping calculation that analyze the roughness length (Z_0) and zero place displacement height (Z_d) and also analyze their distribution for the eight wind direction and secondly grid-based index mapping approach. They also described about the advantages and disadvantages. These all methods are 3D building based methods.

Vinaykumar Kurakula (2007), developed a methodology to build a 3D and 2 ½D noise model. The model can analyze the 3 dimensional noise effects. His case study was based on 3D model of Delft, Netherland. The model was simple 3D model involve 3D observation points which represents the virtual microphone. He used 3D IDW interpolation method to developed a 3D model. The study was lead to four part of conclusion where, first part talked about the basic information, methods and software required to build a model. Second part involved that how 3D and 2 ½D model

was developed using interpolation method. Third part showed the analysis of 3D and 2 ½ D model also a cross-validation for both model. And last part of the study is about potential applications of 2 ½D and 3D model.

David J. Briggs et al. (2010), mapping urban air pollution using GIS application. Regression based methodology for mapping air pollution caused by transport was derived by them. Study was mainly done for particular pollutant NO_2 in Amsterdam, Huddersfield and Prague. They surveyed the concentration of NO_2 in each center using passive diffusion tubes for the period of 2 weeks. They have concluded that the concentration of NO_2 was changed after very short distance nearly within 100m due to complex nature in urban environment. The map also gave good prediction for the unsampled point. They have used nearly 80 monitoring point for their research. They also added that the model also has some limitations due to the statistical optimization.

Nico Goldscheider et al. (2000) did their research on karst aquifers. They gave GIS based approach for mapping Vulnerability of ground water. But the study was conducted with consideration of karst type aquifers. PI method introduced in the study. PI methodology defines two main factor P factor and I factor. P factor stands for the effectiveness as a function of hydraulic properties of strata and thickness of protective cover between the ground water table and surface water table and I factor indicates a degree of protection cover in which it bypassed through surface flow and near surface flow. There was a statement in this study that in European countries, karst aquifers are very important source of water. Study introduced the basic introduction of PI method that how it actually works and also construct the vulnerability map at extreme, moderate and low levels respectively. Also gave results of effectiveness of protection cover (P-factor) and degree of bypassing (I-factor) at extreme, moderate and low levels respectively.

Finbarr Brereton et al. gives a report on GIS analysis mapping and linking contextual data for the European countries like Austria, Belgium, Finland, Poland, Spain etc. they have considered about 23 countries in their study. They also have mentioned country wise total monitoring stations. Comparison of PM_{10} between 2001-2010 years also displayed in the report. The data were compressed in NetCDF format with resolution of 0.25 degree for maps for mean annual temperature between 2001 and 2008. For the main purpose of this study, the original 44 land use categories of the CORINE nomenclature were re-categorized. They are given as residential, forestry, mines and dumps, green urban species, agriculture land, commercial and industrial, natural areas, water bodies etc.

Amrit Kumar et al. (2015) reviewed about GIS applications used in urban traffic air pollution exposure. Study basically introduced about pollution generated from motor vehicles, factors affecting vehicular pollution, worldwide scenario of air pollution, annual mean of $PM_{2.5}$ and PM_{10} in various countries according to WHO (2014), trend of air pollution

in India by domestic (8%), industrial (20%), and vehicular (72%) in urban city according to CPCB, 2012. Review also mentioned information about various annual mean of $PM_{2.5}$ and PM_{10} in various Indian cities according to WHO, 2014. Study also gave a report on annual average percentage of $PM_{2.5}$ and PM_{10} respectively from the brick kilns and vehicular exhaust emissions in Delhi city in 2014. Emissions and dispersion model, land use regression, exposure analysis application also reviewed in this study.

I.K.Wijeratne and W.Bijker (2006) did mapping dispersion of urban air pollution with remote sensing application. Southern part of Netherland area was selected as a study area. Regional, city, street, cloud areas were selected as a ground station in the study. Using linear regression they established relationship between ground data and processed image out. Study was conducted in consideration of Black Particles, PM_{10} and carbon Monoxide (CO). In the end of study they gave results of Daily average of black particles over study area and Hourly average of PM_{10} over the study area. Minimum concentrations of BP, PM_{10} and CO are 5.87, 47.73 and 0 in $\mu g/m^3$ respectively. And Maximum concentrations of BP, PM_{10} and CO are 66.80, 142.44 and 856.56 in $\mu g/m^3$ respectively.

Praful M. Udani and Dhruvesh K. Mathur studied about GIS data base design, development and flood analysis of Olpad Taluka in Surat District. Firstly they gave introduction about types of flood and about study area. In the study they have talked about data base design by Thematic layer, Administrative layer, Topographic and Facilities and in the end of the study they showed results of the study they divided villages by higher risk zone, medium risk zone and lower risk zone.

Khaled Ahmad Al (2010) studied about air pollution and mortality rate and its statistical analysis and mapping GIS application. The main purpose of the study was statistical analysis of air pollution and mortality rate with the help of buffer analysis and correlation analysis of Spear's man rank order. He developed map for the mortality rate due to pollutants and also for the concentration of NO_2, SO_2 and CO. he also gave basic information about effects of lead, Particulate Matter, Carbon Monoxide, Sulphur Dioxide, Nitrogen Dioxide etc. the study lead to conclusion that association between air pollution and number of deaths vary with different geographical areas in Brisbane city of Australia. And this relationship emerges to be stronger in the area where the traffic or numbers of vehicles are very heavy.

Mengesha Endalew Zerium (2017) tried to identify attraction elements for tourism in Gondor town and its surrounding area. He also identifies no spatial data's essential to develop touristic activities for tourism and proposed a web based GIS portal to increase the tourism in Gordon town. The main aim of developing interactive GIS based map to improve and promote tourism activities in that particular area. This was developed through free and open source software for fast improvement and to develop

distribution of tourism spots using World Wide Web (www).

Lucy Mulongo Mamai et al. (2017) developed web system. System which allows dissemination, analysis of water analysis and extraction over the internet. Nairabi Northen region is one of the most important administrative region used for the case study. The researchers has developed open source WebGIS system based on quantum GIS, spatial data creation in GIS, WebGIS for MapServer and postgreSQL as a relational database. The developed open system allows users to view and interact with spatial data. The main purpose of the study was to improve its efficiency and effectiveness of data sharing and decision making process.

Victor Fernandez Nascimento (2017) describes the problem about managing Municipal Solid Waste in a city where population growth and economical development is increasing day by day. So, it's hard to manage proper disposal method Municipal Solid waste (MSW). They used multi-criteria decision analysis (MCDA) regulated by analytical hierarchy process (AHP) in Geographic Information System (GIS) software. Environmental impact susceptibility model (EISM) was also established for Municipal Disposal Website in state of Sao Paulo, Brazil. They have considered factors like pedology, geology, geomorphology, water resources and fifty other sub factors. The result of study showed that 82% of total territory situated in very low, low and medium environmental impact susceptibility and other 18% remaining of state land area and 85 landfills are located in high and very high environmental impact susceptibility. Study further added that the result of the study is dangerous because these 85 landfill received approximately 17,885 tons of MSW daily. Which is corresponds to 46% of all MSW in that state.

Mikko Nivala et al. (2016) studied the basic scenario of total forest chips consumption on the basis of statistically determined in 2012 or predicted in 2020 by assuming that total consumption of forest chips will reach to 13.5 Mm^3. They used GIS coding to spread different kind of forest energy fuel like logging residue, stumps and small sized thinning wood in procurement model. By the subtracting of combined heat, use of heat and power plants forest chips consumption for the municipality data the forest's chips regional balance map was made. The study showed that there is enough supply of forest chips for current and also for future demand if all forest assortments are used in proper manner or use efficiently. Whereas results of the study showed that there will be no extra potential left in some area at current forensic chip consumption rate. In addition zero potential area expands with the increases in consumption. Eastern and northern area in Finland were found as highest potential area while the western and southern were lack free potential.

Akram Javed et al. (2016) studied about the sediment yield of Govindsagar catchment area. The study has been carried out RIS LISS iii data. These data were used to analyze land characteristics. Mainly there were two points are

considered for Sediment Yield Index (SYI) of the catchment area that are surface derivatives and morphometric parameters. The study leads to conclusion that Govindsagar catchment has very low sediment yield. Which indicating sustainable land use practices and gentle slope.

Wahedul Islam and Subaran Chandra Sarkar (2016) introduced about the problems experienced by the study area such as traffic congestion, water logging, solid waste disposal and over urbanization etc. Study has been carried out for integrated study of land use pattern in Rangpur city, Bangladesh. Rangpur city is also headquarter of a division in Bangladesh which is perfect example for poor legislative actions, lack of public awareness and improper or inefficient management. Two main GIS (Geographic Information System) and Remote Sensing were used in study. Landsat Thematic Mapper (LTM) and Landsat Enhanced Thematic Mapper Plus (ETM+) were data sources and images taken in 1989, 2000 and 2014 respectively. The images which were generated in this study were geometrically and radiometrically corrected. Change detection method was also performed in this study. The study was classified into 6 main categories and they were on the basis of field study, geographical condition and remote sensing data. Results of the study showed changes in remotely detected land use from 1989 to 2014. Because of open spaces, planted trees, permanent water sources and low land have been transformed into build-up areas.

Sanaullah Khanet et al. (2016) tried to recording and quantifying changes in land use pattern and also land cover in temporal and spatial extent in Pishin District. Satellite images obtained from USGS official website from 3 LANDSAT satellites such as LANDSAT5, LANDSAT7 and LANDSAT8. The study was conducted for three years 1992, 2003 and 2013. Arc Map 10.1 was used for production of satellite imagery and maximum classifications of images was applied to detecting change in pattern. The study concluded that built-up area was increased by 5.84%, vegetation was at 3.89% water bodies also increased by 0.05% and only surface factor was decreased by 9.78%.

III DISCUSSIONS

The discussions mainly focus on various aspect and purposes of users of database preparations, their inputs and formats, and outputs using different function of GIS software. Examples are involving different disciplines such as socio-economic issues, environmental health and management, interdisciplinary studies in various regions are presented to show potential of GIS software and its application. The final results of such applications involves sustainable maps used for resource availability, land uses, vulnerability of land are accomplished using different software using its different vendors, which helps to integrate data by using modeling and analysis at various scale. Every applications needs different requirement based on various specification. For an example environmental planning and management need spatial data analysis and EDSS which helps to modeling using integrate monitoring

data and gives solution for particular problems in particular area like environmental impact assessment (EIA) including soil erosion, pollution and its impacts on both human and environmental health and their underlying factors. With the help of GIS and using couple of resources with specific model in land use or precipitation patterns or flood related data is useful for the predictions. And this kind of information is useful for management and improved process of dynamics.

IV CONCLUSION

This study has presented many examples of use of GIS software and its function for various studies. Also, GIS needs enormous data input is require for some extra tasks that's why it's necessary to put more data into it. There is an important link between the way in which user structured data into the geographical database system and the use of function to give its best output. It is clear that none of the current GIS software can handle tessellation data analysis and vector simultaneously. There are many study areas and each of them needs a different set of function. Most of the current GIS projects are helpless by staff difficulties and data collection. So it is wrong to say that there are no gaps in the functionality of current system. Integrated GIS, spatial analysis and network processing are main three key areas for attention.

V REFERENCES

[1] Masimalai. P "GIS for rapid epidemiological mapping and health-care management with special reference to filariasis in India." Int J Med Sci Public Health 2015;4:1141-1146

[2] Potoglou. D, Kamarglou. P "Carbon monoxide emissions from passenger vehicles : predictive mapping with an application to Hamilton, Canada." Sciencedirect.com Transportation Research Part D 10 (2005) 97-109.

[3] Kim. Y et al., "GIS based urban air quality model: The case of NO_2." 12th WCTR, July 11-15, 2010 – Lisben, Portugal.

[4] Danish. F "Application of GIS in visualization and assessment of ambient air quality for SO_2 in Lima Ohio." Master Dissertation, Department of Geography and Planning, The University of Toledo, 2013.

[5] Rohde. R, Muller. R (2015) Air Pollution in China: Mapping of Concentration and Sources. PLoS ONE 10(8): e0135749.

[6] Wicht. M et al. "Urban ventilation corridors mapping using surface morphology data bassed GIS analysis." Geophysical Research Abstracts. Vol. 19, EGU2017-1009-3, 2017. EGU General Assembly 2017.

[7] Kurakula. V "A GIS based-approach for 3D Noise Modeling Using 3D city Models." Master of Science Dissertation, International Institute for Geo-information Science and Earth Observation.

[8] Briggs. D et al. "Mapping urban air pollution using GIS: a regression based approach." International Journal of Geographical Information Science ISSN : 1365-8816. Vol-11, issue-7,699-718.

[9] Goldscheider. N et al. "GIS-based approach to mapping water vulnerability with special consideration of karst aquifers." Zeitschrift fur angewandte Geologie, 46 (2000) 3 : 157-166

[10] Brereton. F et al. "Technical report on GIS analysis, Mapping and Linking Contectual Data to the European Social Survey." Institution of the Cross-National and Multi-Level analysis of Human Values.

[11] Kumar. A et al. "GIS application in Urban Traffic Air Pollution Exposure Study : A Research Review." Suan Sunandha science and Technology Journal.Vol-2,25-37January,2015.

[12] Wijeratne. I and Bijker. W "Mapping Dispersion of Urban Air Pollution with Remote Sensing." ISPRS Technical Commission II Symposium, Vienna, 12-14 July, 2006.

[13] Udani. P and Mathur. D "GIS Data Based design, Development and Flood Analysis : A Case Study of Olpad Taluka in Surat District." Pelagia Research Library.7(4) 71-78 2016 ISSN:0976-8610

[14] Ahmad Ali. K "GIS-based mapping and statistical analysis of air pollution and mortality in Brisbane, Australia." Dissertation in Master of Applied Science. Queensland University of Technology Australia.

[15] Zerihun. M "Web Based GIS for Tourism Development Using Effective Free and Open Source Software Case Study : Gondor Town and Its surrounding Area, Ethiopia." Journal of Geographic Information System, 2017. 09(01) 47-58.

[16] Mamai. L et al. "Developing a Web-Based Water Distribution Geospatial Information System for Nairobi Northen region." Journal of Geographic Information System Vol-9, 34-46 February,2017.

[17] Nascimento. V et al "Modeling Environmental Susceptibility of Municipal Solid Waste Disposal Sites: A case study in Sao Paulo State, Brazil." Journal of Geographic Information System. 9, 8-33 February,2017.

[18] Nivala. M et al. "A GIS-based Methodology to Estimate the Regional Balance of Potential and Demand of Forest Chips." Journal of Geographic Information System.08 633-662 October,2016.

[19] Javed. A et al. "Estimation of Sediment Yield of Govindsagar Catchment, Lalitpur District, (U.P), India Using Remote Sensing and GIS technologies." Journal of Geographic Information System.

[20] Islam. W and Sarkar. S "Monitoring the Changing Pattern of land Use in the Rangpur City Corporation using GIS and Remote Sensing." Journal of Geographic Information System. 08(04), 537-545. January, 2016.

[21] Khanet. S et al. "Spatio-Temporal analysis of Land use/ Land cover Change of District Pishin Using Satellite Imagery and GIS." Journal of Geographic Information System. 8(3) 361-368 June,2016.