Paper 1735

Building Spatial Information Infrastructure for Kathmandu Metropolitan City (KMC)

Tribhuvan Man Singh Pradhan, GISS,
Information System Center, KMC

Abstract

Building Spatial Information Infrastructure for Kathmandu Metropolitan City (KMC).
Since 1998, the city has taken leadership in city development. Metropolitan has overall responsibility over urban spatial database development in response to citizens' demands. The city has to not only respond to citizens as a local government body and deliver services, but also disseminate GIS information. The methods of providing efficient urban service deliveries to the people simplifying decision-making are not implemented to the full extent because of a lack of basic spatial information infrastructure applied to complex city management tasks. Based on this concept, Information System Center of KMC is building a spatial information infrastructure to support in the services delivery, planning and decision making functions of KMC. This paper will outline applications and elements of the spatial information infrastructure being developed for the city.

This paper also includes a description of the methods used to identify, creating digital spatial data that may poses a threat of KMC situation as well as an inventory (and maps) of the spatial information in country's one of metropolitan city. The paper has been developed the current status of municipal level GIS datasets generation and discusses about the pilot application that may be lead to better quality GIS datasets. Data from different sources can now be used for geo-information system application generation that it is necessary to set their advantages. There are also many application of spatial modeling such as digital elevation model (DEM), triangular irregular network (TIN), existing land use zonation potential fire disaster due to petroleum (gasoline) station and identify the earthquake prone areas, and ways of processing and presenting them, other vector base spatial datasets are street name and metric addressing road network system, utilities line, various landmarks and metropolitan city physical boundary, and new research is constantly extending and improving there. So, this document discusses the development of a GIS database for the planning and management to different department of the KMC of Kathmandu.

General introduction

Kathmandu, the city of glory is one of the five municipalities in the Kathmandu Valley. It lies about 3 kilometers south east of the capital city. The old core area of the city starts from the ancient gate of the *Dhokas*. Which is very much similar to core city dwelling of the Kathmandu Metropolitan City. The streets are narrow with number of alleyways and courtyards. Up to now the ancient layout of the open and built-up areas has been gradually changed and has preserved the heritage sites such as *Durbar Square*, temples and monument and houses.

KMC at Glance

Country	NEPAL
Capital	KATHMANDU
Longitude	85^0 20' East
Latitude	27^0 42' North
Elevation	1350 m altitude of MSL
City area	5067 ha (50.67 sq km)
Population	671846 (2001) 427045 (1991)
Annual Growth rate	4.6%
Household	152155 (2001) 82293 (1991)
Average Household size	5.2
Average pop-density	175.7per/ha
Wards	35
Residential Buildings	66236 (2001) 53311 (1991)

Per capita income	360 US$
Rate of Building Construction	18.4 % (5309 in FY 2059/60)
Road Length	1036 km (Blacktopped – 31 %, Graveled – 16 %, Earthen – 26 %, Others– 27 %)

Length of Major Water Supply and Sewerage Trunk & Distribution Lines – 373 km

The rapid population has led to change in dwelling patterns of the core cities and the periphery of the Kathmandu Metropolitan City. Hence in the Core City it is usually observed highly rise concrete dwelling structures in core cities. As a result His Majesty's Government of Nepal has established on of Chaitra 2048 B.S. (1991 AD) one Metropolitan City and one Sub-Metropolitan City and other three municipalities in the Kathmandu valley. The metropolitan city's area has been spread out 50.67sqkm in recent IAP survey done at last three year.
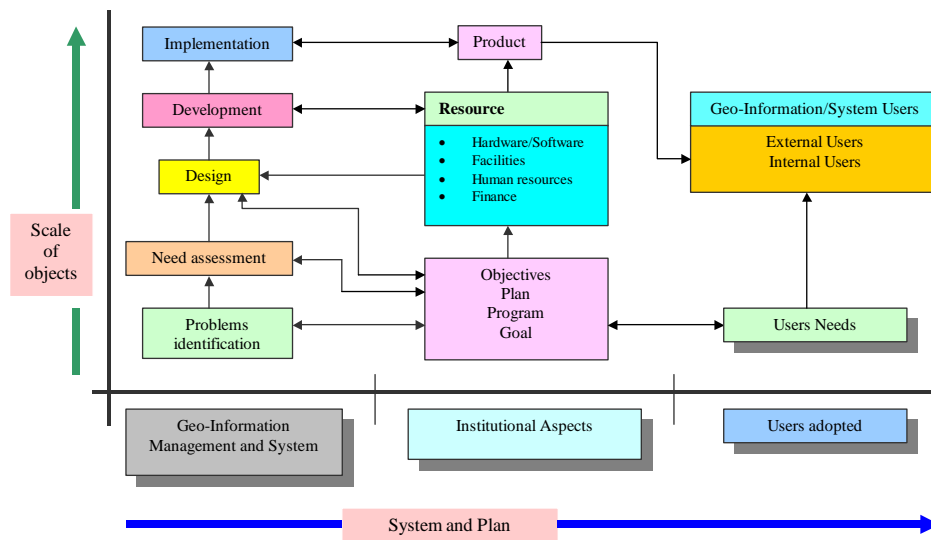
A Kathmandu Metropolitan City experiences
Now a day Geographic Information System (GIS) has been using widely in various field and various line of agencies but not so fully used in planning, management and decision-making process, except storing spatial and non-spatial database and cartographic layout. In state of art, the implementation of GIS is being used for municipal level or district level, it should be clearly identified what is the purpose and how GIS can help in different programme and development practice and procedure of metropolitan city. Instantly, when developing program is lunching by any cause to city management aspects, the base map is needed and sources of maps are major problems to every society. Therefore we have to aware every body via new geo-information technology (GIT) and how to aware the question is rise in every moment to building spatial information infrastructure on city level.

A part of this information system is support to the municipal infrastructure development and planning proposed which is needed to spatially identification of urban delivery services area and implementation management programme by using GIS methodology.

Geo-Information system management object model domain (Bottom up approach)
The object model domain of the geo-information is more concerning about the realistic option to management for geo-information plan to any institutional investment and implementation program of geo-science. In figure shown as the coordinate of the X, Y stand for X direction shows to approach towards the line of system and plan; Y direction shows to approach towards the scale of objects of institutional way out.
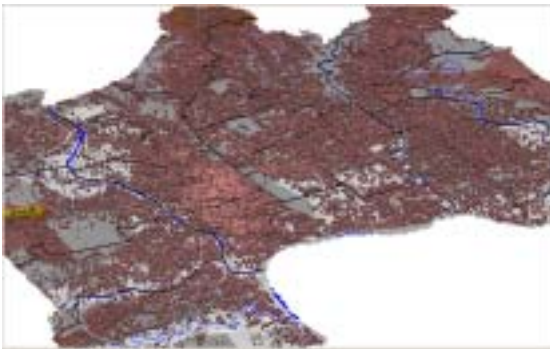

The following system plan of Geo-information technology (GIT) management has required to identify the problems which is most important for every institution to setup the GIS base city development programs, according to institutional financial matter. Then after need assessment can be done for future development in the context of objectives and object-oriented programs. Design part also most important to GI management system, in the sense how to handle the long-term program and short-term program (pilot/case study) for further development. In this part, the existing resources of institution must be considerable such as hardware/software, facilities, and human resource and financial. The implement part also plays the vital

role in GI management system when the system is applied to real base application sites and needs support as well as feedback of new tools and techniques like GIS. In same way the institutional must be needed vision of strategic plan, program and goal to users adopted accordingly, those who are use the GIS base spatial database for any purpose.
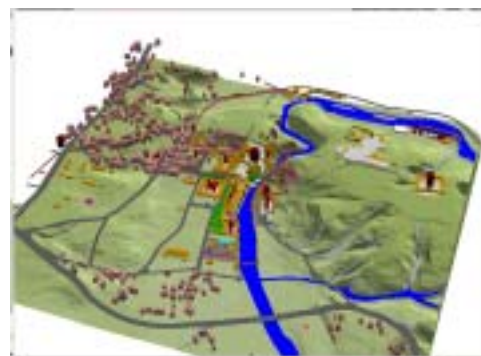
According to this main task, the need for Geographic Information System (GIS) approach is now well recognized in urban level services management for facilities mapping. These fields are concerned with communities or ward level peoples where the more facilities are needed to the citizens when services is more needed in daily life. This paper will outline application, and elements of spatial information infrastructure being developed for city. In addition, the paper presented that the developed information on different types of spatial data – including vector base digital maps, aerial photo, remote sensing and other non-spatial data sets, their purpose as well as technical, policy and institutional issues related to the process of developing information infrastructure for the Kathmandu Metropolitan City. The spatial database and analysis are the first to cover the whole of the country's one of metropolitan city on a large scale. We are confident that this comprehensive report and digital database will be of service to scientist, planning and decision makers in many areas of urban context. Through their informed actions, we hope it will contribute to improving the lives of those living in the KMC, and help safeguard future investments for the benefit of many people in the valley.

The current situation of the metropolitan city
Information technology is dramatically changing in the daily activities of human being. In the sense of the geographic information system technology is also evolving in computer base from last three four decades. In this manner, the laying of the real world geographical features are being always impact relationships between human and natural resources and man made resources in now a days existing society.

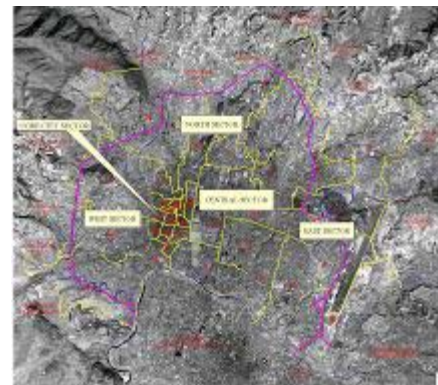*[Digital Elevation Model (DEM) 3D Panorama of KMC,*   *3D Perspective of Pashupati Conservation Area]*

Therefore, this system should be *"the timely implementation programme of GIS technology for municipal level GIS database development and GIS for city building programme. And we have to develop the timely warning information system to every citizens about man made disaster for save life"* According to the use of land, as the settlement of city is expanding at a steady rate of 10.4 % per annum from total land coverage of Kathmandu valley, it is being a lot of pressure on existing utilities and urban infrastructure. Here is a lack of information availability; suitability, compatibility, sharing and accuracy in proper data standardization of digital format for analytical model of identify the disaster prone area. The same problem faces are in administrative boundary positioning and projection system. So that it is very difficult to obtain digital information in easily by corresponding way and proper channel system, if available difficult to bring match them each other. This type of problems must be faced in disaster management programme for where is area and where is the location we have to identify immediately. Look at our city how complex for management point of view, for example 3d model is here.

The current emphasis of urban GIS development plan is setting up new technology and transfer knowledge with the objectives of establishing and institutionalizing a GIS for urban planning and management activities. The urban planning activities in Kathmandu are in their nascent stages and they are being organized using computer based modern approaches with satellite image of 1m PAN IKONOS. The urban GIS under development are also gradually evolving through the same process. It is very appreciable to the Kathmandu Metropolitan City's Hon 'able Mayor and go-ahead programme of information technology.
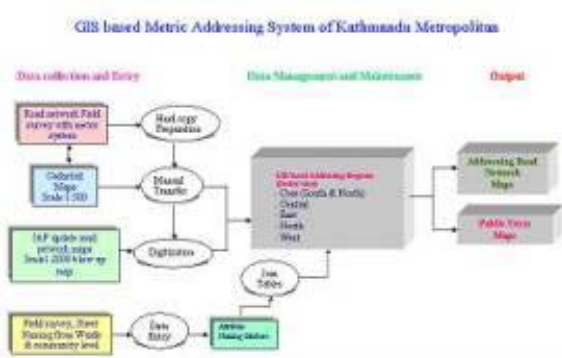
Figure on Procedure for building spatial datasets.

Metropolitan city area IKONOS image with KMC boundary and surrounded for updating

 KMC is trying to develop for these maps in GIS base digital cadastral information system (DCIS). Hope, it will be successed in future.

Cadastral level spatial and non- spatial database has been used for these ward levels and addressing system has being implemented now days. But the biggest problem is that many streets are not systematically like block by block as an avenue, so streets having too zigzags form in this city. In the case, for example, if any disaster may happened in any localities we can not provide immediately better services in that area because lack of address georeference of known location point. Using geographical analysis operations, it can be done how to manage the delivery services in time. And we can do the alert for that incident moment in such settlement areas.

Within the development of the building spatial information infrastructure database in GIS base digital cadastral information system (DCIS), there has been lengthy process between Revenue and Land Reform Department of government level and Local government of metropolitan city as to the meaning of the terms 'parcel' and 'property' and how they are dealt with in the conflict of different jurisdictions.
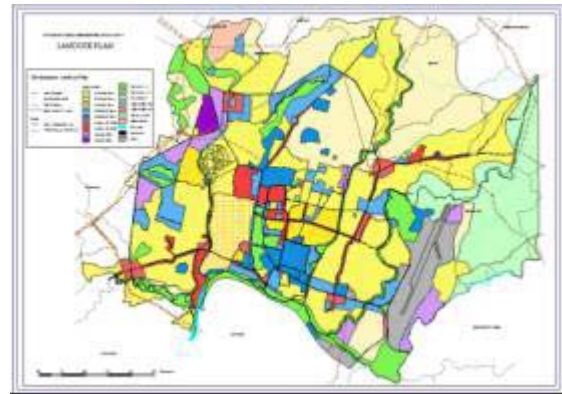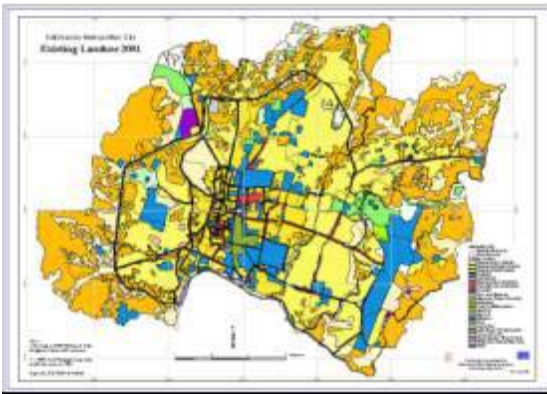

Application on Land management information systems (LMIS) to DCIS with Existing utilities for future management

In this case, the local self-governance act 2056, metropolitan city have growing responsibilities to plan and manage development at local level self. By building urban digital cadastral database, KMC is going to modernize key business and service delivery functions.

The house and land tax collection, building permit and management of metric address system are some among the most prominent applications of the system. The data of building information infrastructure for KMC comprise of the following components:
1. Building urban digital cadastral database for Kathmandu Metropolitan City have being nearly 1000 cadastral map sheets at 1:500 scale created by the survey is 250m x 250m covers area on map sheet.
2. Digital topographic mapping of Kathmandu Metropolitan City area at 1:1000 scale on map sheet of cadastral base for planning purposed and
3. Digital topographic mapping of Kathmandu valley at 1:10000 scales for valley floor planning and management.

The essence of this building spatial database development in metropolitan city area, the existing land uses have been delineated and development control map of KMC. In such way the updating process has been done with imagery map and aerial photo.
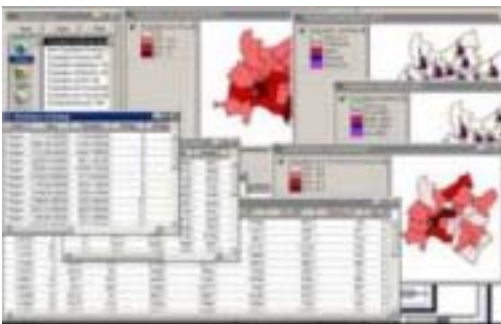

Measurement of the Development Potentialities from Land use pattern Land use mapping and Land control mapping.
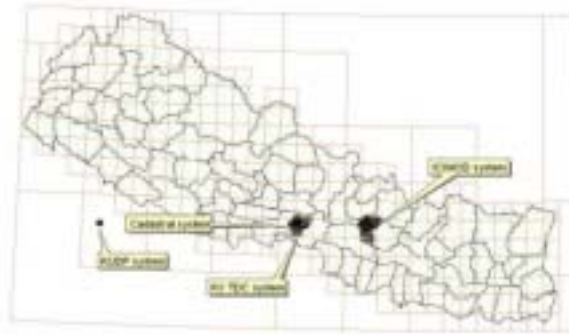
Spatial and non-spatial database field verification, processing and developing has being going on. Such as different coverage of thematic maps and its uses e.g., road network, water supply line, sewerage line, land marks with naming and other related layers. Supportive role is playing to other units by GIS data with data base development and its module and procedure frame works for urban planning.

By Thematic mapping Urban/Rural Planning and Monitoring for Societal. Problem identify, GIS/RS systems for spatial data Updating process and analysis!

Tribhuvan MS Pradhan
GIS Manager/Specialist, KMC

Quality of spatial data maintaining for, map projection and coordinate system problems (shown in map) for standardization of spatial data infrastructure development in urban context.
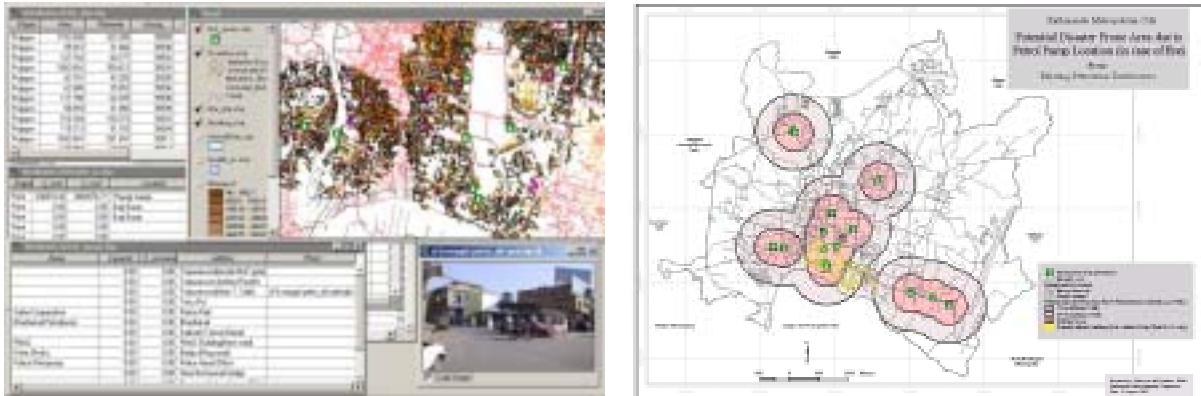

Projection system irregularities and problem of spatial data standardization indicator!!!, and how to manage it?

Simple GIS Application:

A GIS based application has been developed for Potential Disaster Prone Areas due to Petroleum materials distributors in High residence areas
The mainly focusing on man made disaster problems in Kathmandu Valley and metropolitan city highly residences area. Because of the mostly petrol pumps area located in 5 to 15 minuets walk distance at each other. It is very hazardous for every body. And it can be dangerous area of the city cause by massive assault of the pump explosion. This is also one of the major parts of vulnerable for metropolitan city. As the part of, an approach to integrated urban development and urban management focusing on the metropolitan area of Kathmandu in future for emergency response to the save of residence area and their property. Same problems seems to be in moving gas vehicle which is cause by smokers and other machinery sparking plug like ignition switching problems in crowded bus stand and tempo stand. If vehicle's gas cylinder is burst out in moving time so many life and property will be damage and lost. No body knows how much safety on this situation in this city and how much serviceable for transportation facilities. Similarly same problem has been in gas industry located nearer beside in other industry. The question is about that how to manage all these major task of before disaster and after disaster.

A base map is being preparing to city level and surrounding of metropolitan city for planning purpose for every aspect such like spatial modeling with identification of disaster management. In such a way, this type of information can be use on timely inform to the peoples awareness from potential incidence occur which is generated by fire.

Man made Vulnerability Assessment (MVA), Potential Disaster Prone area due to Petroleum materials distributors in High residence area.

All petroleum deposes are in city of high residences areas are supplied by kept at the 14 distributors but now, we have more than this mention distributors. These depots include petrol, diesel and kerosene for daily consumers consumption, etc. This figures are only located in city center area which are more vulnerable for fire problems but does not included out side the ring road petrol pump. One of the example shown in the map, this is only for assumption case study of the potential explosion accidents occur by strike, Nepal Bandha, Valley Bandha etc. the detail survey is not been done but in the pipe line.

If in the case, the two or more petrol pumps are fired out in one time the nearer residences are being more affected zone. 500 meter and 1000 meter buffer is being generated to find out areas, which are in the potential effective disaster range; we can imagine that it might cause some accidents to occur at these distributors. In this manner, GIS application can give help to identify the area of influence and how much settlement are more affected, population, and properties will be lost and be damaged in case of disaster. In this way we can calculate the loss of properties and valuable materials supposed to accident depending on pump capacities and volume of storage tank by using GIS tools and techniques. Therefore these distributors are located in right places or wrong places or more services places the decision makers have to decide their own decision. Although we can say it is not in right place in this growing urban situation. So that the limited fire bridge resources as well as traffic problems we can not give better service delivery in time within five minutes because lack of existing traffic system, manpower, awareness of no smoking zone and fire fighting system. This is one of the major challenging daily activities task of disaster problems for Kathmandueits. And it can be complex tragedy for high residences of Kathmandu.

We should have to think about the preparedness programme of this type of disaster occur in nearer future. We should have to do a lot of work to make information flow to citizens for alertness with such disaster by media information technology. GIS is not computer play game and making beautiful cartographic map product. It is one of the strong planning tools and decision-making tools. Kathmandu Metropolitan City is trying to gear up for this application use in the near future through web based GIS.

Table 1

Potential Disaster Prone Area due to Petroleum materials distributors in High residence area

Potential affected building blocks and influence area					
Buffer creation	50 meter	100 meter	200 meter	500 meter	1000 meter
Fire Influence area in sq.m.	6698.46	23493.98	72205.74	188386.59	284789.05
Influence area in % by Total Bb	1.96	6.88	21.14	55.15	83.37
Total area of Bb Ward No. 11 = 341595.75m					
Influence area in % by Total area m.	0.36	1.28	3.93	10.25	15.49
Total area of Ward No. 11 = 1838671.00m					
Fire Influence area in ha.	0.67	2.35	7.23	18.84	28.47
Influence area in %	1.96	6.88	21.17	55.15	83.34
Total area of Bb Ward No. 11 = 34.16ha					
Influence area in % by Total area ha.	0.36	1.28	3.93	10.25	15.48
Total area of Ward No. 11 = 183.87ha					
Male population in Ward No. 11 = 12765					
Female population in Ward No. 11 = 10766					
Total population in Ward No. 11 = 23531					
Total no. of building blocks	31	86	287	930	1496
Building blocks in %	1.54	4.29	14.30	46.34	74.54
All total Bb in Ward No 11. = 2007					

Bb = Building blocks

Data sources: Sample field data of existing Petrol pump
Building footprint data from KUDP base map on 1:10000 Aerial photography of 1992/1998
Population data, CBS census 2048/2058 (1990/2001)

Conclusions / Issues:
The border institutional framework for KMC is clear, but it should be given a bigger hammer from the policy level to give shape to sustainable and more dynamic spatial management information system (SMIS), that clear in vision and goals, is directed by proper polices, comforted by right management and escorted by active operations within the framework of Metropolitan City, a local government of its own. Some issues are here when spatial information developing process in way.

Issues:
Maturity of spatial information for GIS base application. From previous experiences of building the spatial information, so that phase wise development process is needed. Cost and time effectiveness of spatial data sets development has not been consider and calculate in urban context. Complexity of spatial data sets and its geo-references with coordination between line agencies, such as HMG level with different department NGO/INGO. Lack of knowledge of spatial information development sides in managerial level. There is no such political commitment to develop the Metropolitan City level spatial data sets for planning and decision making process. Affordable spatial data sets development for every year, in terms of financial matter, human resources of trained technical person. Difficult to manage the spatial information infrastructure for the KMC level in the sense of haphazard urban planning system, complexity of societal convinces to decision maker and policy maker about the spatial data sets and desired level so high when map making and production time. Problems on coordination between line agencies to share the spatial data and non-spatial data and it accessibility mechanism.

- Maturity of spatial information for application
- Phase wise development process is needed
- Cost and time effectiveness of spatial data sets development
- Complexity of spatial data sets and its geo-references with coordination between line agencies, such as
  - HMG level different Department
  - NGO/INGO
- Lack of knowledge of spatial information sides in managerial level
- Political commitments to develop the Metropolitan City level spatial data sets for planning and decision making process.
- Affordable spatial data sets development for every year, in terms of financial matter, human resources of trained technical person
- Difficult to manage the spatial information infrastructure for the KMC level in the sense of haphazard urban planning system, complexity of social convinces to decision maker and policy maker about the spatial data sets and desired level so high when map making and production time.
- Data sharing system.

Future spatial management
Spatial information if institutionalized well, can bring transformation to the local government departments by making the processes transparent, effective in decision making, creating accountability and improving overall efficiency. The final beneficiaries of an effective information system are the people living in the city. Then where is the question of an information system becoming un-sustainable? Here some points are required for future spatial management to metropolitan city level.

- It should be strong commitment to development of spatial datasets of KMC level from policy level.
- Digital data sets must be well to organize with topological and naming convention system for future updating.
- Easy to use in context of user those who are using the application purpose from well organized data sets.
- Accuracy must be known to every user and one standardization, in the sense of cadastral base mapping sites and other topographic maps.
- Awareness must be needed of maps interpretation and spatial data and non-spatial data those who are decision maker and spatial data user.
- Every ward chairman should know that they can not decided without spatial data sets (maps and other information) in ward level planning process.

Acknowledgements:
The author would like to express sincere thanks to Kathmandu Metropolitan City (KMC) of Local government and staff of KMC for their kind supports. Gratefully acknowledge to the ESRI products for spatial database developments and applications on various field to Kathmandu Metropolitan City development and planning process.
Suggestion and comments are welcome!!!

Tribhuvan MS Pradhan
GIS Manager/Specialist, KMC