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16 & 17 October 2015

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Editors

B Radheshyam

Vasudeva

The Organizing Committee

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Shri Madhwa Vadiraja Institute of Technology and Management
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Land Use and Land Cover Change Detection Study in Parts of Mangalore Taluk, Karnataka Using Multi-temporal Remotely Sensed Data and GIS Techniques

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Abstract

The land-use and land-cover pattern of a region has direct relationship with natural and socio-economic factors and their utilization by man in time. Land-use and land-cover change has become a central component in current strategies in managing natural resources and monitoring environmental changes. In Dakshina Kannada district rapid urbanization took place due to population growth. This growth has significantly changed the landscape of many villages. In the context of urbanization, a large amount of agricultural land has been converted to built-up or urban land uses. Mangalore is one of the taluk of Dakshina Kannada has been experiencing significant land-use and land-cover changes due to both socio-economic and natural factors. The present research work examines the use of GIS and Remote Sensing in mapping land use land cover in and around Mangalore between 2003 and 2013 so as to detect the changes that has taken place in a span of 10 years. Remote sensing and Geographical Information system (GIS) provide fundamental tools which can be effectively used in the investigation of land use/land cover changes at the village as well as at the city levels. The result of the work shows a rapid growth in built-up land between 2003and 2013.

Keywords: Land use, Land cover, Remote sensing, GIS, Mangalore.

Introduction

Land use referred to as man's activities and the various uses which are carried on land. Land cover is referred to as natural vegetation, water bodies, rock/soil, artificial cover and others resulting due to land transformation. Land use/cover changes also involve the modification, either direct or indirect, of a natural habitats and their impact on the ecology of the area. Urbanization is inevitable, when pressure on land is high and population increases are excessive, as in the case of most developing countries of the world. However, uncontrolled urbanization has been responsible for several problems, our cities facing today, resulting in substandard living environment, and acute problems of drinking water, noise and
air pollution, disposal of waste, traffic congestion etc. To minimize these environmental degradations in and around cities, the technological development in related fields have to address to these problems caused by rapid urbanization, only then the fruits of development will percolate to the most deprived ones.

Change detection is the process of identifying difference in the state of an object or phenomenon by observing it at different time [1]. High temporal resolution, precise spectral bandwidths, and accurate geo-referencing procedure are factors that contribute to increase use of satellite data for change detection analysis [2]. Geographical information systems (GIS) and remote sensing are well-established information technologies, the value of which for applications in land and natural resources management are now widely recognized. Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics- detect, identify, map, and monitor differences in land use and land cover patterns over time. Recent improvements in satellite image quality and availability have made it possible to perform image analysis at much larger scale than in the past.

Study Area

The study area of Mangalore Talluk, Dakshina Kannada District is located in between $12^{o}50'$ to 13^{o} 0' north Lattitude and $74^{0}45'$ to$74^{0}55'$ east Longitude, falling in Survey Of India (SOI) 1:50,000 scale Topographical map (48L/13) with an areal extent of 233.318 sq.km (Fig. 1). Mangalore taluk is bounded by Karkala taluk in the north, Bantwal taluk in the east, Puttur Taluk in the south and Arabian Sea to the west.

C**limate:** High moisture content, heavy rainfall during monsoon and hot weather during summer are common features. It is pouring heavily from June to September. From March to May the weather is very hot. The average temperature ranges from 16.7^{o} Celsius during winter to 37.8^{o} Celsius during summer. Mangalore taluk receives enough amount of rainfall (3707 mm on an average). There are 120 average rainy days in a year.

Population: As per 2011 census the total population of the taluk was 11, 04,449. Male population was 5, 48,275, which

accounts to 49.64% while the female population was 5, 56,174 which accounts to 50.36% of the total population of the taluk.

Infrastructure Facilities:
Power: Mangalore Electricity Supply Company Limited (MESCOM) which is the provider of electricity has one division in Mangalore taluk namely Mangalore Division.

Water: Mangalore taluk is endowed with rich water resources. The two main rivers Netravathi and Gurpur flow in Mangalore Taluk and join the Arabian Sea. The rivers are mostly rain-fed and the magnitude of flow is related to rainfall.

Transport
The taluk is well served by good network of roads. All the towns of the taluk are well connected to the taluk headquarter Mangalore and also the towns are well connected to the neighboring taluk. The roads existing in the taluk can be categorized as National highways (NH-13, NH-17, and NH-48) State highways, district major roads, other district roads, and village roads. The taluk has only broad gauge type of railway lines. There are 9 railway stations in this taluk. Airport is situated at a distance of 19 km from Mangalore which is at Bajpe. The taluk is having an old port in Bunder. The New Mangalore Port located 10 km north of the city.

Materials and Methodology

Survey of India (SOI) topographical map 48L/13 surveyed during 1967 was used to generate the base map of the study area. Indian Remote sensing satellite IRS-1D LISS- III data of 2003 and IRS-P6 LISS- III data of 2013 were used to generate the land use/land cover maps as well as to carry out the change detection studies.

The topographical map is geo-referenced using ERDAS imagine. The four ground control points are added to the topographic map. Then selecting the Geometric Model as polynomial was performed. Next change the projection as geographic and datum WGS84. Similarly the satellite imagery was geo-referenced using the topographic map as the reference map. A total of five ground control points (GCP) were chosen for each image.

The study area was extracted from Topographical map and satellite images using Area Of Interest (AOI) option. Layer stacking of the satellite image is done using ERDAS imagine. The band combination of bands 4 (near infrared), 3 (red), and 2 (green) were found to be most effective in discriminating each class and identify the features. Unsupervised and supervised classifications of satellite images were performed using ERDAS imagine software, to understand the land use land cover pattern of the study area in a better way. Supervised classification normally provides more accuracy than unsupervised classification, since the analyst provides the training sets to the computer during the classification. In the case of unsupervised classification, the software itself will classify the image based on pixel values.

Land use and land cover map has been generated by digitizing the vector layers, using Arc map and the vector layers are generated based on 2003 and 2013 satellite data. The area calculation for LU/LC map has been carried out from digitized vector layer. The changes occurred in land use and land cover pattern is obtained by comparing 2003 and 2013 land use and land cover maps. Flow chart showing the broad steps followed in the work for deriving statistics of land use pattern of the area is shown in fig. 2.

Development of classification scheme
The land use and land cover classification system presented in this report includes only the more generalized first and second levels. For land use and land cover data needed for planning and management purposes, the accuracy of interpretation at the generalized first and second levels is satisfactory, when the interpreter makes the correct interpretation 85 to 90 percent of the time [1]. The Anderson level II classification is used to classify the digitized area, which is shown below.

Level I	Level II
1 Urban or Built-up Land	11 Residential
	12 Commercial and Services
	13 Industrial
	14 Transportation, Communications, and Utilities
	16 Mixed Urban or Built-up Land
	17 Other Urban or Built-up Land
2 Agricultural Land	21 Cropland and Pasture
	24 Other Agricultural Land
5 Water	51 Streams and Canals
	52 Lakes
	54 Bays and Estuaries
7 Barren Land	72 Beaches
	74 Bare exposed rock
	76 Transitional Areas
	77 Mixed Barren Land

Results and Discussion

The significant changes in the land use/land cover pattern were analyzed using supervised classification and the derived vector layer was digitized and then the area was computed. Statistical values show that there were both positive and negative changes (Table 1).

Urban land:
There were significant positive changes noticed in the built-up areas. From the statistical analysis of the study the urban areas formerly occupied a proportion of 35.5% in 2003 got increased to 50.2% in 2013. There is an increase of 14.7% urban land from 2003 to 2013. This is a clear indication of increase in population, infrastructure development and increase in industrialization.

Agricultural Land:
There were great negative changes in the agricultural land. From the statistical analysis of the study the agricultural land formerly occupied a proportion of 34.3% in 2003 and decreased to 13.1% in 2013. There is a decrease of 29.9% agricultural land from 2003 to 2013. This is the result of urbanization, and industrialization.

Barren land:
Barren land mainly comprises of scrublands and abandoned granite/laterite quarries. There were negative changes in the barren land. From the statistical analysis of this study, the barren land formerly occupied a proportion of 18.8% in 2003 and decreased to 17.3% in 2013. There is a slight decrease of 1.5% barren land from 2003 to 2013.

Range land:
In the case of range land also negative changes is noticed. From the statistical analysis of the study, the range land formerly occupied a proportion of 3.1% in 2003 and decreased to 3% in 2013. There is a minor decrease of 0.23% range land from 2003 to 2013.

Water Bodies:
The proportion of the study area under water bodies recorded a negative change although very minimal in nature. The study based on 2003 satellite data shows 8.3%, of the area is coming under this category, while in 2013 data shows 8.1%. There is a minor decrease of 0.28% water bodies from 2003 to 2013. This is due to the sand deposit, land reclamation and other developmental activities in the near vicinity of Nethravathi-Gurupur estuary and along the coast.

The multidated satellite data study indicated that there is an increase in the areal extent of urban land than any other classes of land use land cover during 2003 and 2013. The total area occupied by this urban land in 2003 was only 82.284sq.km which has been increased to about 117.161sq.km in 2013. Rapid growth in population and number of residential buildings has been reported from each village of the study area. The major changes in the built-up category are noticed in, Katipalla, Derebail and Surathkal, Kankanady areas. The significant changes are due to the major commercial and residential initiatives taken by the real estate companies/agencies. In Baikampady area also, number of industries were established. Kalavar village although located very close to the major industries, has under gone very small change mainly due to the rugged/undulating terrain conditions of the area. Bajpe and surrounding areas have experienced maximum changes because of the conversion of Bajpe Airport into International Airport (Mangalore Airport). About 70% of the land in Bala village is occupied by Mangalore Refinery and Petrochemicals Ltd (MRPL). During 2011, companies like ONGC and OMPL have expanded their base in Bajpe and Permude villages. Due to this, most of the agricultural lands are converted into industrial land uses.

Conclusion

Remote sensing is a powerful tool and can be effectively used for mapping and analysis of land use and land cover for micro, meso, and macro level planning. The data gathered by the remote sensing satellites have the capability of providing time series data, which is very much required for carrying out the change detection studies. For ensuring planned development and monitoring the land utilization pattern, preparation of land use and land cover map is necessary. The present study demonstrates the usefulness of satellite data for the preparation of accurate and up-to-date land-use/land-cover maps depicting existing land classes for analyzing their change pattern for Mangalore area between the year 2003 and 2013by utilization of digital image processing techniques and GIS. Result of classification clearly shows constant positive increase in urbanization and decline in the vegetation. It is concluded that remotely sensed data obtained by the analyses of multidated satellites can be effectively used to understand the land use land cover status and certainly it is a best tool for the decision makers in framing the policies related to urban environment.

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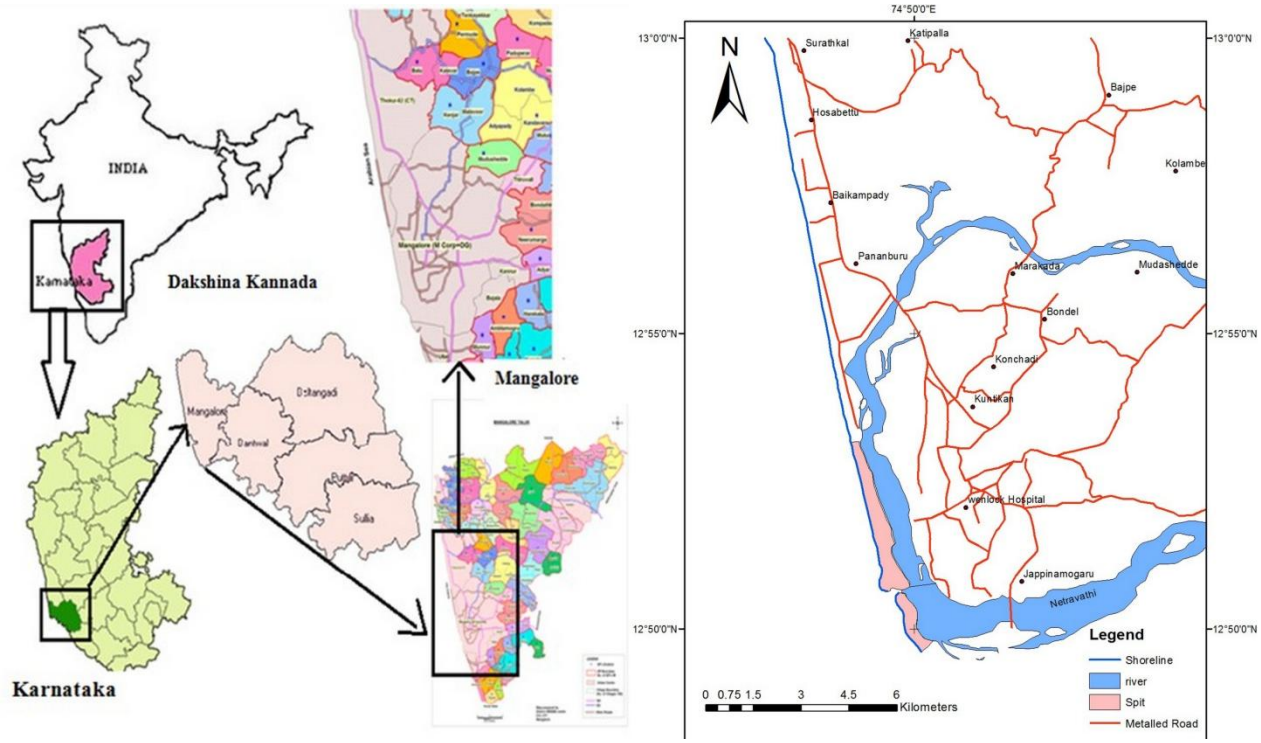

Fig. 1: Location map of the study area

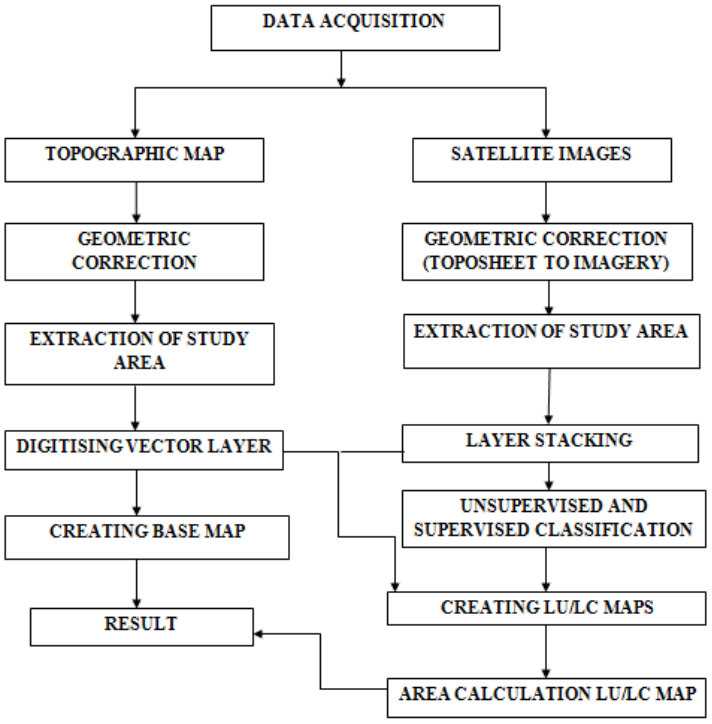

Fig. 2: Work flow diagram

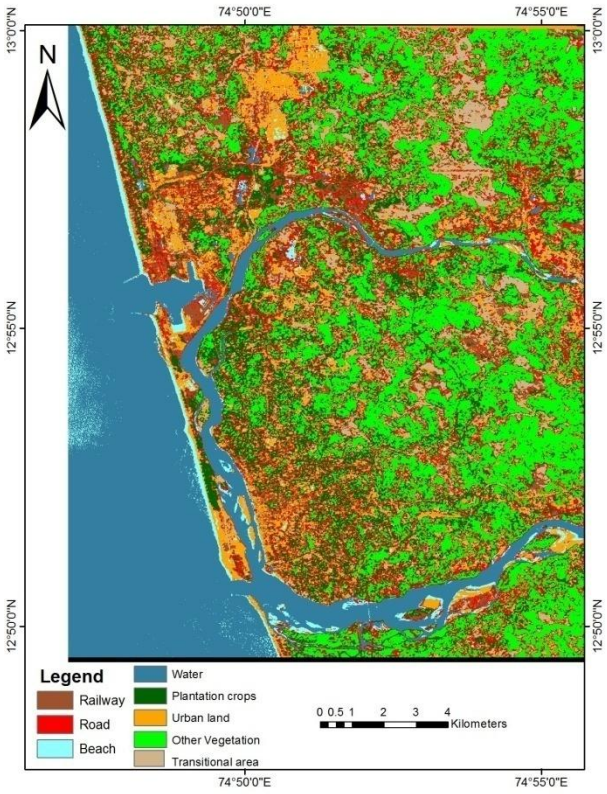

Fig. 3: Supervised Classification of IRS 1D – LISS III image (2003)

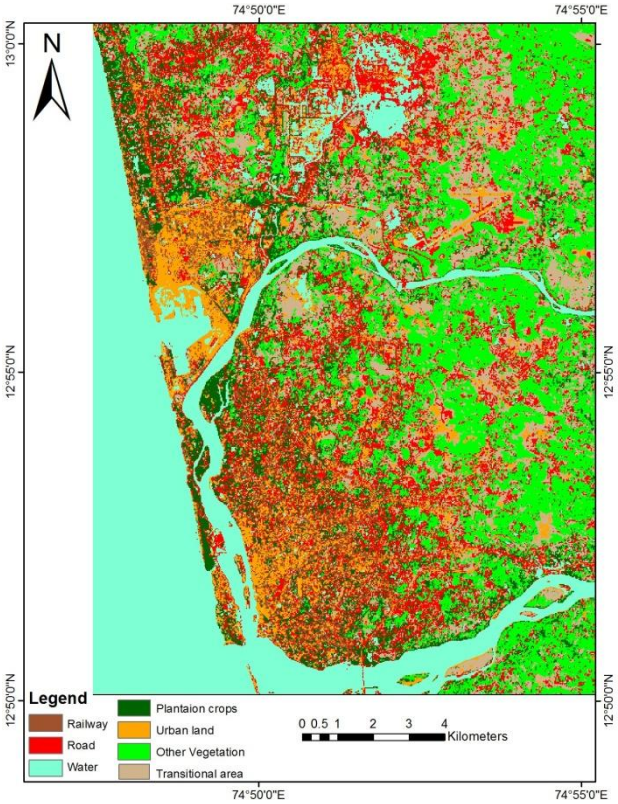

Fig. 4: Supervised Classification of IRS P6 – LISS III image (2013)

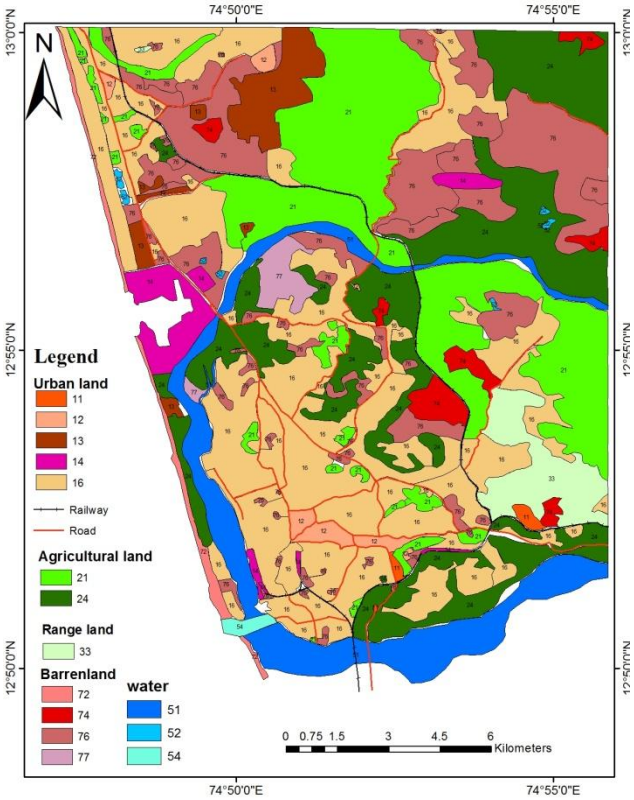

Fig. 5: Land use and land cover map for the year 2003

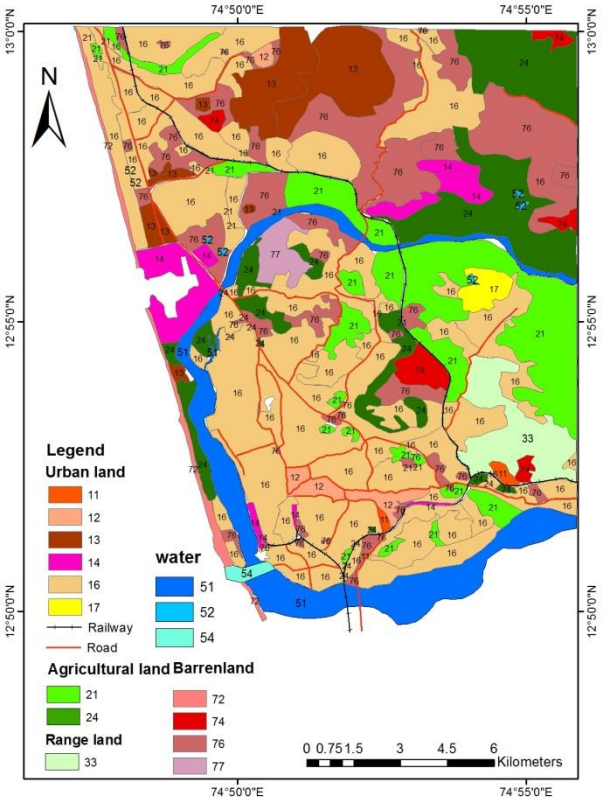

Fig. 6: Land use and land cover map for the year 2013

Sl. No.	Class name	Area in 2003		Area in 2013		Change detection 2003-2013	
		In Sq.km.	% Area	In Sq.km.	% Area	In Sq.km.	% Area
1	Urban land	82.284	35.5	117.161	50.2	34.877	14.7
2	Agricultural land	79.444	34.3	49.538	21.2	-29.906	-13.1
3	Barren land	43.496	18.8	40.31	17.3	-3.186	-1.5
4	Range land	7.748	3.1	7.192	3.1	-0.556	-0.23
5	Water	19.786	8.3	19.115	8.2	-0.671	-0.28
	Total	233.318	100	233.318	100		

Table 1: Shows the Land use and Land cover change detection 2003-2013

Comparative analysis of drainage maps extracted from conventional approaches and Open Source DEMs: A case study in Southpenna watershed

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ABSTRACT - The conventional identification of stream networks from topographic maps is effort and time consuming. Many algorithms have been developed for the automatic extraction of stream networks from Digital Elevation Models (DEMs) derived from satellite data's. Recent DEM data's are available as open source compared to topographic maps. But the drainage map derived automatically still has some disagreements with the maps obtained from conventional methods. The purpose of this work is to analyze the difference between the stream networks generated from the DEM obtained from Cartosat-1 and those generated from topographic maps. Quantitative analysis is done by calculating the linear aspects of a drainage map. Morphometric analysis is carried out using GIS techniques and the morphometric parameters obtained from two different data sources were compared. The study reveals that the adaptation of specific thresholds in algorithms of digital pixels, considering the geomorphologic properties of the basin has improved the automation method.

Index Terms - Bifurcation ratio, GIS, Morphometric analysis.

I Introduction

From middle of 20th century drainage maps were derived from printed toposheets for the quantitative analysis of the basin [1]. Morphometric is the measurement of the configuration of the earth surface, shape and dimension of its landform [2].

Remote sensing and Geographical Information System (GIS) techniques are increasingly being used for morphometric analysis of drainage basins throughout the world [3]. The purpose of this work is to compare the drainage maps generated from different sources through morphometric analysis. Conventional method of preparing drainage maps from toposheets is more time consuming and tedious. Free downloadable DEMs can be utilised to generate drainage maps through a sequence of steps in open source GIS software. A comparative analysis has been made between the stream lines generated from the above mentioned sources.

II Study area

Study area is located in the Survey of India Toposheet Nos. 57K/1, K/3 and D43R15, lies between North Latitude of $13^0 58' 29''$ to $14^0 58' 29''$ and East Longitude of $77^0 12' 31''$ to $78^0 12' 31''$. Southpenna watershed as shown in figure 1 is a part of upper Ponnaiyar sub catchment between Cauvery and Krishna basin, partially covered in Chikballapur, Sidlagatta and Chintamani taluks of Chikballapur District, Karnataka. The study area is one of the watersheds of Southpenna river system which originates at Nandhi hills of Chickballapur district, Karnataka, India.

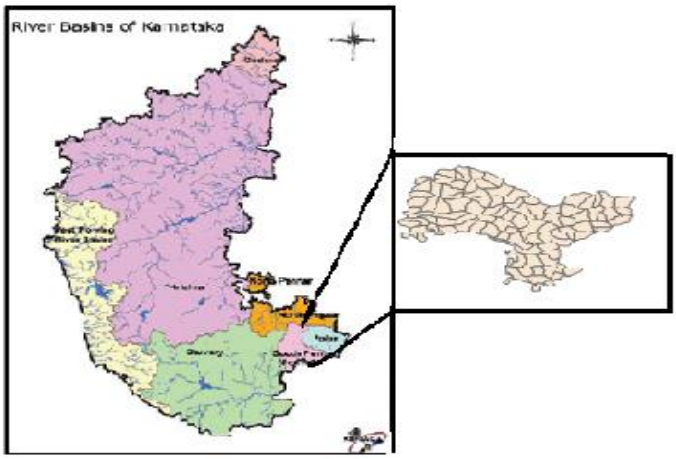

Fig.1 Location of the study area

III Materials and Methodology

Survey of India toposheet was colleceted and scanned to georeference in UTM coordinate system. Toposheets were mosaiced and clipped for the study area as shown in figure. 2. Open source GIS was utilised for this purpose. Drainage map for Southpenna watershed area as shown in figure.4 was generated by on screen digitisation technique. Ordering of stream lines were done simultaneously based on Strahler stream ordering method.

Free Open Source Cartosat-1 Digital Elevation Model was downloaded from Bhuvan Portal. DEM tiles were clipped to the study area as shown in the figure. 3. A sequence of steps: Fill, Flow direction, Flow accumulation and Stream order were used to automatically generate the drainage map as shown in figure. 5

Morphometric parameters under linear aspect were generated separately for both the drainage maps.

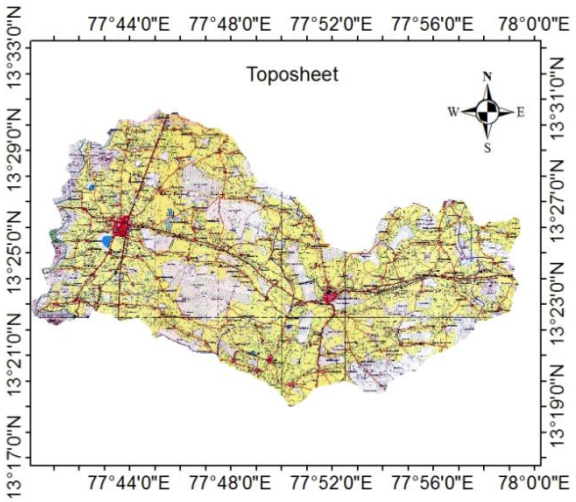

Fig.2 Study area delineated from toposheet

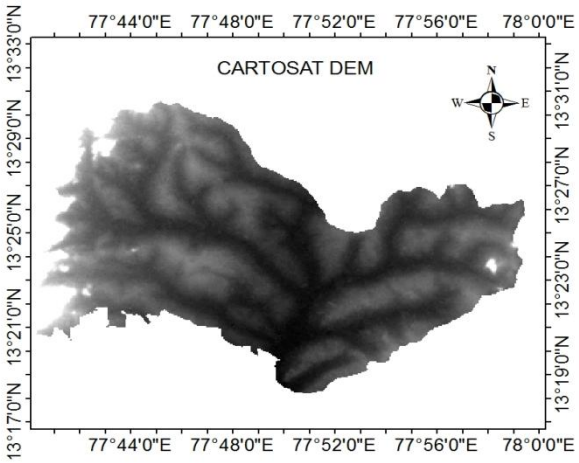

Fig. 3 DEM image from Cartosat-1

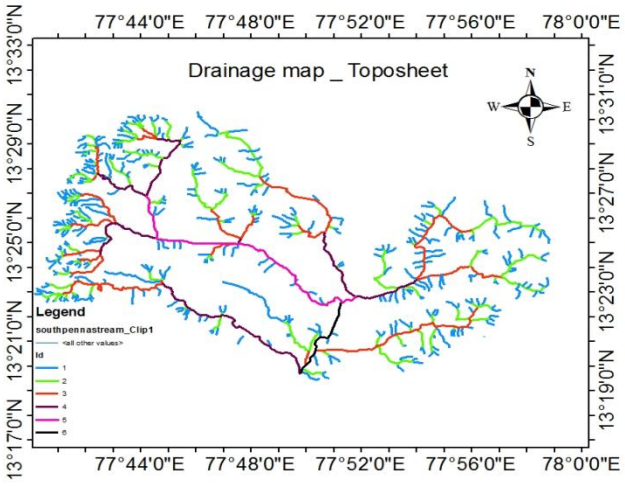

Fig.4 Drainage map derived from Toposheet

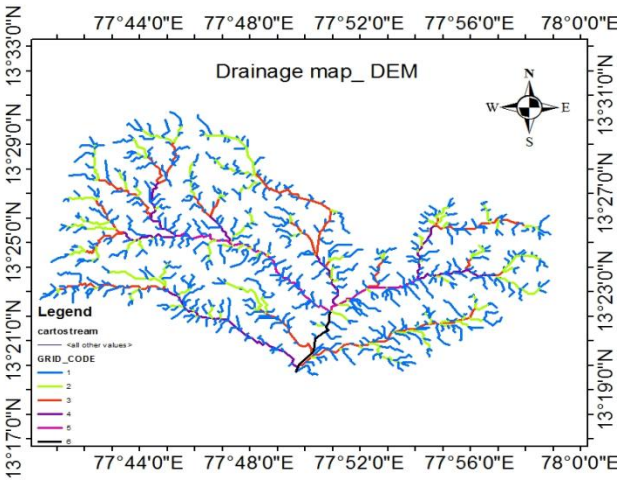

Fig.5 Drainage map derived from Cartosat DEM

IV Results and Discussions

Linear Aspect

Some of linear aspects considered for this study were stream order, stream numbering, stream length, mean stream length, cumulative mean stream length, bifurcation ratio and stream length ratio. These parameters were determined from both the drainage maps and given in tabular form (Table 1 and Table 2).

1. Stream order

Based on Strahler's method hierarchical ranking of different streams been carried for this study. Southpenna watershed possesses up to sixth order stream from both the drainage maps. The streams of higher order indicate less infiltration and permeability.

Table 1: Linear aspect of Southpenna watershed derived from Toposheet

Stream Order	Stream Number	Stream Length (Km)	Mean Stream Length(km)	cumulative Mean Stream Length	Stream Length Ratio	Bifurcation Ratio
1	370	121.07	0.33	0.33		4.07
2	91	51.19	0.56	0.89	2.70	4.55
3	20	37.96	1.90	2.79	3.13	2.86
4	7	20.7	2.96	5.74	2.06	3.50
5	2	9.94	4.97	10.71	1.87	2.00
6	1	3.31	3.31	14.02	1.31	
	491	244.17				AVG: 3.39

Table 2: Linear aspect of Southpenna watershed derived from Cartosat DEM

Stream Order	Stream Number	Stream Length (Km)	Mean Stream Length(km)	cumulative Mean Stream Length	Stream Length Ratio	Bifurcation Ratio
1	556	269.89	0.49	0.49		4.45
2	125	76.55	0.61	1.10	2.24	6.25
3	20	54.76	2.74	3.84	3.49	2.86
4	7	28.33	4.05	7.88	2.06	3.50
5	2	14.88	7.44	15.32	1.94	2.00
6	1	3.86	3.86	19.18	1.25	
	711	448.27				AVG: 3.81

2. Stream number

According to Horton's rule count of channels and its order is known as numbering of streams. In Southpenna watershed the number of 1st order streams is 370 from conventional digitisation method and 556 from automatic method, of 2nd order is 91 and125, from 3rd order the values are same as 20, of 4nd order is 7, 5th order is 2 and 6th order is 1. It is observed that there is an increase of stream frequency as the order decreases. The difference between the number of streams is higher as the order is lower. The 4th, 5th and 6th order streams are the same in count.

3. Stream Length

Using GIS software, the length of all streams of every order is measured. Though there is a difference in number of streams in only first and second order, the stream length shows high difference in first to fifth order.

4. Mean Stream Length

It is dimension less property showing the characteristic of components size of a drainage network and the contributing watershed area [7]. The mean stream length of order n is obtained by total stream length of order n divided by number of streams in nth order.

Mean stream length shows high difference in third, fourth and fifth orders.

5. Stream length ratio

Horton's law defines this as the ratio between the mean lengths of one order to next lower order of stream segment. Study reveals that in Southpenna watershed, there is a variation of length ratio and this variation is because of topography and late youth stage of geomorphic development.

6. Bifurcation ratio

Defined as the ratio between stream number of given order to its next higher order as per Strahler's method. In Southpenna watershed bifurcation ratio from both drainage maps varies from 2.0 to 4.08 and this indicates control of lithology.

V Conclusion

The study of morphometric parameters is essential for understanding the erosion status, hydrological behaviour etc. Quantitative analysis of drainage network found that the distorted trellis drainage pattern is developed in the area. Bifurcation ratio of the watershed shows a continuous variation along the consecutive stream orders from both the drainage maps. Conventional method is more time consuming and tedious then the automatic method. By considering the correct threshold value in map algebra in statistical analysis of DEM, drainage map can be made more similar to the actual existence. So that the drawbacks of the automatic method can be reduced and open source DEMs can be used in hydrological studies.

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Pipe Composting – An Emerging solid waste disposal alternative

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Abstract— **The degradation of wastes is one of the methods to decrease the quantity of solid wastes. Composting is a natural way bioconversion of organic matter by heterotrophic microorganisms (bacteria, fungi) into humus-like material called compost. The composting can be accelerated by controlling favorable conditions like moisture, air, feed material and nutrients. Pipe composting is an emerging technology and gaining popularity in the field of solid waste management. The town municipality of Puttur City (Dakshina Kannada, Karnataka) is promoting the people to have a pipe composting unit in individual houses. In this context a feasibility study was taken up on Pipe Composting by collecting the degradable garbage from hotels and hostels in the town municipality area. Jaggery and cow dung slurry were added along with the shredded bio degradable mass. Various physical and chemicals tests were conducted on the produced compost to assess Nitrogen, Phosphorus, Potassium, Carbon Nitrogen ratio etc. Optimal time for composting, effect of porous pipes and diameter of the pipe were also monitored during the study. The soil around the pipe compost area was also monitored for its characteristics. Results revealed that porous pipes outperformed the non porous pipes. Further, Cement pipes showed better compost properties. Soil around the pipe compost area showed increased signs of Potassium in the soil. Good amount of solid wastes were converted into useful nutrient rich soil. Results showed that, even smaller households and residential layouts can practice this method to ease off the solid waste management.**

Index Terms— **Carbon-Nitrogen Ratio, Compost, Cow-dung, Jaggery and Porous Pipes.**

INTRODUCTION

The solid waste management in cities has become a extreme challenge for engineers these years. Though the local administration and state governments are trying to bring in best disposal programs, the problem has worsened due the improper management of solid wastes, lack of lands for disposal, poor response and careless attitude of public. Though there are various methods available to manage degradable solid wastes, but not being put in good practice. However the management of non degradable solid wastes remains still challenging.

Composting is a best method in practice to dispose degradable solid waste. In this method, the microorganisms like bacteria and fungi are used to convert the organic matter into the end product compost [1]. Amount of composting depends on moisture, air, type of bacteria, temperature and p^H environment. Pipe composting is an extended method of composting where a better and controlled environment is produced for accelerated decomposition. Moreover the pipe composting can fit well to individual households to manage their own solid wastes. Town municipality of Puttur is encouraging the public to adopt this method. A study was conducted in this project to know the optimized environment for the rapid composting using pipes. Degradable garbage from local restaurants and hostels was used for the study. Pipe diameter, Pipe material, Pores in pipe, time required for composting, chemical and physical properties of compost were observed during the study.

LITRATURE STUDY

Nebojsa Jovicic et al. in their research paper have discussed the different methods of composting like Open Systems and Closed Systems. Open System mainly contains 3 methods namely Turned Piles, Turned Windrows and Static Piles. Closed System mainly contains three methods namely Rotary Drums, Tanks, and Bunkers [2]. *Manjit Singh et al.* in their study proved that the use of perforated pipes (10% perforations) in the compost piles significantly altered the substrate physico-chemical characteristics and shortened the composting period [3].

MATERIALS AND METHOD

Table I shown in this section shows different materials used in the experimental study.

Table I Different Materials used

Pipes	Pipe 1	6 inch Non Porous PVC (Poly Vinyl Chloride)
	Pipe 2	4 inch PVC Non Porous
	Pipe 3	6 inch PVC Porous
	Pipe 4	4 inch PVC Porous
	Pipe 5	8 inch Cement
Compost Material	Bio degradable waste, Jaggery, Saw dust, Buttermilk and Cow-dung	

The chosen pipes were firmly installed on a level ground as shown in Fig 1. The collected garbage from the local hotels was shredded and put into the pipes (1.5 Kg /day/pipe) for 45days. A small amount of fine grained soil was also added in to the pipes. For every seven days the Cow-dung and Jaggery, slurry, buttermilk and saw dust were added (4 times in 45 days) into the pipes to ensure seeding of the microorganism faster. In between, the pipes were slowly rotated to improve the air circulation. At this stage, the addition of degradable material was stopped and the pipes were left alone for next 45 for continuation of

decomposition process. Pipes were covered from the top to ensure no entry of rain water into the pipes. At the end of 90 days the pipes were removed and the compost was ready. The compost from each pipe was taken for further lab tests for Moisture, pH, Nitrogen, Phosphorous, Potassium, Carbon, and Carbon-Nitrogen ratio. Soil samples around the compost pipes were also collected and tested for pH and Potassium.

Fig. 1 Installation of different Pipes.

IV. RESULTS AND DISCUSSION

A. Results of Compost Testing

The Table II shows the results of various tests conducted on different compost samples.

Table II Various Results of Compost Testing

Parameter		Pipe				
		1	**2**	**3**	**4**	**5**
pH		6.0	6.0	6.5	6.5	7.0
Nitrogen (% of Ammonia)		5.9	5.2	5.0	4.6	6.1
Phosphorous (mg/lit)		148	154	166	172	174
Potassium (mg/lit)		74	69	76	73	80
C-N Ratio		13.5	15	12.7	13	15.4
Moisture (%)	**In 30 days**	40.2	41.6	37.5	39.2	70.2
	In 90 days	70.2	69.3	68.3	67.4	63.8

From the results it was observed that pH levels were between Acid to Neutral range. No much variation was seen across the pipes. Initially it was in alkaline range. This is the ideal range of good compost. The nitrogen level in the form of Ammonia found to be maximum of 6.1% in cement pipe. This is the good indicator of the nitrogen release during the decomposition. It was found to comparatively less in PVC pipes. Phosphorus too was found in elevated levels across all pipes, but maximum in cement pipe. This is a good nutrient for plant growth. Potassium level was between 70-80 mg/lit in the pipes. Cement pipe showed a maximum of 80mg/lit. Carbon-Nitrogen ratio was in between 13-20 mg/lit, which is the ideal range of matured compost. Moisture level considerably increased in the compost of all pipes, as shown in Fig.2.

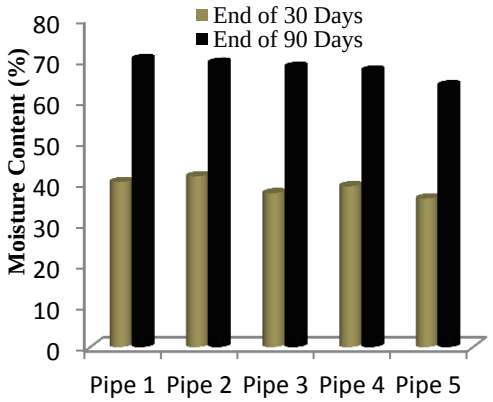

Fig. 2 Moisture Content Variation in the Compost

B. Results of Soil Testing

From the pH results it was observed that the soil beneath the pipe was acidic in nature. The pH value observed prior to the installation of pipes was 6.3. After 90 days the pH is slightly decreased to a value of 6.1. Potassium in the soil increased considerably from a value of 198.9 to 1009 kg/hectare. This is a good indication of ideal compost.

CONCLUSION

From the experimental results, following conclusions are drawn-

- Compost produced in Cement pipe was more nutrient rich as compared to PVC pipe.
- Porous Pipes produced better Compost than Non Porous pipes because of better aeration.
- Good compost produced at the end of 90 days.
- Pipe diameters 6 inches and above can be ideal for Pipe composting for a small household.
- The compost can be used for Gardening and Agriculture.
- Considerable amount of load on the Municipality Solid Waste can be reduced, which can save the acres of landfill area.
- In urban areas, the Housing Layouts and Apartments can practice this method conveniently.
- The pipe composting method is easy to practice, easy to maintain with least cost.

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Outline of Geospatial Data Services Encapsulated in Cloud Computing

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***Abstract*- In earlier decade there has been a tremendous growth in commodity desktop and distributed Geographic Information System applications with browser-server or client-server architectures, mainly as an output of network performance and efficient hardware. But, because of the complicated geospatial data formats and geographically distributed resources, there are still few issues, in the field of GIS applications, which can't be effectively used. The new way of Utilities computing known by various names, such as Cloud computing, Grid computing or cluster computing is a new trend. Since GIS is a data intensive application, it can be benefited from Cloud computing to solve the application interoperability barriers. Therefore, in this paper, we analyse the drawbacks and problems of traditional GIS, and then give the approach to solve those issues by web services and Cloud computing. This paper gives the outline of architecture of Geospatial Data Service within Cloud computing environment and its relative technology. In conclusion, this paper provides a solution of execution model based on Web Services and GML.**

***Index Terms*— Geographic Information System, GIS applications, Utilities computing, Cloud computing.**

INTRODUCTION

Geographic information system (GIS) has developed in a faster rate and its applications have been used in various fields and are becoming more and more combined into many aspects of modern life [1]. There are very huge data of these GIS applications. The data obtained from global position system (GPS) and remote sensing (RS) and so on become huger and more complicated. Those applications are difficult to interact and are isolated. To get connected with online geospatial resources the traditional Desktop GIS programs are emerging into distributed applications, compatible with various distributed systems architectures [2]. As a result, browser-server, client-server based distributed GIS applications have been introduced to fill the gap. The GIS companies and research groups have developed their own spatial databases along with various data manipulation and data access tools.

There are several obstacles associated with traditional distributed GIS approach: Problems with assembling data: Due to the distributed nature of geospatial data, users are required to make use of different tools to access data in various HTTP or FTP servers, XML or relational databases etc. In addition to the archived data, real-time data providers employ different communication and data transport protocols which makes the access tedious.

Data format problems: Applications that digest geospatial data require input in different formats depending on the user's choice. Users spend lots of their time converting data from one format to other to make it easily available for their purpose.

Amount of resources for processing data: After the data is collected and converted into a usable format, enough software and hardware resources need to be allocated for analyzing the data. In most situations the amount of collected data reaches to an amount in the order of gigabytes or even terabytes, so handling this data becomes tedious task for most organizations and users. Also, simulation and visualization software used in combination require high performance computing platforms which are not reachable for naive users. In order to make use of those GIS applications and geospatial data more effectively, the next generation GIS applications is switching towards developing systems for millions to consume as a service, instead of running on the individual computers. Several computing paradigms have assured to deliver this utility computing include cluster computing, Cloud computing [4] and Grid computing [3]. In such a 1578 model, users access services based on their requirements without considering how the services are provided or where the services are hosted. It will be as same as accessing content across the Internet independently without reference to considering the underlying hosting infrastructure.

TECHNOLOGY TRENDS

Through the virtualization techniques, Cloud computing provides the end users a variety of services covering the entire computing stack, from the hardware to the application level, by charging them on a pay per use basis[5]. Another important feature, Cloud computing provides a flexible mechanism for delivering IT services at each level of the computing stack: from the hardware level to the application level. This makes the spectrum of options available to GIS wide enough to cover any specific need for their applications.

There are some recent trends in geo-science and its relative technology.

Cloud Computing

Computing is being evolved to a model consisting of services that are commoditized and delivered in a

manner that is similar to traditional utilities such as gas, electricity, water, and telephony.

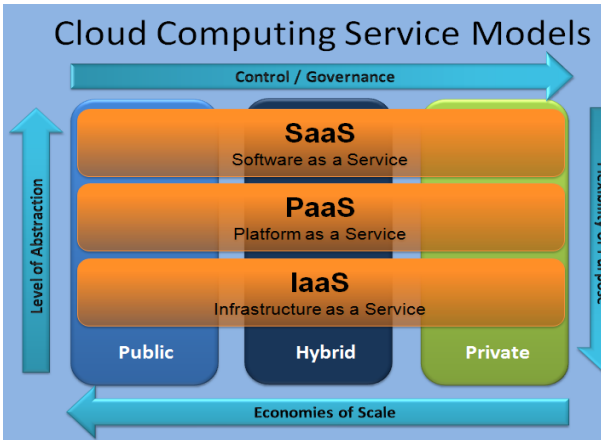

Figure.1. Overview of Cloud Computing Model

In such a model (Figure 1 show the overview of Cloud computing model), users access services based on their requirements without any concern about how the services are hosted or where they are delivered. Several computing standards have promised to deliver this utility computing vision and these include cluster computing [7], Grid computing [3], and more recently Cloud computing. The latter term assumes the infrastructure as a "Cloud" from which businesses and users are able to access applications from anywhere in the world on demand. Now a days, it is common to access content across the Internet independently without considering the underlying hosting infrastructure. This infrastructure [8] consists of data centers that are controlled and maintained around the clock by content providers. Cloud computing provides opportunities for organizations to become more productive, and flexible in order to deliver new capabilities at faster rate.

Cloud clients should be benefit, because they are consuming state-of-the-art systems that are highly reliable and easier to handle large traffic fluctuations. The burden, then, is on the vendor to scale and continually reinvest in the on-demand IT architecture and service so that consumers are persistently provided with updated and robust solution. The amount of fragmented infrastructure can be reduced by moving parts of the corporate data and computing center to the cloud. It also reduces, driving down up-front capital spending. As monies are reallocated to be invested in core business, other initiatives could be launched to provide direct value to customers and employees, giving the organization a competitive advantage.

With outsourcing and off shoring growing, leading to creation of a global workforce, team productivity depends on the power of networks and the Internet as a common platform. As such, cloud services are available 24/7, accessible from any browser on any device regardless of time zone. This provides faster, easier access for workers to do their jobs, allowing competitive differentiation for the organization and, likewise, retaining and attracting valuable and talented staff.

Web Services

It is also obvious that the diversity of the GIS applications and data sources is a great challenge. That is where a new breed of distributed systems approach may help the Web Services. "A Web Service is an interface that describes a set of operations that are network accessible through standardized XML messaging."[9]. In practice the operations, interface and the XML messaging are standardized. The service interface hides the implementation logic from the users, which allows the service to be used on different platforms than which it was implemented. Also any application capable of communicating through the standard XML messaging protocol and regardless of with which programming language it was developed, it uses the service through the standard interface. These properties allow Web Services based frameworks to be loosely coupled and component oriented. Because of the messaging protocols and standard interfaces the Web Services can easily be assembled to solve more complex problems. Another important aspect of Web Services is that they allow program-to-program communications. With the help of many Web Services specifications a complete cycle of describing, publishing, and finding services can be made possible. As new specifications are being developed and the industry matures the system integration that includes these steps will eventually happen dynamically structural concerns are handled by the runtime framework while the web services provide the core functionality. For enabling runtime. In the Cloud computing environment, the distributed Cloud computing environment on top of the container, various services such as an execution services resource information indexes, storage services, scheduling and resource allocation would be necessary. The services are independent of each other in a container and only interact with other services on the network, or the local node through known interfaces.

Most of the geospatial data applications usually contain three major kinds of components: presentation, data and logic. For example, considering an online mapping application, the web server is responsible for the presentation by displaying the map images. The logic spatial data engine usually communicates with a geospatial database, which contains the map data. As we know, the geospatial applications in Cloud

Computing environment have several distributed components and interoperability between these components must be considered. When we think about the bigger picture where hundreds, even thousands of data repositories, data analysis and

visualization applications are available, we realize the need for GIS standards to make interoperability possible. Its obvious that the capabilities provided by Web Services can be of great benefit to the geo-science community as well. Because the possibility of accessing various types of geospatial data sources and applications using standard service interfaces may help solve the interoperability issues.

Currently there are several universally used standards to address these requirements: XML is the commonly used for representing the data while Simple Object Access Protocol (SOAP) [10] is universally being used for information exchange. SOAP provides rules that tell us how to use XML to represent data as well as bindings to the HTTP protocol and conventions for representing remote procedure calls (RPCs). The Web Service Definition Language (WSDL) [11] is used to describe what type of message a Web Service can accept and generate. Available protocols such as Web Services Dynamic Discovery are used to locate services.

SERVICE MODEL WITHIN CLOUD COMPUTING ENVIRONMENT

The wide range of Cloud computing services can be classified and into three major models. These are: Infrastructure/Hardware as a Service (IaaS/HaaS), Platform as a Service (PaaS), and Software as a Service. Figure 2 provides an overview categorization.

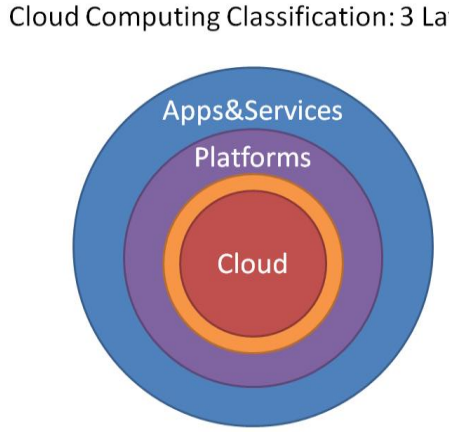

Figure 2. Cloud computing layered Categorization.

Hardware as a Service or Infrastructure as a Service(IaaS) are terms that refer to the practice of delivering IT infrastructure based on physical resources which is of different nature: workstations, clusters and spare desktop machines to customers. These resources satisfy the end user requirements in terms of memory, CPU type and power, storage, and 1580 operating system. Infrastructures Cloud computing environment deployments mainly constitutes of datacenters hosting hundreds or thousands of machines. Users can set up their system on top of these resources that are hosted and managed in datacenters owned by the vendor. The infrastructure layer is managed by the Infrastructure Cloud Computing Platform layer which aims to provide an appropriate runtime environment for geospatial data applications so that the physical resources can be exploited at best. Platform as a Service (PaaS) provides middleware or an application platform as a service on which developers build and deploy the custom applications. It provides a wide set of services that assist service providers in delivering a commercial and professional service to end users. These services include: admission control, negotiation of the quality of service (QoS execution) management and monitoring, Billing and accounting. The Cloud Computing Platform represents the platform on top of which the particular geospatial applications are deployed in the Cloud.

More commonly, the services delivered by the Cloud Computing platform are accessed through a user level middleware. This provides environments and tools simplifying the deployment and development of applications in the Cloud Computing platform. The user-level middleware constitutes APIs and tools to business process and data base management systems, to security integration, allowing developers to build applications and run them on the Cloud Computing environment.

Software as a Service (SaaS) comprises end-user applications delivered as a service. Users are not allowed to customize the service but get access to a specific application hosted in the Cloud. The most common example of the SaaS implementation is the services provided by Google such as Google Map, which is charged for professional quality services and delivered for free to the Internet users.

ARCHITECTURE OF CLOUD COMPUTING ENVIRONMENT

Aneka [12] is a pure PaaS implementation platform and a framework for developing distributed applications on the Cloud by using the .NET technology. Aneka Clouds can be built on top of different physical infrastructures and integrated with other Cloud computing solutions such as Amazon EC2[13] in order to extend on demand their capabilities.

It harnesses the computing resources of a heterogeneous network of desktop PCs and servers or Data centers on demand. Aneka provides developers with a rich set of APIs for transparently exploiting such resources and expressing the logic of applications by using a variety of programming abstractions. The flexible and service-oriented design of Aneka and its fully customizable architecture make Aneka Clouds able to support different scenarios. System administrators can leverage a collection of tools to monitor and control the deployed infrastructure. This can be the public geospatial applications available to anyone through the Internet, or a private geospatial applications constituted by a set of nodes with restricted access within an

enterprise. As a modular architecture, an Aneka node consists of an instance of a configurable container that hosts several compulsory services and any number of optional services. The compulsory services provide functions such as security, persistence mechanisms, and communication protocols, and are together called as the base infrastructure. The optional services include specific executors for different types of programming models and/or associated schedulers. The following sections will give more details about each of these components within Aneka.

This is also accomplished by the variety of application programming patterns supported through an extensible set of programming models. These define the logic and the abstractions available to developers for expressing their distributed applications. As an example, in order to run geospatial applications it is possible to rely on a classic bag of tasks model, or to implement the application as a collection of interacting threads or MPI processes, a set of interrelated tasks defining a workflow, or a collection of Map Reduce[14] tasks. If the available options do not meet the requirements, it is possible to seamlessly extend the system with new programming abstractions. In this particular scenario, Aneka acts as a middleman mitigating the access to public clouds from user applications. It operates as an application service provider that, by using fine and 1581 maximizes the utilization of the rented virtual resources and shares the costs among users. Figure 3 gives an architectural overview of Aneka. In order to develop cloud computing applications developers are provided with a framework that is composed by a software development kit for programming applications, a management kit for monitoring and managing Aneka Clouds and a configurable service based container that constitute the building blocks of Aneka Clouds. In this section we will mostly focus on the details about the major components within Aneka: The Container, The Base Infrastructure, Node Arrangement the application model, and Web geospatial services available for integrating Aneka with public clouds.

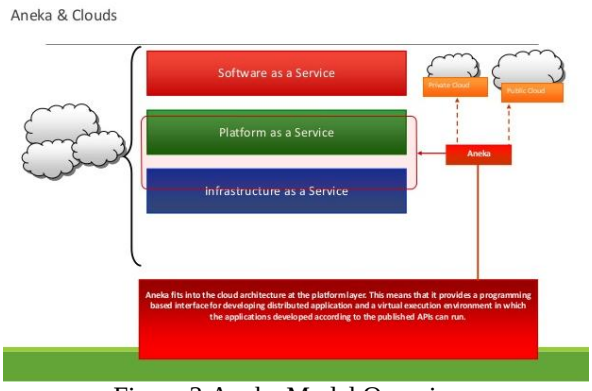

Figure 3:Aneka Model Overview

The Container

The container is designed as a runtime host and coordinator for other components. Details of compulsory and optional services, security, persistence, and associated communication protocols are specified in an XML configuration file which is read by the container when it is initialized. The main responsibility of the container is to initialize the services and present itself as a single point for communication to the rest of
the system. However, to improve the reliability and flexibility of the system, neither the container nor the hosted services are dependent on each other. This is so that a malfunctioning service will not affect the others and/or the container. Also, this enables the administrator of an Aneka system to easily configure and manage existing services or introduce new ones
into a container.

Base Infrastructure

The base infrastructure for the runtime framework gives essential services like logging, message dispatching, communication, security, network membership, and persistence functions that is then utilized by the main services, and it is possible to substitute various implementation of these basic functional services corresponding to the needs of the services. For example, user can select different kind of security method by editing the configuration files, and the runtime machine will connect them on demand by the services. The system also allows various types of persistence methods like memory, file or database back ends in a same way. The message dispatcher module acts like a front controller and allows point to point service communication. All requests from the client or other Cloud Computing nodes until the container are handled as a message, and is identified and sent through the message dispatcher module. The communication technique can also be set to use socket or web services.

Node Arrangement

The network architecture is dependent on the interactions among the services, as each Container has the ability to directly communicate along by other container reachable on the network. Every cloud computing node present in the network has a role relating to the services provided in its container. For example, a node can be an index server if only the index services are saved in the container; nodes with scheduler services can be pure scheduler node that clients submit their jobs to; nodes which have execution services can be mainly dependent on completing the needed execution. A node can also provide various services, and be both a scheduler and executor at the same instance. As shown in Figure 3, wherein various types of Aneka nodes are designed to provide a network which has every node working as a peer, a request from the end user can literally spread

to each node with the respective functions. In the following case, as there is no central manager to manage other executors, the request will be separated by each node which will decide whether to process or to leave the request.

Web Geospatial Services

We use GIS standards and Web Services methods to pair data assimilation tool with geospatial data. The system uses a publish/subscribe operation depending on messaging basis to give high performance spatial services between data sources and client applications. Initial step for creating GIS services is to decide the respective encodings for demonstrating the data. The essentiality of the data format is in the fact that it transforms into the basic building block of the system which hence determines the level of interoperability. The standard XML encoding i.e. Geography Markup Language (GML) is widely known for geographic data and it is widely accepted as the universal encoding for geo-referenced data. Considering the wide acceptance of OGC specification, both at global and national level, we have used OGC specifications to construct geospatial data applications.

IMPLEMENTATION COMPONENTS OF CLOUD GIS

An ideal Geospatial Web service request-response cycle begins with the client request. The Client communicates to the service through the WSDL interface. A request may contain various types of queries such as UPDATE, SELECT, and DELETE etc. As we have implemented the general geospatial Web service currently, we only allow SELECT queries. After the request is sent the geospatial Web service extracts the SQL query from the request using the OGC Filter Encoding implementation [18] classes. Next the query is executed and the outputs are obtained. At this point the geospatial Web service uses the configuration files to construct the GML Geospatial Collection object. Depending on the type of geospatial Web services the outputs are sent to the user through appropriate channel.

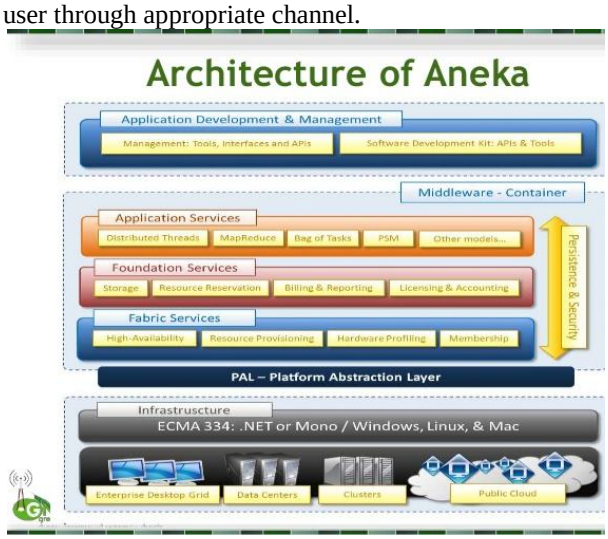

Figure 4. The implement architecture of geospatial data services based Aneka.

As per system view, the elements in this model are of two main kinds (Fig 4. shows the implement architecture): User applications are the software mostly seen by users; they may be highly customized analytical field applications, or general-purpose viewers. They obtain their input from directly the data storage or from intermediate services that pre-process data for its use. Geospatial data service is the "workhorses" of the inter-operability stack. IT may simply obtain maps from raw data; or might perform high analytical functions like feature extraction or coordinate transformation. It provides data, maps, or other inputs to user applications or to other services, that what is known as "service chaining." Geospatial data services contains of two main components, the scheduler and the worker. The scheduler is maintained for monitoring the status of every worker, dispatching ready tasks to respective workers and tracks the progress of each job respective to the data dependency graph. It is designed as a set of four main services: Registry service handles the location information for available geospatial data. It contains a list of indices for every available geospatial data. Dataflow service keeps track of the data dependency for each job and keeps track of the availability of jobs and explores ready jobs. As it finds ready jobs, it will tell the scheduler component. Scheduling service is responsible for organizing the execution of job units containing the application, sending them to various nodes, obtaining back the output, and giving them to the end user. In every task, the master notifies workers of inputs and starts the respective execution module to produce the output data. Catalog service allows clients and services to find out what repositories or services are available and applicable for their use. Gazetteers are such examples of such "meta-service"; which provides the geographic locations of place name. The worker works in a peer to peer manner. To work with the scheduler (that performs as the master), every worker has two functions: executing the requests from master and storing the geospatial data. Hence, the worker has three services: Executor service obtains execution requests from master, obtains input from the storage component, stores results to the storage component and sends notification to the master about the availability of the resultant data. Storage service is required for managing and holding data produced by executors and giving it upon requests. To handle failures, the storage component keeps data constantly locally or replicate some vertices on remote side to increase the reliability and availability. To increase the scalability of the system, workers send partial data in a P2P manner amongst themselves. When the executor service receives an executing request from the master node, it sends a fetch request to the local storage service. If there is a single local copy for the requested data, the storage service will obtain the data from remote worker respective to the location mentioned in the executing request. As all the input data is available on the worker node, the executor

service constructs an instance for the execution module upon on the serialized object from the master, initializes it with the input vertices and begins the execution. After computation completes, the executor service stores the result vertex into local storage and notify the registry service. The storage service keeps hot spatial data in memory while keeping cold data on the disk. The spatial data will be thrown into disk asynchronously to save memory space if needed. The worker schedules the executing and network traffic of multiple tasks as a pipeline to increase the performance. A task is a single unit of work processed in a node. It is independent from other tasks that may be executed on the similar or other node at the same time. It is also atomic, i.e. it either executes successfully or fails to give any appropriate result. The task model contains the following components: the client, the scheduler and the executor. The task object is serialized and submitted by the client to the scheduler. The task scheduler is used as a service hosted in the Aneka container, and simultaneously listens for messages for requests such as task submission, query, and abort. After a task submission is received, it is listed in its database. The scheduler thread picks up queued jobs and maps them to available resources based on various parameters including priorities, user QoS requirements, load and so on. While these parameters and scheduling policy is pluggable and can be changed with custom policies. The task scheduler keeps account of the queued and running tasks and details about the perceived performance of the task executor nodes that it is able to find in the network, by communicating with the membership service. The task executor is also used as a service hosted in a container, and its main role is to listen for task assignments from the scheduler. When the executor receives a task, it unpacks the task object and its dependencies, creates a separate security context for the task to run, and launched the task. This permits the task to run in a sandboxed application domain separate from the main domain in which the container runs. The executor supports multi-core and multi-CPU scenarios by accepting as many tasks to run in parallel as there are free CPUs / cores. After a task is complete, it notifies and sends the results back to the scheduler. The executor can accept tasks from any scheduler in the network.

VI. Conclusion for Future Work

Cloud computing is quickly emerging as a technology trend that almost every industry that provides or consumes software, hardware, and infrastructure can want. The technology and architecture that Cloud service and deployment models provide are a main area of research currently for GIS technology. The adoption of Cloud computing as a technology and a paradigm for the new era of GIS has surely become popular and appealing amongst the software vendors. In the paper, we have seen the architecture, implementation and deployment of Geospatial applications based on Aneka, and OGC geospatial web services.

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Spatio-temporal Pattern of Urbanization in Mangaluru

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Abstract— **Over the years, urban and rural landscapes are prone to changes. Urbanization is, an intensification process in a particular landmass, evolving enormously in earlier 21st century. Demographic explosions and rural migrations are mainly accepted as causal factor for urbanization. Dispersed haphazard development at the periphery and near the highways which are obstacle for the sustainable development is often termed as urban sprawl. Urban sprawl seizes the possibility of uniform development in a particular land mass by devoid of basic amenities. In this regard, spatial data obtained from remote sensing satellites are useful in understanding the aforesaid phenomenon. Mangaluru, port city of Karnataka is demographically diverse due to expanding trade activities. Land use analysis of the study area, having 15 km radii from central business district, is carried out using supervised Gaussian maximum likelihood classification in an open source geospatial tool GRASS- Geographic Resource Analysis Support System. Accuracy assessment of this classification yields 90% overall accuracy. Land use classification shows drastic increase of urban patches in recent year. Further, study region is divided into eight parts and spatial metrics are calculated. Spatial metrics are used to quantify the pattern of urban sprawl. Various business activities along with transportation contribute to the sprawling nature of the region. South east, east and north parts are highly effected by urban sprawl. This highlights the need of providing basic amenities in sprawled region.**

***Index Terms*—Urbanization, Urban sprawl, Remote sensing, spatial metrics.**

INTRODUCTION

URBANIZATION is one of the major consequences of trade activities emerged at the end of 20th century. Urban areas are the dense agglomeration of people and firms. Industrial revolution is considered as an initial impetus to urbanization. Urbanization followed by urban growth is driven by demographic widening and rural migration. Urbanization induces both favorable and unfavorable conditions, in which unfavorable conditions shade the productivity of the system. According to 2011 census, growth rate during 2001-2011 was 2.76% with hike in urban population of 377 million. As a whole, urbanization in India has seen an increasing trend with a value of 3.3% all through last decade [22]. Differential urban population growth rate in rural and urban area is considered critical for urbanization.

Unplanned urbanization leads to dispersed haphazard growth at outskirts and along the highways which is referred as sprawl. Sprawl will create heterogeneous urban fringes which further causes unplanned and unsustainable development. Sprawled areas experience rapid population growth with decreasing urban services. In this respect, quantification of urban sprawl can assist the planners in structuring appropriate policies which uniformly maintains cost of benefits around a city.

There have been many attempts in identification, defining, measuring and quantification of urban sprawl ([2], [3], [7], [11], [14], [15], [16], [17], [18] and [19]). Though, socioeconomic indicators can reveal sprawl phenomena, temporal unavailability of this directs to follow the process flow involving spatial data from remote sensing satellites [19]. Sprawl always follows a pattern and this with the aid of holism and visual interpretation sprawl can be identified [11]. Temporal information from remote sensing images are capable to address the degree of sprawl ([3], [16], [21]). Communication [3] discusses the concerns of scales and parameters in identification of pattern of sprawl. Several other methods that are analytical in approach such as metric calculations ([11], [12], [15], [19]) and entropy ([3]) measures etc. Shannon's entropy is widely accepted method in understanding degree of sprawl in urban growth and from this degree of freedom is found in [3]. In this study, extent of urbanization is found using land use analysis of two images belonging to different time scale. Spatial pattern of urbanization is further analyzed through metrics using FRAGSTATS ([9]).

Section II portrays study area, data used in this study are explained in section III. Method involved in the study of urban sprawl and results of which are shown in section IV and V respectively.

STUDY AREA

Mangaluru is an intoxicating cocktail of all religions, city famous for education, industry and commerce activities. Spatial extent of the city are 12^0 44' 39"N to 13^0 02' 03"N and 74^0 39' 54"E to 74^0 58' 57"E (fig. 1). Mangaluru is situated at the backwaters of Nethravathi and Gurupura rivers. The Western Ghats and Arabian Sea acts as a natural boundary from east and west respectively. Population of this area is approximately 0.4 million [22]. City is well equipped in transportation with all four types of connectivity viz. road, rail, air and port. Industries, transportation and emerging IT sectors may be considered as main source of urban agglomeration of Mangaluru.

DATA

Landasat-8 image for the study area is downloaded from the public domain of United States geological survey portal. A 15 km circular buffer, drawn from central business district is considered as the study area.

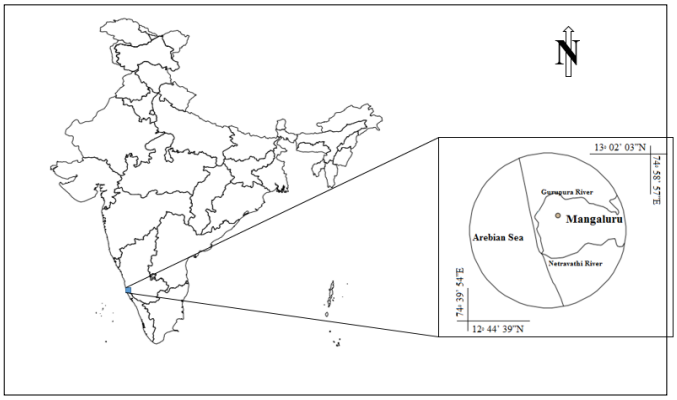


Fig. 1. Study area.

METHOD

Land use analysis

Landsat imagery, for 2003 and 2015, is georectified and clipped to the study area. False color composite (FCC)-5, 4, 3 is generated. Training sites for land use classification is obtained from FCC. Of these, 60 percent of the training sites are used for land use classification. Land use classification is achieved for the classes- urban, vegetation, water body and other classes. Remaining 40 percent of the samples are used as testing sites and a classification for validation is performed. Classification accuracy using statistical parameters such as overall accuracy and kappa statistics is attained. Overall accuracy for 2003 and 2015 were 95.2 and 89.9 percentages and resulting kappa statistics for 2003 and 2015 were 0.85 and 0.92. A detailed method is represented in fig. 2.

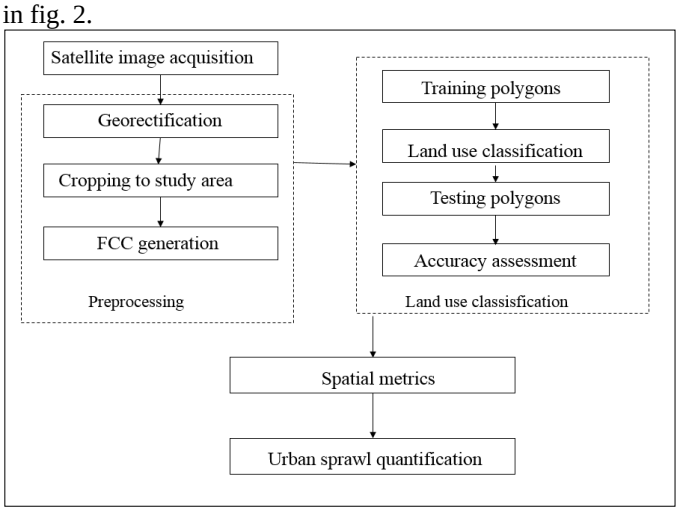


Fig. 2. Method

Land use classification is performed in GRASS - Geographic Resource Analysis Support System an open source software. GDAL, OGR, i.maxlik, r.kappa etc., modules are extensively used in this tool.

Spatial metrics

Spatial metrics are the numerical measurement that quantifies the spatial pattern of urban sprawl ([9]). These metrics are grouped as patch, class and landscape metrics.

TABLE I
LANDSAT IMAGERY DETAILS

Year	Landsat sensor	Spatial resolution
2003	Enhanced thematic mapper plus (ETM+)	30 m
2015	Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	30 m

These are available in the public domain under the program FRAGSTATS. This study encompasses computation of class level metrics. Study area is divided into eight parts: north, north east, east, south east, south, south west, west and north west. Class level metrics used in this study are tabulated in table-III.

TABLE II
LAND USE ANALYSIS

Land use	2003		2015	
	Hectare	%	Hectare	%
Urban	10065	14.4	17903	25.6
Vegetation	24759	35.4	17033	24.36
Water	29980	42.8	30598	43.77
Others	5108	7.31	4378	6.26

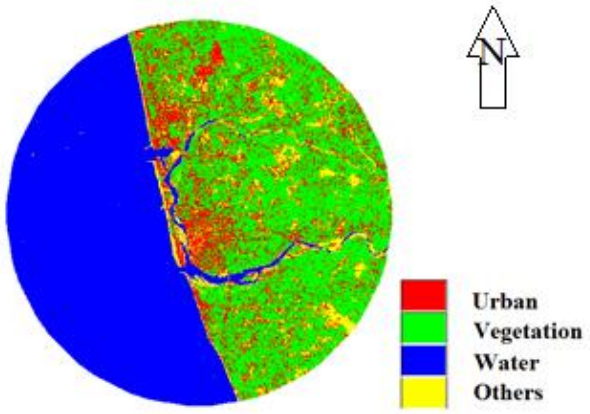


Fig. 3. Land use classified map of Mangaluru, 2003

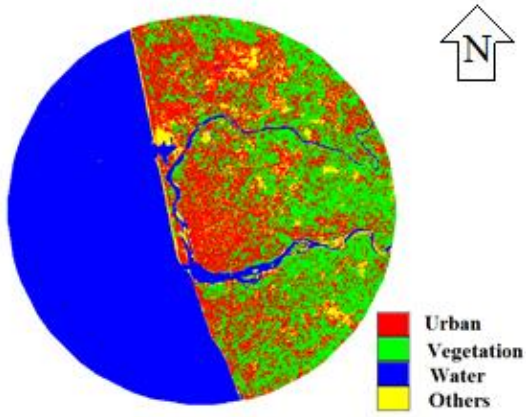


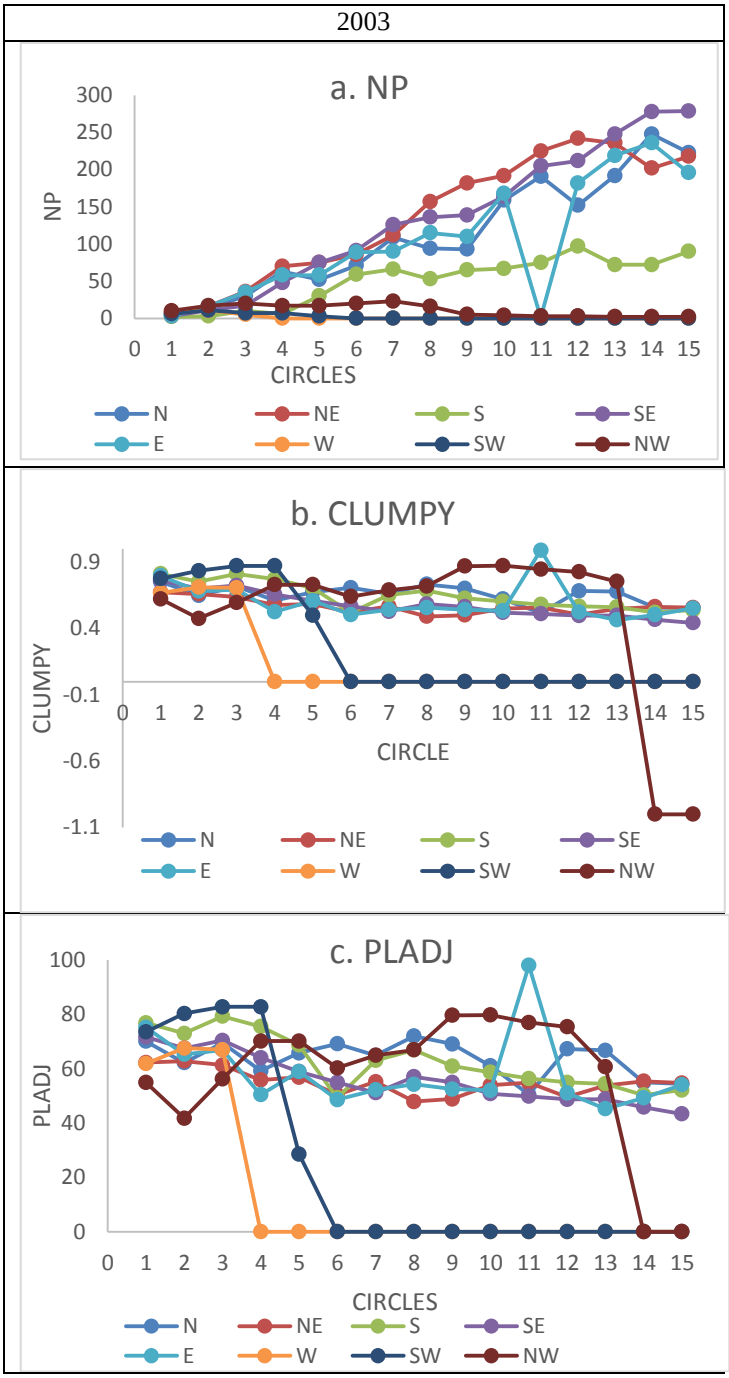
Fig. 4. Land use classified map of Mangaluru, 2015

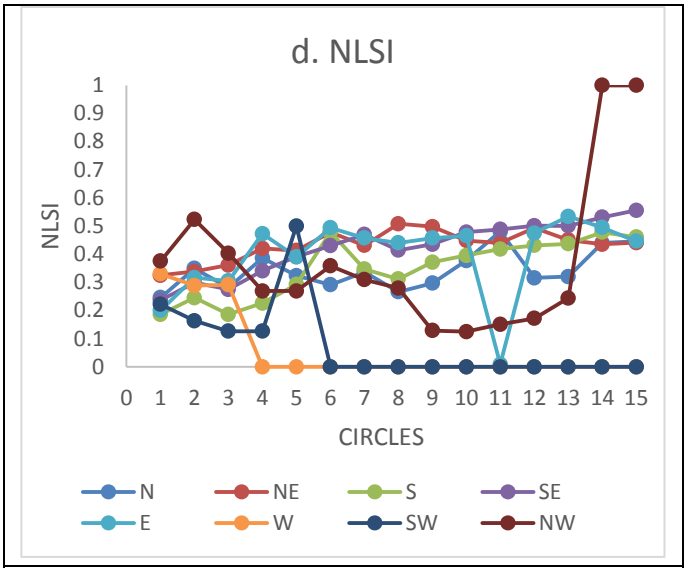
TABLE III
CLASS LEVEL METRICS ([9])

Code	Name	Formula	Range
NP	Number of patches	NP = n NP equals the number of patches in the landscape.	NP>0 without limit
CLUMPY	Clumpiness index	$CLUMPY = \frac{Gi-Pi}{Pi}\ for\ Gi < Pi\ Pi < 5$ $else$ $Gi = \frac{gii}{\sum_{k=1}^{m} gik - \min ei}$ g_{ii} =number of like adjacencies between pixels of patch type i based on the *double-count* method. g_{ik} =number of adjacencies between pixels of patch types i and k . min-e_i = minimum perimeter of patch type i for a maximally clumped class. Pi =proportion of the landscape occupied by patch type (class) i.	-1≤ CLUMPY ≤1
PLADJ	Proportion of like Adjacencies	$PLADJ = (\frac{gii}{\sum_{k=1}^{m} gik}) \times 100$ g_{ii} = number of like adjacencies between pixels of patch type i based on the *double-count* method. g_{ik} = number of adjacencies between pixels of patch types i and k	0<=PLADJ <=100
NLSI	Normalized landscape shape index	$NLSI = \frac{\sum_{i=1}^{n} \frac{Pi}{Si}}{N}$ S_i and P_i are the area and perimeter of patch i, and N is the total number of patches.	0≤NLSI<1

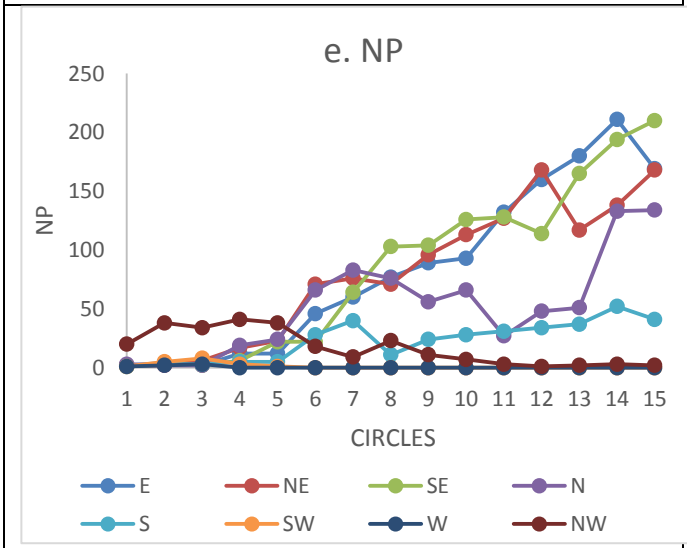
V. RESULTS

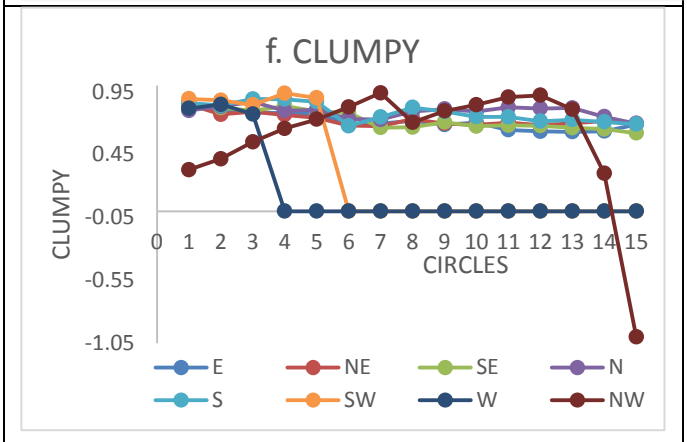
Land use analysis, using GRASS, of the study region yields area estimation for different land use classes. This is shown in table. II. Urban areas are increased from 14.4 % to 25.6 %. This is followed by the decrease of vegetation cover from 35.4 % to 24.36%. Spatial metrics are the indices, indicates different pattern of urban sprawl in the city surroundings. Spatial metrics of class level viz. number of patches, proportion of like adjacencies, clumpiness index and normalized shape index are determined for urban patches. All patches have touched a value equal to zero in westward zones (fig.5) signifying the unavailability of urban patches.

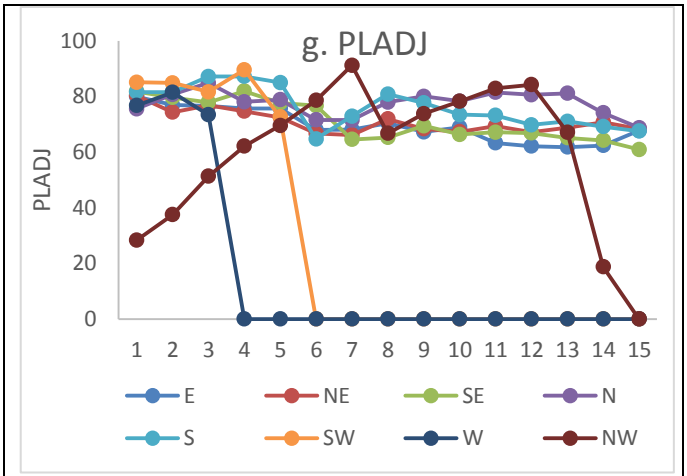




2015







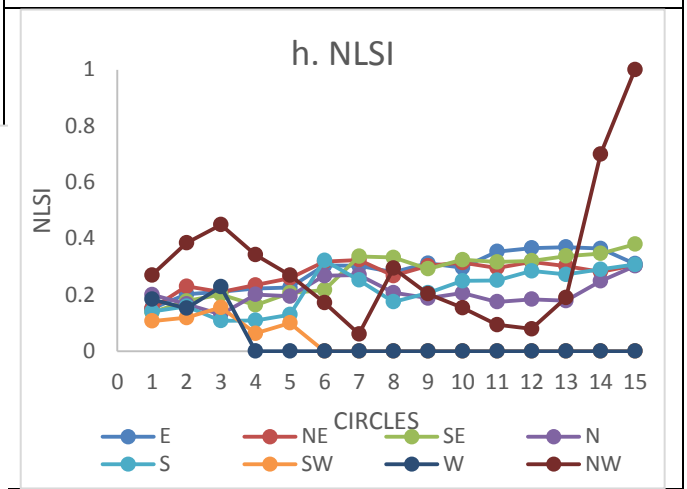


Fig. 5. 2003: a. Number of patches, b. Clumpiness index c. Proportion of like adjacencies, d. Normalised landscape shape index
2015: e. Number of patches, f. Clumpiness index g. Proportion of like adjacencies, h. Normalised landscape shape index

DISCUSSIONS

Urban settlement, in this study, has profound effect near stream banks, along highway and other peripheral roads (from fig). Both stretches of NH-66, is densely populated which passes through port and city centers and further Ullal. Other roads such as Mangaluru – Bantwal, Mangaluru-Bajpe popularly known as airport road, Mangalore – Vamanjuru road etc. act as drivers of urban sprawl. Urban intensification in the core or central business district forms a single patch of paved area. There is a vast change in the urban land use from 2003 to 2015.

Spatial metrics, class level metrics are used here to indicate the spatial pattern of sprawl. Number of urban patches, an indication of compaction or fragmentation, shows east part of the study area contains maximum number of patches followed by south east and north east. East, north east, south east portions houses several business activities. Maximum number of urban fringes at east, is an indication of haphazard sprawled development. Clumpiness index values equal to one indicates maximally clumped form of urban patches which can be seen in north west. Urban patches in coastal belt (inside core region) are maximally compacted which resulted high like adjacencies. Proportion of like

adjacency is also having a profound effect on north direction which encompasses ribbon development near national highway 66. Normalized shape index (NLSI) is an indication of complexity of shapes helps in identification of sprawled and compacted regions. Core area consists of simple shapes and higher values of NLSI on the periphery is a sign of fragmented growth. It is also seen that some policy factors which would have cause sprawling development. For instance, special economic zone (SEZ) has indirectly triggered the residential development in mostly north east and north directions. Sprawling behavior of urban patches have also triggered by establishment of educational institutions. This is true in south, south east part of the city, where most of the educational (Engineering colleges, Medical institutions, Mangaluru University) developments reside. Clumpiness index and proportion of like adjacencies have touched its peak along the core areas of north west part and subsequently decreased to zero. Urban agglomeration and sprawl pattern in 2003 and 2015 are following a similar trend. Since, 2010, there has been many field specific centers in the outskirts which have initiated fragmentation of urban patches.

CONCLUSION

Comparative assessment of land use scenarios of 2003 and 2015 shows that there is a tremendous increase in urban patches by 177%. There is also decrease in vegetation cover by 145%, mostly inside core area. Spatial metric analysis helps in identifying pattern of urban sprawl which is severe in east, north and south east regions.

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A Land Cover and Land Use Assessment for Different Agriculture Cultivations Using Graph Based Image Segmentation Techniques

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***Abstract*— Remote sensing application plays a major role in the analysis of land cover and land use. The drift in generation leads to the change in the land use also. The globalization introduces and motivates the new trends in agriculture field which may be financially benefit to the formers but in the meantime it may also affect the land cover. This may leads to an unfortunate environmental adversity in the globe.**

There is no accurate and effective model or map which measures the land cover and land use over the period of years. An automated technique can be developed which assist experts, planners, policy makers, farmers and for other organizations.

***Index Terms*—land use, Remote sensing, vegetation.**

INTRODUCTION

Remote Sensing

Remote sensing is the acquisition of information about an object without being in physical contact with it. Generally, remote sensing refers to the activities of recording/observing/perceiving (sensing) objects or events at far away (remote) places. The object recognition is one of the primary tasks in remote sensing. For example, identifying land cover based on satellite images has an important role in agriculture, environment protection and economics.

Graph Theory

Graph theory is a powerful tool to describe the images received from the remote sensing using different image processing algorithms. Its theoretical results greatly help in the analysis of methods.

Image Processing

The aim of digital image processing has always been the recognition of shapes and objects in images. In the way leading to object recognition image segmentation is an elementary step in the classification process. In the meantime time segments are also having an important role. Segments are homogeneous, contiguous components of images.

The digital image processing has several leading areas where development is very spectacular like remote sensing. The aim of image processing systems is usually to identify the objects of "real world" in images.

Land Cover and Land Use

The definition of land cover is fundamental, because in many existing classifications and legends it is confused with land use. Land cover is the observed (bio) physical cover on the earth's surface. When considering land cover in a very pure and strict sense, it should be confined to the description of vegetation and man-made features. Consequently, areas where the surface consists of bare rock or bare soil are land itself rather than land cover. Also, it is disputable whether water surfaces are real land cover. However, in practice, the scientific community usually includes these features within the term land cover.

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. Definition of land use in this way establishes a direct link between land cover and the actions of people in their environment. The following examples are a further illustration of the above definitions:

- "grassland" is a cover term, while "rangeland" or "tennis court" refer to the use of a grass cover; and
- "Recreation area" is a land use term that may be applicable to different land cover types: for instance sandy surfaces, like a beach; a built-up area like a pleasure park; woodlands; etc.

.

II LITERATURE SURVEY

A number research papers has been studied before starting the work. In [1] the image classification is done using one of the four image segmentation algorithms, which gives the optimum results. Here it also discusses the mapping of classification into image classes by using Bhattacharya classification method. These concepts show that the concepts of image classification and clustering can be done within these concepts.

The one more paper [2] discusses the features of building detection using SIFT key algorithms, using patterns recognition techniques. Here instead of detecting the land use, it detects the building and residential plots in the Urban area.

In many papers object recognition using different image processing algorithms have been discussed and many algorithms use the graph theory concepts

III METHODOLOGY

1. Extracting primitives(lines) from image
2. Use objects as textual primitives and exploit their spatial patterns
3. Primitives are detected using spectral and morphological processing
4. The image segmentation is used to partition the nodes into a complete disjoint system, where partitions can be connected.

5. A normalized cut-based image segmentation algorithm can be used to partition the images.
6. After segmentation, segments are assigned to land cover categories with supervised classification
7. This result of classification is used to measure the accuracy of the procedure.
8. It is a known observation in remote sensing that a large number of pixels belonging to the same kind of land cover can be approximated by a normal distribution or by the composition of several normal distributions.
9. To determine classification accuracy, ground truth data are used.

CONCLUSION

In this paper we have proposed a graph theoretical method to analyze land cover and land use. The effective implementation of the method is expected to help the policy makers, farmers and others.

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A Hybrid Approach to facilitate Context Based Search

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***ABSTRACT*: Information retrieval (IR) is a method of gaining information resources related to a need of information from a group of information resources. Information retrieval systems can also be described by the scale at which they operate. In web search, the system should provide search over billions of related documents stored on different millions of computers. Searches can be either metadata or content-based indexing. Information retrieval is used in various fields such as universities and public libraries, to provide access to books, journals and other documents. The traditional information retrieval is based on keywords but lack context. In this work we have provided context using ontology and our experimental evaluation shows an improvement in the results.**

KEYWORDS: Information Retrieval, Ontology, Context.

INTRODUCTION

The search engines that we use such as Google, yahoo or Bing have become a part and parcel of our day to day life. These search based applications roots goes back to the field of Information Retrieval. Traditionally the scope of information retrieval was in the field of libraries to search books etc. But the impact of web has brought a great change in the field of Retrieval. The process of retrieval starts when a user inputs a query into the system. A query is used in order to retrieve certain information from large amount of data. A query is not used to uniquely identify a single object in the collection; it can match several objects, perhaps with different degrees of relevancy.

Information Retrieval (IR) deals with the recovery of documents from a collection for a given user information need expressed with a Query. With enormous data emerging on the web, the process of searching and managing massive scale content have given increased challenge overall. This have led to the development of the IR models that seem to have an upper hand over the other with respect to

performance, specifying the query, arranging the documents with regard to relevance and many other factors. The use of ontologies to overcome the limitations of the traditional keyword-based search has been carried forward as motivations of the semantic web. Since then, a lot of work began with the aim of getting the web to be a place that will facilitate a more meaningful search.

It is very important to retrieve information accurately and efficiently. There have been many attempts to improve the precision of the searching. One such attempt is to understand the context by using ontology. Though ontology is a term used in philosophy it has gained momentum in computer science after the advent of World Wide Web in particular after the vision of semantic web. Ontology characterizes concepts that are a part of the world. At present, ontology serves as a backbone of the Semantic Web. It provides vocabularies and formal conceptualization of the provided domain to facilitate information exchange and sharing. In this study, ontology is used to provide context by creating ontology. We have created a domain ontology for Pizza's, and have used to queries related to pizza.

In the next section we will be explaining about Context, then definitions of query, query refinement and ontology, the implementation of the prototype system, results and discussion and then will be the conclusion.

CONTEXT

The use of context in the field of computer science is not at all new, it is studied in many areas such as machine learning and Artificial Intelligence. With the emergence of information retrieval and in particular after the impact of web that has created lot of challenges in different levels, context has been in the forefront for researchers. Information retrieval context can be used to understand and learn the different aspects such as link analysis, language models, background of the user and the background of the knowledge resources, so that it can be used to improve the performance of the Information Retrieval System.

QUERY AND QUERY REFINEMENT

A query is the formulation of a user Information need. In its simplest form, a query is composed of keywords and the documents containing such keywords are searched for. A query can be simply a word or a more complex combination of operations involving several words. The most elementary query that can be formulated in a text retrieval system is a word. The output of word queries is the set of documents containing at least one of the words of the query. An initial query made by a user may not be adequate enough to fetch him the desired output or result immediately. Further the user needs to be more specific on what exactly he is looking for. The user then makes

preferences by making the attributes appropriately and then tries to resubmit the query and tries to get desired result. This process of filtering the queries is also known as **Query Refinement.** Query Refinement Provides user with new keywords related to particular query**.** It is a powerful tool for a document search and retrieval system. To get a better search result user query has to be refined. Query Expansion (IE) is nothing but a process which reformulates a seed query to improve retrieval performance in information retrieval operations. In the aspect of search engines IE involves evaluation of user's input. Precision in query expansion is increased by including in the result set pages which are more relevant or at least equally relevant.

ONTOLOGY

"Ontology" is the term used to refer to the shared understanding of some domain of interest. Ontology is the study or concern about what kinds of things exists or what entities are present in the universe. Ontology is derived from the Greek words *onto* which means being and *logia* which means written or spoken disclosure. It is a branch of metaphysics, the study of principles or the essence of things. Ontology provides common understanding of a term and also how other terms are related to the current term. In Information Technology, ontology is working model of entities and some particular domain of knowledge or practices. Ontology is a set of concepts like events, things and relations that are specified in some way in order to create an agreed upon vocabulary for exchanging information. Ontology describes a domain, while a knowledge base (based on ontology) describes particular state of affairs. Each knowledge based system or agent contain its own knowledge base, and only what can be expressed using ontology can be stored and used in the knowledge base. When an handler wants to communicate to another handler, he uses the constructs from some ontology.

IMPLEMENTATION OF THE PROTOTYPE SYSTEM AND ANALYSIS OF TEST DATA

1. **ONTOLOGY CONSTRUCTION:** Ontology is a formal way to represent knowledge. It is a set of concepts within a domain. It is a knowledge base for our project that is built based on the concepts related to Pizza domain. By referring to the Pizza broachers and websites a handful of data is collected and based on the information gathered ontology is constructed taking into consideration the various aspects under Pizza domain.
   TOOL USED: Protégé 5.0 Beta
2. **USER INPUT:** The user enters a query related to Pizza domain in natural language. The result is expected to be relevant web links based on the search made and other irrelevant web links must be eliminated or filtered out.
3. **PARSING OF QUERIES:** The query that is passed as an input by the user is initially parsed using a parser. This is done in order to analyse the query syntactically which checks the part of speech of each word in the query. In this way of parsing the query is analysed grammatically.
   TOOL USED: Stanford Parser
4. **WORDNET:** The output that is obtained from the parser is passed through the WordNet API in order to get the related synsets of various words present in the query. Hence semantically related words are obtained from the output of WordNet
   TOOL USED: WordNet API
5. **EXTRACTION FROM ONTOLOGY:** This is an important process where the information related to the given user input query is extracted from the built ontology. The initial query after passing through Stanford Parser and WordNet API, gives a set of classified and semantically analysed words. These words are matched with the concepts that are contained within the ontology to get a set of more related key words. At the end of this process we get a collection of words which are domain specific keywords.
   TOOL USED: Jena API
6. **FORMATION OF REFINED QUERY:** The next process is query formation that is using collection of the words that were collected before this step. The query that is formed will produce more refined results and will fetch more semantically related links when we pass the query as an input in the search engines. The refined query will be sent to the search API which fetches web links related to user query.

   TOOL USED: Google Search API

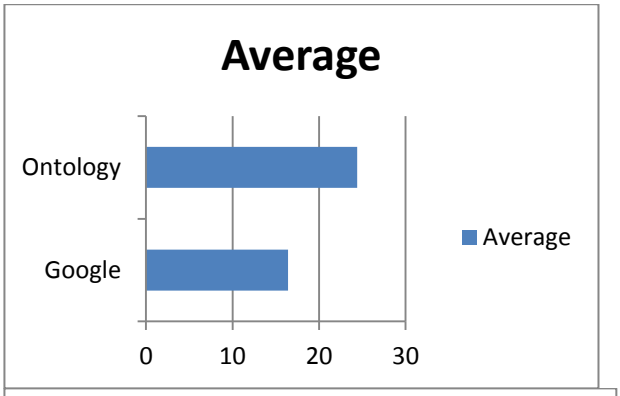
RESULTS AND DISCUSSION

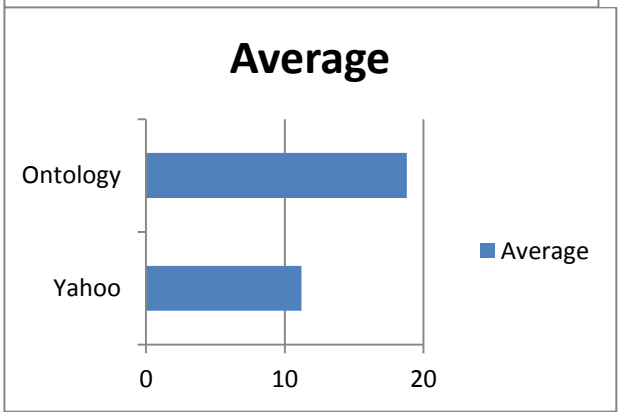
Our experiment proves that the refined query gives more relevant web links and is producing better results when compared to passing the query directly to the search engines. We have experimented this in the month of August and September 2015. The first 25 results were manually checked for relevance.
The queries that were processed are given below.

Sl.no	Sample Queries	Google	Yahoo
1	Categories in pizza	4	2
2	Divisions in veg pizza	3	2
3	Types in non-veg pizza	5	4
4	pizza toppings	5	3
5	Crust options in pizza	4	2
6	Combos in pizza	4	5
7	Side orders in domino's pizza	7	5
8	Types of Italian Exotic pizza	3	2
9	Beverages given in pizza	6	3
10	Sizes in pizza	6	3

Sl.no	Refined Queries	Google	Yahoo
1	Category or Categories in pizza	5	3
2	Section or Divisions in veg pizza	5	3
3	Type or types in non-veg pizza	7	5
4	Topping or pizza toppings	6	4
5	Crust or Crust options in pizza	5	6
6	Combo or Combos in pizza	6	6
7	Side or Side orders in pizza	8	7
8	Type or types of ItalianExoticpizza	5	4
9	Drink or Beverages provided in pizza outlet	7	4
10	Sizes in pizza	7	5

COMPARITIVE RESULTS:





CONCLUSION

In this paper we have used ontology to facilitate context based search. It helps to understand the advantage of using ontology over the traditional keyword based search. The quality of ontology plays a vital role in the context based search. The context based search will yield better relevant results than the traditional information retrieval methods. Since our ontology is based on Pizza domain it provides a better result when query is related to this domain.

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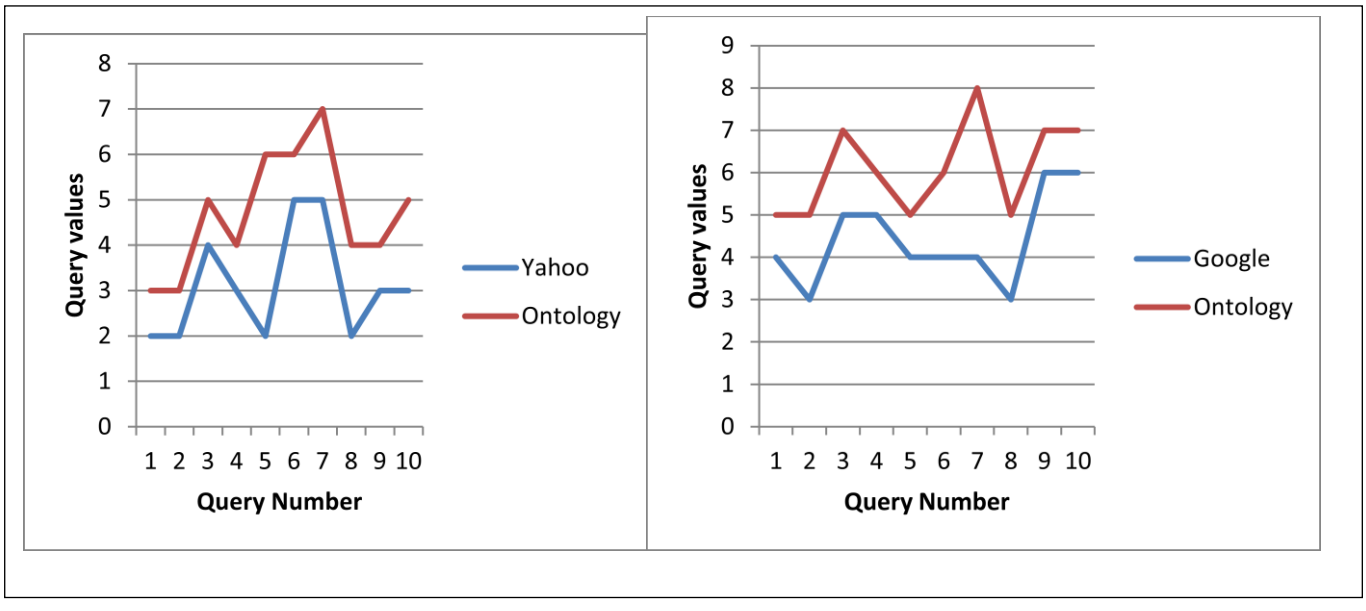

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Multi-Dimensional Resource Scheduling Algorithm for Cloud DataCenters

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ABSTRACT
In distributed environments load balancing is essential for efficient operations. Load Balancing strategies are of huge significance in improving the reliability and performance of resources in data centres. Allocating and migrating virtual machines (VMs) which are reconfigurable and taking into consideration integrated features of hosting physical machine (PMs) are one of the challenging problems in scheduling resource in cloud data centres. Therefore load balancing due to its challenges and importance for the cloud has become a major research area. Various algorithms were proposed to supply productive mechanisms for tending to the client's requests to available Cloud nodes. In this paper, we investigate the different multi dimensional resource scheduling algorithms used to achieve scheduling of various task and balancing load in Cloud Computing.

KEYWORDS: scheduling, integrated load balancing, imbalance value, cloud computing

1. INTRODUCTION

Cloud load balancing is the distribution of workload over various available computing resources. Cloud load balancing increases resource availability and decreases costs associated with document management systems. Load balancers can perform a range of specialized runtime workload distribution functions, such as:

- *Asymmetric Distribution* - Computing resources with higher processing capacities are issued larger workloads.
- *Workload Prioritization* –Based on priority levels various scheduling processes are carried out.
- *Content-Aware Distribution* –As per the content of each request, they are provided with various computing resources

1.1 Importance of Load Balancing

Cloud computing benefits users with "cost, flexibility and availability of service users."[11] The rise in the demand of Cloud services are directly the result of these advantages. Due to this high demand various technical issues like high availability and scalability in Internet (IOS) and Service-style applications arise. Dynamic local workload are allocated across all nodes[12] by the load balancer which allows cloud computing to "scale up to increasing demands"[11]which solves a major concern in the issues stated.

1.2 Challenges in load balancing

Modified resource allocation techniques and better improved strategies through efficient job scheduling are the main provisions of the load balancer. The load can be network load, CPU load, memory capacity or delay. Load balancer performs the distribution of load among various nodes in a distributed system while also being able to avoid a situation where some of the nodes are idle or less loaded while others are overloaded and to improve both utilization of resources and response time of jobs. At any instant of time load balancer ensures that equal amount of work is done by every node in the network or all the processors in the system. This is the important factor to be considered during the resource allocation but this has become more difficult especially in elastic cloud computing where the user can dynamically request for the resource.

The performance prediction also plays an essential role in load balancing. But cloud environment is highly variable and unpredictable. To increase resource utilization, providers try to oversubscribe as many users to a shared infrastructure. This results in resource contention and interference. Other factors that contribute to unpredictability of the environment include heterogeneity within the same instance type and administrative action (e.g., eviction) to maintain the service level. These make it extremely difficult to predict the performance variability and track down its causes.

2. PROBLEM STATEMENT

In a cloud data center, within certain time period there are *M* Physical Machines (PMs), also called hosts, which configuration may be heterogeneous. CPU, memory and network bandwidth of each host are considered as multi-dimensional resources. In Infrastructure as a Service (IaaS), each user requests a Virtual Machine (VM) represented in a vector $r=(vC, vM, vN)$ where *vC, vM, vN*is CPU, memory and network bandwidth requirement respectively. All virtual machines on a physical machine share CPU, memory and network bandwidth capacities provided by the physical machine.

2.1 Problem:
Allocating and migrating virtual machines (VMs) which are reconfigurable and taking into consideration integrated features of hosting physical machine (PMs) are one of the challenging problems in scheduling resource in cloud data centres. This problem can also be defined as given a set of *n* requests (VMs) and a set of *m* identical machines (PMs) *PM*1, *PM*2, ...,*PMm*, each request has a processing time, the objective of load-balance is to balance load on every machine while they are being assigned requests.

3. LITERATURE SURVEY
Virtual machines demand is changing over time very highly in Cloud computing environment. So in this paper we consider dynamic load balancing scheduling when total number of physical servers is fixed. In this case, dynamic load balancing is conducted by allocating virtual machines to minimize current total imbalance-value.

3.1 ZHCJ Algorithm:
Wood et al. [1], introduced a few virtual machine migration techniques. One integrated load balance measurement is applied as follows:

$$V = \frac{1}{(1-\mathrm{CPU}_u)(1-\mathrm{MEM}_u)(1-\mathrm{NET}_u)}$$

Where CPU, NET and MEM are the corresponding utilizations of that resource for the virtual or physical server. The higher the utilization of a resource, the greater the volume; if multiple resources are heavily utilized, the above product results in a correspondingly higher volume. The volume captures the degree of (over)load along multiple dimensions in a unified fashion and can be used by the mitigation algorithms to handle all resource hotspots in an identical manner. The algorithm always chooses physical machines with lowest referred V value and available resource to allocate virtual machines.

3.2 ZHJZ Algorithm: Zheng et al [3]. proposed integrated load-balancing measurement as following:

$$B= \frac{aN1_iC_i}{N1_mC_m} + \frac{bN2_iM_i}{N2_mM_m} + \frac{cN3_iD_i}{N3_mD_m} + \frac{dN4_iNet_i}{Net_m}$$

The referred physical server *m* is selected firstly. Then other physical servers *i*is compared to server *m*. *N*1*i* is the CPU capability, *N*2*i* is for memory capability, *N*3*i* is for hard disk. *Ci*, *Mi*is for average utilization of CPU and memory respectively, *Di* is for transferring rate of hard disk, *Neti*is for network throughput. *a*, *b*, *c*, *d* is for weighting factor of memory, network bandwidth, CPU and hard disk respectively.

The algorithm selects a physical machine , and calculates the value and chooses lowest referred B value in different physical machines and available resource to allocate virtual machines.

3.3 LIF algorithm: WenhongTian et al [5]. proposed new algorithm based on demands characteristics (for example, CPU intensive, high memory, high bandwidth requirements etc.), always selects lowest integrated imbalance value in different physical machines(as stated in equation (2-3)) and available resource to allocate virtual machines.

LIF algorithm considers imbalance values integrated CPU, memory and network bandwidth utilization, and the following parameters are considered:

Average CPU utilization CPU_i^U of a single server *i*: is averaged CPU utilization during observed period. For example, if the observed period is one minute and utilization of CPU is recorded every 10 seconds, then CPU_i^U is the average of six recorded values of server *i*.
Average utilization of all CPUs in a Cloud data center. Let CPU_i^n be the total number of CPUs of server *i*,

$$CPU_u^A = \frac{\sum_{i=1}^{N} CPU_i^U CPU_i^n}{\sum_{i=1}^{N} CPU_i^U}$$

where *N* is the total number of physical servers in a Cloud data center and CPU_i^n represents the number of CPUs in physical server *i*. Similarly, average utilization of memory, network bandwidth of server *i*, all memories and all network bandwidth in a Cloud data center can be defined as MEM_i^u, NET_i^u, MEM_u^A, NET_u^A respectively.
Datacenter-wide integrated imbalance value *ILBi*, of server *i*. In statistics variance is used as a measurement of how far a set of numbers are spread out from each other, therefore it is widely used. Using variance, an integrated load imbalance value (*ILBi*) of server *i* is defined

$$\frac{(Avg_i - CPU_u^A)^2 + (Avg_i - MEM_u^A)^2 + (Avg_i - NET_u^A)^2}{3}$$

Where

$$Avg_i = \frac{(CPU_i^u + MEM_i^u + NET_i^u)}{3}$$

is average utilization of multi-dimensional resource in a physical machine, also called integrated load in LIF

3.4 Rand algorithm: randomly assigns requests (virtual machines) to physical machines which have available resource.

3.5 Round Robin (RR): the round-robin is one of most used algorithm for scheduling (for example by Amazon EC2 and Eucalyptus [4]), in which PM's are allocated VM's in turns. Simplicity in implementation is the advantage of this algorithm.

4. PROPOSED SOLUTION

The proposed solution is the modification of LIF algorithm .while calculation integrated load imbalance value (*ILBi*) of server *i* The variance is used as a measure of how far a set of numbers are spread out from each other in statistics. Using variance, an integrated load imbalance value (*ILBi*) of server *i* is defined

$$\frac{(CPU_u^U - CPU_u^A)^2 + (MEM_u^U - MEM_u^A)^2 + (NET_u^U - NET_u^A)^2}{3} \quad (6)$$

Modified LIF algorithm is stated as follows

```
Algorithm :  modified integrated load first ()
Input: placement request r = (id, vC, vM, vN);
       status of current active tasks and PMs
Output: placement scheme for r and IBL_tot.
1) initialization: LowestAvg = large number;
2) For i=1:N Do
3)   If request r can be placed on PMi
4)   Then
5)    compute Avgi utilization value of PMi it using equations 1 and 6
6)      If Avgi <LowestAvg
7)        Then
8)  LowestAvg=Avgi;
9)           Else
10)       EndIf
11)    Else  //find next PM
12)  Endfor
13)  IF LowestAvg== large number L  // cannot allocate
14)    Then put r into waiting queue or reject
15)  Else
16)         allocatedPMID=i;
17)         place r on PM with allocatedPMID and compute IBL_tot
```

Fig 1 : Modified LIF Algorithm

5. EXPERIMENTAL RESULTS:

Algorithms are tested using the cloud tool –cloudsched. Experiment is conducted using the following DataCenter characteristics

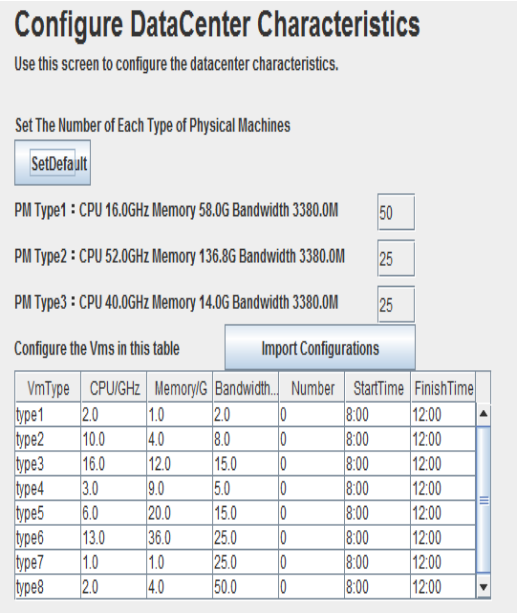

Fig 2: DataCenter characteristics Random Algorithm

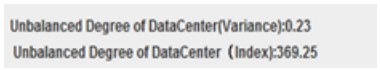

Fig 3: Result using Random load balancing algorithm

RoundRobin Algorithm

Fig 4: Result using RoundRobin load balancing algorithm

ZHJZ Algorithm

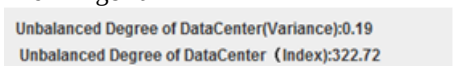

Fig 5: Result using ZHJZ load balancing algorithm

LIF Algorithm

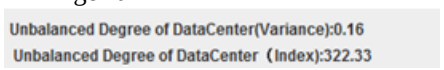

Fig 6: Result using LIF load balancing algorithm

Modified LIF Algorithm

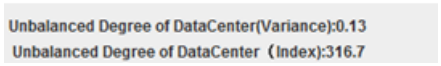

Fig 7: Result using ModifiedLIF load balancing algorithm

Cloudsched simulator generates different requests as follows: the total numbers of arrivals (requests)can be randomly set; all requests follow Poisson arrival process and have exponential length distribution; therefore to test the algorithm , it is executed six times and its average is taken as follows

	Unbalanced degree of datacenter
Random Algorithm	0.24
RoundRobin Algorithm	0.20
ZHCJ Algorithm	0.21
ZHJZ Algorithm	0.19
LIF Algorithm	0.17
Modified LIF Algorithm(proposed algorithm)	0.15

Fig 7: The average of six experiments

6. CONCLUSION

Essential requirements of a dynamic resource scheduler is to have low Computational complexity, require little information about the system state, and be robust to changes in the traffic parameters. To meet these requirements, in this paper, we introduce a dynamic resource scheduling algorithm (Modified LIF) in Cloud datacenter by considering multi-dimensional resource. Modified LIF makes current total imbalance value of all servers in a Cloud datacenter the lowest...

ACKNOWLEDGEMENT

The authors would like to thank the dedicated research group in the area of Cloud & Grid Computing, wireless networks at the Dept of Computer Science, Mangalore University, Mangalore, India, for many simulating discussions for further improvement and future aspects of the Paper. Lastly but not least the author would like to thank everyone, including the anonymous reviewers

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Identification and Analysis of Accident Black Spots along the Selected Stretches of NH-75 Using Remote Sensing & GIS Technology

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Abstract: **The Study has been carried out to identify the Black spots utilizing remote sensing & GIS techniques for a specific stretch of NH – 75, beginning from Nelyadi to Sakaleshpura. In the study, ten areas were spotted/recognized as a accident prone area using high resolution satellite images taking into account the non-spatial information gathered from Police division and the field survey conducted by keeping into account of traffic volume and vehicle speed. The whole 58 km stretch was studied using satellite images and were integrated environment in a GIS. For a distance of 500m around the transport stops the Buffer Zones were generated in such identified black spots and found that the buffer zone was secured the whole accident inclined areas. The cause for the accidents were generated from the accident information on GIS platform and it was found that the significant explanations behind the accidents were because of over speed, faults of the driver, climatic condition, bad over taking and improper highway design. The remedial measures were recommended for every accidental zones to neutralize the accidents**

Index Terms **-** Black spots, GIS, Buffer zone & ArcGIS.

1.0 INTRODUCTION:

India has one of the largest highway and road networks, second only to the road network of the United States. The total length of roads in the country exceeds 33 lakh kms (approx). This tangled network consists of 96,260 km of national highways, 1,31,899 km of state highways, and an informal network running to an astounding 31,17,763 km[1].

Traffic accident analysis is basically planned to explore the reasons for accidents by distinguishing risky areas and Accident prone locations of accident occurrence and to break down basically reasons attributing for the same in order to guarantee highway well being. The integrated approaches of Remote Sensing (RS) and Geographic Information System (GIS) have been a prevalent device for representation of accident information and investigation of problem in any area. Accident Black spot and conditions of the National Highways are identified or monitored by few researchers using Remote Sensing and GIS techniques[2][3]. Accident investigation studies goes for the identification of high rate accident areas and security inadequate zones on the Highways. The study displays RS and GIS based accident analysis System created for the NH-75 (National Highway connecting Mangalore- Bangalore). In the present research paper remedial measure for particular stretches where accidents are frequently occurring are also suggested.

2.0 SCOPE AND OBJECTIVES*:*

The objectives of this study are to,

1. Develop a methodology to identify the hazardous locations and to find out the most danger accident zone.
2. Find out most vulnerable accident zone (Black spots) in Shiradi Ghat (NH-75) by applying the methodology developed.
3. Identify various traffic and road related factors causing accidents and suggestion of possible improvements.

2.1. *Study area:*

The study area is located in Puttur Taluk, Dakshina Kannada District of the Karnataka State, situated along Nelyadi to Sakaleshpura (NH-75 connecting Mangalore to Bangalore) that is about 58 km road stretch (Refer Fig. 1& 2).

Table.1: Longitudinal And Latitude of Study Area

Sl. No.	Place	Latitude	Longitude
1.	Nelyadi	12° 50’ 9” N	75° 24’ 19” E
2.	Sakaleshpura	12°58’12’’N	75°46’48’’E

Table.2: Starting and End Point Elevation

Place:	Elevation(Mean Sea Level)
Nelyadi	108 metres (337 feet)
Sakaleshpura	924 metres (2885 feet)

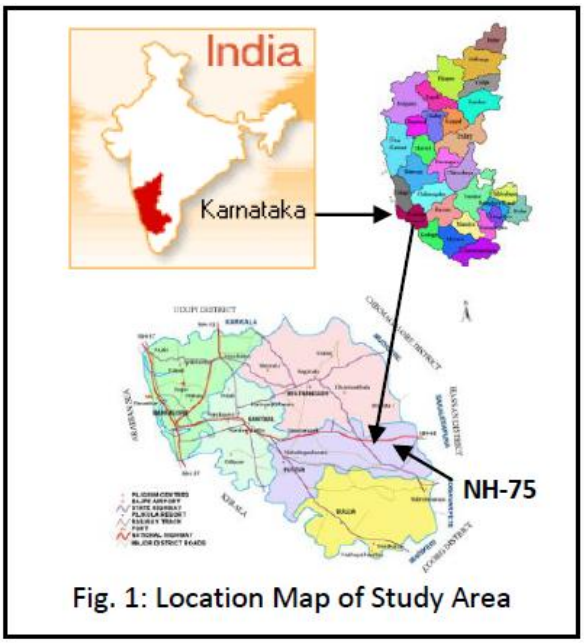

Fig. 1: Location Map of Study Area

2.2. Spatial data:

- Topographical map of the study Area (48 P/9).
- Physical map of Dakshina Kannada District.
- IRS-1C LISS-III & PAN merged Satellite image.

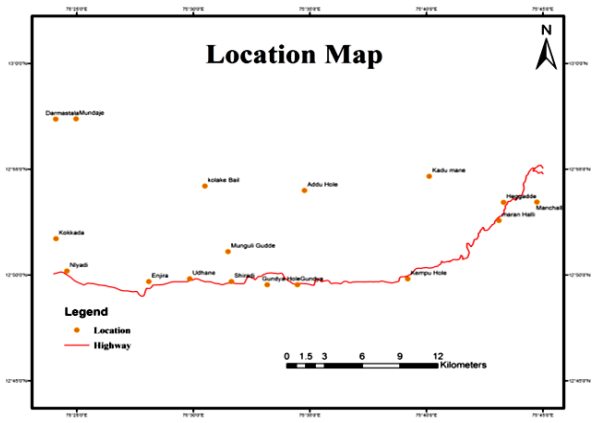

Fig. 2: Location Map

3.0 RESEARCH METHODOLOGY:

The methodology used for the accident analysis in the present research can be broadly classified into two parts. First are the spatial data and its related analysis, and the second one the non spatial data and its analysis. Both these arrangements of information were obtained from distinctive sources and broke down independently and were conveyed to the GIS stage for acquiring the visual representation of the outcome.

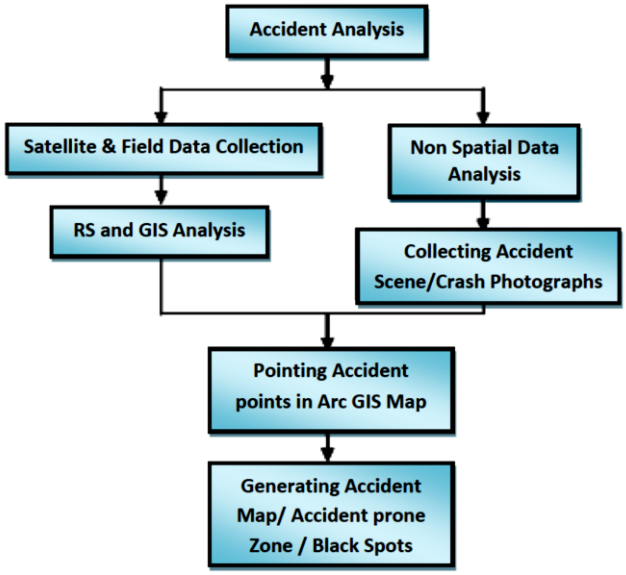

Fig. 3: Research Methodology A

3.1. Remote Sensing & GIS:

The Survey of India (SOI) Topographical map of the study has been used to prepare a base map (scale 1:50,000). Remote sensing data from IRS-1C LISS-III & PAN sensors have been primarily used for generating various thematic data layers. The digital data were transformed into the GIS platform (ArcGIS 9.3) and geo-referenced. The accident prone areas were plotted by obtaining the GPS co-ordinates for the specified locations mentioned as per the accident data obtained from the police department for the past 4 years. Different thematic maps were prepared such as petrol pumps, bus stops junctions etc. Buffer zones were generated for a radius of 500 m around the bus stops/junctions in all the accident prone areas in such a way that it covered the entire stretch where the traffic speed and the pedestrian crossing have to be strictly regulated.

***3.2. Characteristic in GIS*:**

The characteristic information incorporates two classes. The principal was achieved by the field overview and the second was achieved by the accident information which was collected from police department. The property information got from the documented overview incorporates the area of distinctive organizations and its vicinity, method of transportation, commercial ventures and its closeness, method of transportation accommodated the representative's area of Highway structures like middle opening, culverts, zebra intersection, spans and area of the transport stops. Spot speed of the vehicles at diverse areas among day time and evening, movement volume, street width, surface conditions, whether conditions and so on were collected and accounted in GIS. From the accident information the accompanying points of interest were inferred, for example, areas were most extreme number of accidents were happened, foundations for the accident, number of persons harmed, number of fatal cases, vehicle included, hourly conveyance of accidents.

3.3. Overlay Analysis:

The created distinctive thematic maps were overlaid and were connected with the whole characteristic information on the GIS stage and the outcome got by the accurate and spatial examination was represented visually. Demarking the clumsy prone areas as per the need and suggestion of suitable remedial measures were suggested for particular area.

3.4. Accident analysis on yearly basis:

Here the inquiry was carried out based on the information set according to year and sorted according to level of damage and concerned Police Station. The technique for question utilizing ARC GIS as a part of request to demonstrate the conveyance of distinctive levels of accident damage under every police headquarters from the years 2011-2014(Refer Table 4). It has been observed that the average number of accident for the specific year is pretty much same for alternate years. None the less, the quantity of average accidents and appalling harm is constantly expanding moderate. In year 2014, accidents are relatively more compared to previous years. Maps are an intense and successful approach to appear what example is happening with accident information spatially and every one of the maps were generated for two distinctive Police Stations for four unique years.

***3.5. Identification of Black spots locations*:**

The locations of places were the accidents are occurring more frequently were marked as the Black spots (Refer Fig. 4). Maps were generated based on the integration of RS and GIS it can be seen that the

accidents are occurring at locations like Donigal, Double turn (S curve), Near Kempuhole Chowdeshwari Temple, Near Gundya junction, Uhaney, Lavathadka cross, Periyashanthi, Kowkardy, Addaholey etc due to the inbound traffic from the feeder. Table.3 shows some of the major accident zones and their distance from Nelyadi to Sakaleshpura

Source: From Puttur Traffic Police Station, Rural Police station Sakaleshpura

Fig. 4: Location of Black spots near Donigal

3.6 Generation of Buffer Zones:

A buffer zone was created for a distance of 500 meters around each bus stop/junctions located in the Black Spots and it was found that it covered the entire stretch of the accident prone areas as shown using satellite images (Fig. 5(a), 5(b), 5(c), 5(d)). From this analysis, it indicated that if we regulate vehicles speed in this stretch (buffer zone stretch) the prevention of accident can be done in major extent.

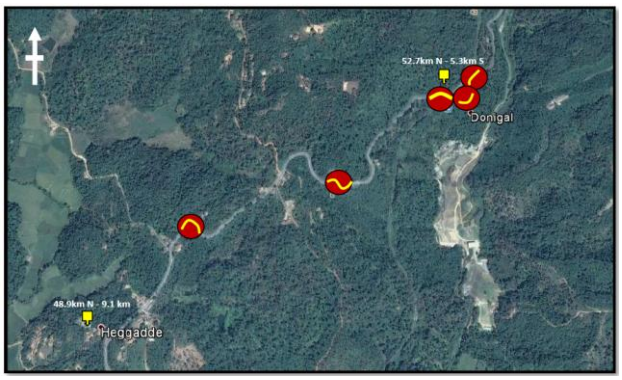

Fig.5 (a): Location of Buffer zones near Donigal

Fig. 5(b): Location of Buffer zones Near Kempuhole

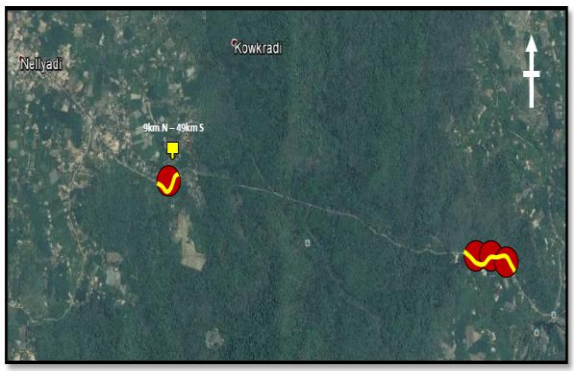

Fig. 5(c): Location of Buffer zones near Maranahalli

Fig. 5(d): Location of Buffer zones near Nelyadi

3.7. Accident Analysis on Vehicle Basis:

Table.3 : Location of Main Accident Zone/ Black Spot

Accident Zone	**From Nelyadi**	**From Sakaleshpura**
Donigal	52.7km	5.3km
Double Turn	40.5km	17.5km
Near Kempuhole Chowdeshwari Temple	34.0km	24.0km
Near Gundya Junction	20.7km	37.3km
Udhane	11.5km	46.5km
Lavathadka Cross	3.9km	54.1km
Periyashanthi	15.2km	42.8km

The inquiry to the database is performed utilizing sort of vehicle included as a part of accidents. The vehicles have been characterized into three categories

(a) Heavy Vehicles – Truck, Bus and carriers.

(b) Medium Vehicles – Private Car, Jeep, Van, Auto-Rickshaw, Taxi, Pickup.

(c) Light Vehicles – Motorcycle, Scooter.

It can be obviously seen that medium sort of vehicles are more involved in accidents when contrasted with other kind of vehicles on the highway road (Refer Fig. 6(a), 6(b)). This is because of the reality the regularly vacationers going through the travels in Cars, Taxis, Vans and Jeeps. Additionally light vehicles are next in number as to accidents. Another explanation behind such high number of accident including medium and light vehicles might be because of carelessness for movement rules/ traffic rules. The remedial measures for implementation of activity standards must be entirely

authorized by movement police. On the other side the Heavy vehicle is primarily includes on the National Highways and numerous time the accidents cause death.

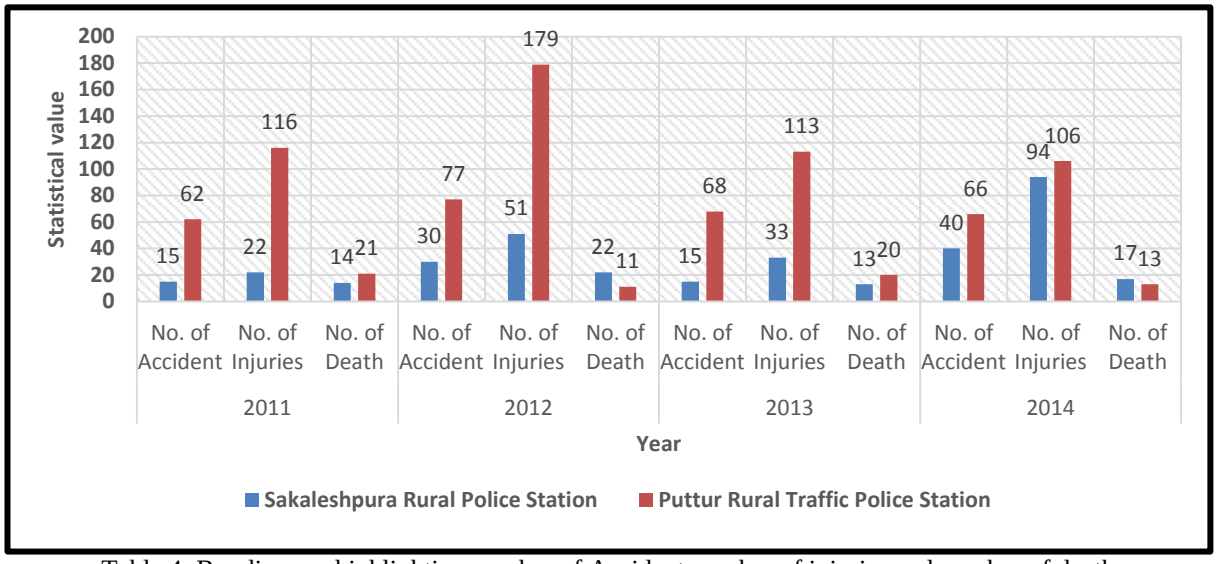

Table 4: Bar diagram highlighting number of Accident number of injuries and number of death

Table 5: Graph indicating number of accidents in selected Black spot Zones

Fig.6 (a), 6(b): Photographs of Vehicle involved in Accident

3.8. Remedial measures in each location:

The measures that can be adopted at each location to reduce the occurrence of accidents are

- Construction of Bus Bay.
- Installation of speed barriers in both directions to reduce the speed of the vehicles to 40km/hr.

- Appointment of traffic police at the bus stand junction during peak hours especially during night time to control the vehicular movement from the bus stand & to the feeder roads.
- Installation of automatic traffic signals at the junction or curves.
- Providing suitable street lighting system in the entire buffer zone throughout the night using solar energy.
- Provide adequate drainages.
- Installation of barricade on either side of the road to prevent the illegal crossing of animals

and local pedestrians particularly near junctions like Shiradi, Gundya, Lavathadka.

4.0 Present Road Condition:

Recently Government has undertaken Shiradi Ghat Road concreting project. Till now 14km of road stretch has been concreted. Highway was closed for vehicle users for approximately 11months. Recent statistics indicates that accidents are increasing because road condition is good throughout the Ghat section, and the drivers of vehicle will be driving without following speed limits (Traffic rules). Speed breakers are not yet installed. Enough amount of Sign boards are installed were ever it is required.

5.0. CONCLUSION:

The number of accidents occurring along Shiradi Ghat of NH-75 was found to be increasing constantly at a higher rate compared to the total number of accidents occurred on the other roads in the district. The percentage was found to be 38% in 2012, 37.72% in 2013 and 28% in 2014. The analysis of the present study showed that RS & GIS is a much more compatible means of black spot analysis than conventional methods, because of its geographic referencing capabilities (both spatial and non-spatial analysis). From this remote sensing and GIS information system the black spots were exactly identified and remedial measures were suggested to reduce the accidents. From this analysis it is inferred that highway authorities and police department can effectively utilize Remote Sensing & GIS based information system, instead of traditional maps and analysis. The present study on Black spots analysis will be highly helpful in charting out the frame work for highways and Police patrol for planning, preventive and remedial measures and to increase their awareness of Black spots. The information derived based on integrated approach of RS and GIS can be effectively used to reduce accidents along the National Highways and Highway Authorities and Police department will be really benefited by this technique or tool.

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Application of Neural Network model for LU/LC classification of satellite images of Nethravathi river basin

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***Abstract*— Remote sensing is widely used to study the large spatial characteristics of various land forms, which in turn helps in the studies on change detection, urban planning, crop and ecosystem management. Image classification is the process of generating thematic maps which can be used effectively in above mentioned applications. Satellite image classification can be either supervised or unsupervised. In recent days, soft classification techniques like fuzzy logic and Artificial Neural Networks (ANN) are also being used. Comparing the conventional and soft classification techniques through Maximum Likelihood Classifier (MLC) and Neural Network model has been done in this study. IRS-P6 LISS- III satellite image has been used to study the Land Use/ Land Cover of Netravathi river basin considering nine classes. A multi layered feed forward network with one hidden layer having 12 neurons is used to compare with the conventional MLC method. The analysis reveals that ANN yields better classification with an accuracy of 87.14% when compared with MLC that gives an accuracy of 81.25%. This study has also measured the impact of internal parameters that are used in ANN like Activation Function, Momentum, Threshold, Number of iterations, learning rate and the number of hidden layers on the classification accuracy. Results show that, by training the network with 1 hidden layer, a momentum value of 0.7, learning rate of 0.01 and a maximum of 1000 iterations are necessary to get a good classification result.**

Index Terms*— Artificial Neural Networks, Image classification, Maximum likelihood classifier

I. INTRODUCTION

The knowledge of land use and land cover is important for most of the planning and management activities as it is considered as an essential element for modeling and understanding the earth system. Image classification is a key component of remote sensing and relies on the spectral distinctness of classes and/or spectro-temporal variability and the context of classification (Benediktson et al. 1990). The term land use relates to the human activity associated with a specific piece of land, while the term land cover relates to the type of feature present on the surface of the earth (Lillesand and Kiefer, 2007) The advancement in remote sensing technology has widened its pertinence over various fields.

Image classification is the process of assigning the pixels of a raster image to predefined land cover classes (Huang et al. 1997). Visual image interpretation was used earlier for classification purpose and it has become outdated because of the variation in the accuracies from interpreter to interpreter. Digital image interpretation came into use which uses spectral signatures for classification. There are two types: Unsupervised and Supervised classification. As the name indicates, unsupervised classification does not require a prior training. Interpreter has to give the number of classes required in the output. Supervised classification involves training the classifier with the proper data set prior to classification. This method can be either based on statistics derived from training sites or neural network algorithm. In this paper ANN has been used for classification and it is compared with the conventional MLC classifier.

ANN mimics the human brain through a number of interconnected processing elements that are similar to neurons. These processing elements are joined by weighted connections that are analogous to synapses in the human brain. Neural network has to be trained to establish the relation between the input and output given during training. A good data set is required to draw better classification accuracy.

The present study was carried out with the objectives to: i) Develop a neural network model for land-use classification of remotely sensed images, ii) Compare the results with the conventional classification method and iii) Develop guidelines for parameterizing the neural networks.

Most land-use classes have a characteristic value for intensity, which is used in generating spectral classes from image classification. Lambin et al. (2003) compared several texture methods for image analysis. The performance evaluation was based on the ability of a classifier to recognize unseen samples of the four classes on the basis of training data. Studies carried out by Hilbert and Ostendorf (2001), Blaschke et al. (2004) and Kavzoglu (2009) proves that in the last decade, neural network classifiers have been widely used in the fields of pattern recognition, image interpretation and clustering/categorization. Ji (2000) presented a new type of neural network called Kohonen Self-organizing Feature Map (KSOFM, or feature map) neural networks for land-use/land-cover classification from remotely sensed data. It was found that the feature map network has the advantage of faster learning but has the drawback of being a slow classification process. Madhubala et al. (2010) classified LISS-III satellite images into different classes as agriculture, urban and water body by using a Neural Network Model. There was an increase in accuracy as the network was trained with more number of images. Prashant et al. (2012) deals with the comparative study between the various

classification techniques and choosing the best technique based on the accuracy results. From the above literatures it can be understood that ANN is an efficient tool for pattern recognition problems and is superior to many conventional classification methods

II. STUDY AREA AND DATA USED:

The Nethravathi river basin, upto the gauging station at Bantwal is considered as the study area, which lies between the North latitudes 12º29'11" to 13º11'11" and East longitudes 74º49'08" to 75º47'53". It has an area of about 3312 sq. km. The river flows towards westward for about 103 kilometres with a drainage area of 3657 sq. km. and empties into Arabian Sea, after joining Gurpur river at Mangalore city. This river is the main source of water to Bantwal and Mangalore. The location map of the study area is shown in Fig. 1.

Indian Remote Sensing (IRS) P6 LISS-III sensor data was used in this study and the details of both conventional and remote sensing data are furnished in Table I. To check the classification accuracy of classification, around 76 GPS points were collected from the study area for a total of 9 classes such as Water, Plantation, Cropland, Urban, Sand, Dense forest, Less dense forest, Wasteland with scrub and Wasteland without scrub.

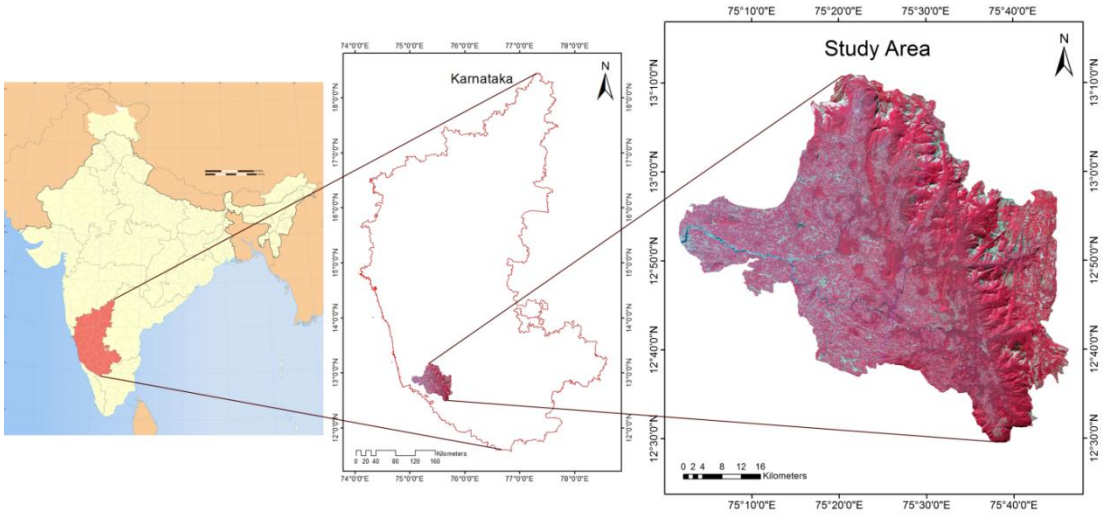

Fig. 1. Location map of study area

TABLE I. DATA PRODUCTS USED

S.No.	Type of Data	Source	Scale	Path/Row	Date of Acquisition	Purpose
1. a)	**Conventional Data** Toposheet 48O8,48O12, 48P1, 48P4, 48P5, 48P6, 48P9, 48P10 48P11	SOI	1:50000			To prepare the base map.
2. a)	**Satellite Data** IRS P6 LISS-III (Spatial resolution: 23.5 m)	NRSC, Hyderabad	1:25000	097/064	5th January 2005	To prepare the LU/LC map of 2005 using MLC and ANN.
3. a)	**Ground Truth Data** Trimble GPS Instrument	Dept. Of Applied Mechanics, NITK, Surathkal				To obtain the latitude and longitude of LU/LC classes.

III. METHODOLOGY

The methodology adopted in the present study is shown in Fig. 2 as flow chart.

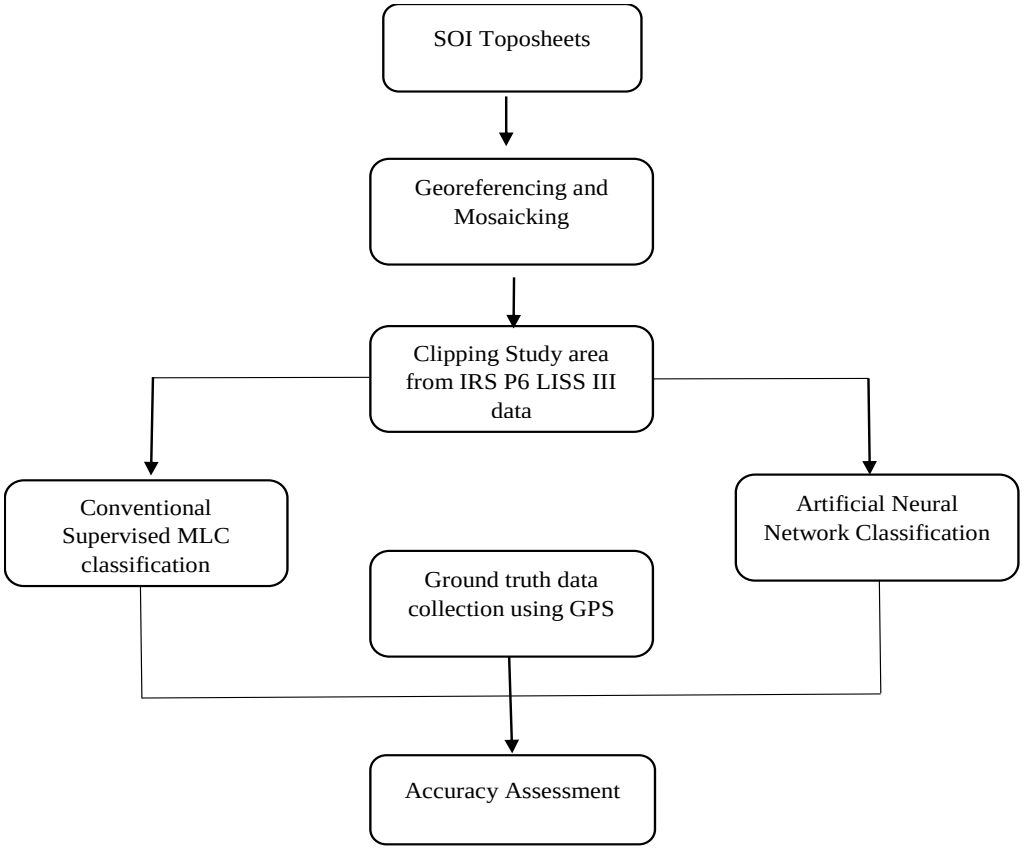

Fig. 2. Flowchart showing the methodology

IV. RESULTS AND DISCUSSION

PARAMETERIZING NEURAL NETWORK MODEL

Initially the number of hidden layers was checked, ranging from 0 to 4. Based on the accuracy obtained, it is found that increasing the number of hidden layers more than ONE does not increase the accuracy. Likewise optimum values for each parameter were found. Main five parameters affecting the network architecture are found to be Hidden layer, Learning rate, Activation function, Momentum and Number of Iterations. The model having tan-sigmoid function does not show much variation in accuracy, when the number of iterations were increased. Increasing the momentum upto 0.7 shows variation in accuracy and further increase leads to overfitting. This can cause the network to become unstable. Very low momentum coefficient leads to slowing down of the training of the system. In the case of iterations, large increase shows decrease in accuracy. This is due to over training of the model configured. A maximum of 1000 iterations are more than sufficient to obtain better classification accuracy. Over fitting will exaggerate minor changes in the data. By adjusting the learning rate, the accuracy was increased. A lower learning rate value of 0.01 was found to be optimum to get better results.

CLASSIFICATION AND ACCURACY ASSESSMENT

Supervised classification was done using Maximum Likelihood Classifier. The resulting classified image has an accuracy of 81.25% and kappa coefficient of 0.78 which is shown in Fig. 3. The study area has more of plantation and cropland towards the middle reaches of the basin. The eastern highlands are covered by dense forest and coffee plantations.LU/LC Map of the study area using ANN is shown in Fig. 4. An overall accuracy of 87.14% and kappa co efficient of 0.85 was obtained. This proves that, ANN is better than MLC.

A classification is not complete until its accuracy is assessed. As any map is simply a model or generalization, it will contain error. It is important to check the accuracy of maps derived from remotely sensed data and expressed in a meaningful way. User's, Producer's and overall accuracy for both the classifiers are shown in Table II and Table III.

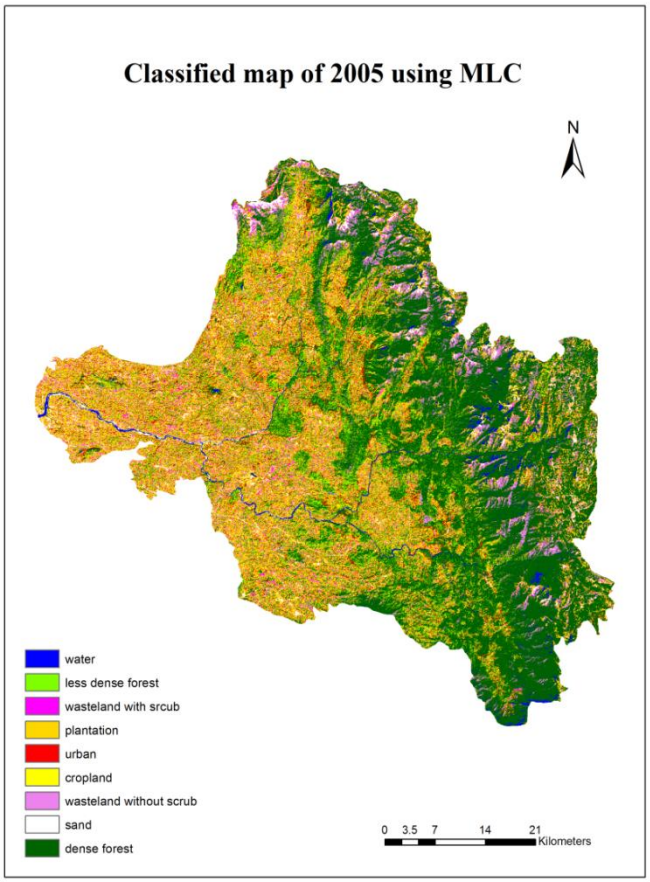

Fig. 3. LU/LC classification using MLC

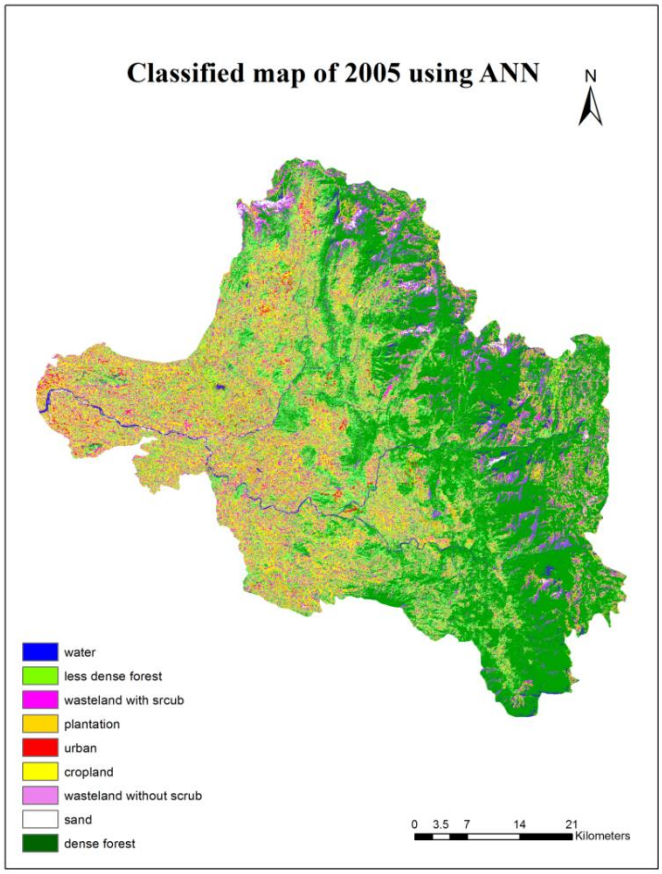

Fig. 4. LU/LC classification using ANN

TABLE II. LU/LC CLASSIFICATION ACCURACY OBTAINED USING MLC

SL NO.	CLASS NAMES	YEAR 2005		
		OVERALL ACCURACY (%)		KAPPA VALUE
		PRODUCER'S	USER'S	
1	Water	100.00	100.00	1.00
2	Plantation	75.00	75.00	0.72
3	Cropland	80.00	80.00	0.77
4	Sand	83.33	100.00	1.00
5	Urban	100.00	80.00	1.00
6	Wasteland with Scrub	66.67	80.00	0.77
7	Wasteland without Scrub	75.00	60.00	0.56
8	Less Dense Forest	75.00	60.00	0.56
9	Dense Forest	66.67	80.00	0.77
	OVERALL ACCURACY (%)	**81.25**		**0.78**

TABLE III. LU/LC CLASSIFICATION ACCURACY OBTAINED USING ANN

SL. NO.	CLASS NAMES	YEAR 2005		
		OVERALL ACCURACY (%)		KAPPA VALUE
		PRODUCER'S	USER'S	
1	Water	100	97.6	0.87
2	Plantation	63.5	87.9	0.87
3	Cropland	91.5	81.1	0.87
4	Sand	89.56	80.29	0.87
5	Urban	76.72	78.76	0.87
6	Wasteland with Scrub	87.36	91.20	0.87
7	Wasteland without Scrub	74.02	77.02	0.87
8	Less Dense Forest	97.67	75.00	0.87
9	Dense Forest	85.82	93.96	0.87
	OVERALL ACCURACY (%)	**87.14**		**0.8575**

V. CONCLUSIONS

In the present study, classification of satellite data was done by developing neural network model and for validation and comparison, MLC classification was carried out. The impact of internal parameters was also analysed by configuring 55 models and it is found that the performance of neural networks was highly sensitive to Hidden layer, Momentum, Activation function, Number of iterations and Learning Rate, whereas threshold had only a marginal impact on the classification accuracy. A careful neural network configuration can lead to a moderate overall accuracy improvement when compared to the outcome by Maximum Likelihood Classifier (MLC). Several practical guidelines emerged from this study, which can be useful when parameterizing the MLC neural network architecture for image classification. Specifically, a small number of hidden layers should be used when the training sample size is moderate or the number of input and output neurons is small. The log-sig function should be used as it can help to yield much better classification accuracies and is relatively less sensitive to training threshold values. For better classification accuracies, a small learning rate, large momentum, and moderate number of iterations should be used.

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Planning of Marine Facilities for an LNG Terminal in India

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***Abstract*—The rising gas consumption in India and the diminishing supply of natural gas has necessitated for import of LNG and need for LNG receiving terminals. By the end of 2009-10, the gas consumption in India stood at 165 MMSCMD with LNG occupying 15 %(25MMSCMD) of the entire gas demand. Imported LNG is stored, regasified and distributed to the centers of consumption via the high pressure natural gas pipelines. The selection of a preferred location for an LNG receiving terminal, types of LNG import terminals and development of suitable marine facility for offloading LNG is based on a top down approach briefly describing the existing and projected gas demand at all India level further sub divided into regional level and to identify a few suitable sites in the proximity of demand for setting up the receiving terminal. The preferred site for the development of the import facility is based on the proximity of the pipeline connectivity, environmental (ecological) factors, topography, cost consideration in terms of required dredging, need for breakwater and other available infrastructure such as existing ports, material offloading facilities (MoFs) and hinterland facilities. This report also presents a comparative assessment of various types of LNG import terminals such as conventional or a floating storage regasification unit and its aptness to the selected site with suitable mooring concept for safe LNG transfer.**

***Index Terms*—Floating storage regasification unit, LNG, Breakwater**

INTRODUCTION

The world Liquefied natural gas (LNG) trade has been increased steadily (over 6% per year) since the industry began. The rising gas consumption in India and the diminishing supply of natural gas has necessitated for import of LNG and need for LNG receiving terminals. Gas is slowly emerging as a primary source for India, along with coal and oil. By the end of 2013-2014, the gas consumption in India stood at 165 MMSCMD with LNG occupying 15 %(25MMSCMD) of the entire gas demand. This trend is expected to continue as natural gas becomes the fuel of choice for electric power providers and as developing countries increase their energy demands.

LNG is Natural Gas that has been cooled to the point that it condenses to a liquid, which occur sat a temperature of approximately -256°F (-161ºC) at atmospheric pressure. Liquefaction reduces the volume by approximately 600 times thus making it more economical to transport between continents in specially designed ships. Thus LNG technology makes natural gas available throughout the world.

The LNG receiving terminal is one of the components of the LNG value chain between the gas field and the residential consumer. With the rise in natural gas consumption, many countries are constructing their LNG receiving capabilities and will continue to do the same in upcoming years. Where as in industrialized or populated areas, it sometimes proves difficult to overcome environmental concerns of local residents to install a new-built, land based terminal due to NIMBY (Not in my back yard). Floating storage and regasification unit is one of the preferred solutions to overcome these troubles.

LNG value chain mainly consists of four highly linked operations and they are interdependent process: Extraction /production of natural gas, Liquefaction, Shipping, Regasification process followed by storage of natural gas and Distribution of Natural Gas to the End users.

After the process of extracting natural gas from earth surface (called as feed gas) and liquefaction process, it is transported to the consumer by sea through specialized LNG carriers. It can be stored in a specialized containment system within the inner hull of the LNG carriers where it is kept at a temperature of -162^0c under atmospheric pressure. After receiving liquefied natural gas from LNG carriers either it can be stored temporarily or it can be directly sent for regasification process. During the process, LNG is converted back to its original gaseous form. After regasification, it can be sent to end users by pipeline/trucks.

The key objective of this study is to study and understand about the need for LNG demand in India and selection of appropriate site for the development of LNG terminal.

Most of the LNG import terminals operating all over the world are conventional jetty along with onshore regasification terminal. The conventional terminal consists of a jetty for unloading of LNG from an LNG carrier and a regasification terminal. However, conventional onshore terminal are relatively expensive to build and also for a typical regasification plant with two storage tanks consume 3-4 years of construction time (Sonne et al., 2008).

The design of an onshore LNG facility is influenced to a significant degree by its location. Also the detail design and layout of the terminal will be influenced by environmental condition, concentration and activities of the population around the site location (Sonne et al., 2008).Whether an onshore facility is located on a shoreline adjacent to an open ocean or along a sheltered waterway, met ocean conditions such as wind, wave and current will require consideration (Sonne et al., 2008).

Another important factor which needs to be addressed while considering a location for a LNG import terminal i.e. access to a commercial pipeline for gas distribution. Even though a pipeline distribution is located near to the facility, it may not have adequate capacity for send out (Sonne et al., 2008).

The concept of FSRU has been developed and is rapidly becoming very popular amongst all potential LNG import terminal being planned and built. Typically, existing LNG ships are converted to FSRU by making necessary changes to accommodate unloading arms, regasification system and utilizing the storage tank on the ship as storage media.

Further to this, the concept of Floating Storage Unit

(FSU) can be considered with regasification unit located onshore and LNG carrier can be used as a storage medium in order to save considerable time and cost on the construction of onshore LNG storage tanks. At one end of the spectrum, the FSRU stands an alternative to a land based LNG receiving terminal (Gervois et al. 2005).Combining the relative technologies, a safe, reliable and economic LNG FSRU may be consider as an alternative of the onshore LNG receiving Terminal (Hans 2002).Existing LNG carriers can be converted into floating storage and regasification unit (FSRU). It may arise because a converted/modified LNG carrier can be seen as a possible solution where there is high value given to achieving early gas delivery into market (Wayne and Powell, 2003).

II.DEMAND ASSESSMENT

Over the years the LNG demand has been steadily increased more than 6% per year and predicted to be 160MMTPA by the end of 2005-06.By end of 2011, 18 countries were exporting their LNG resources and among these Qatar is the largest exporter of LNG.

Gas is slowly emerging as a primary source of energy for India, along with coal and oil. The British Petroleum Statistical Review 2010 places natural gas as accounting for about 10 per cent of India's energy source and this figure is forecast to reach 20 per cent by 2025. Current consumption of gas in India is around 170 mmscmd.

Demand has been computed in four regions of India. The Fig. 1 shows the regional wise demand, gas fields and LNG terminals in India.

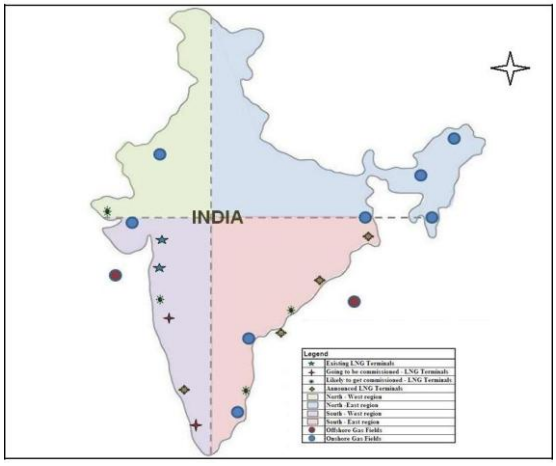

Fig.1Gas fields and LNG Import Terminals

Demand has been considered from all the areas where fields and pipelines are currently supplying gas and are expected to cater in near future. Most of the gas production currently comes from the western and eastern offshore areas .The onshore fields are located in Andra Pradesh, Tamil Nadu, Gujarat, Rajasthan, Assam and Tripura. The Table I show the percentage of regional wise gas demand based on current and future expected demands.

The regional wise supply and demand has been assessed on the consumer categories in all aspects including power, fertilizers and others. As a result North-East region found to be highest demand deficiency in India.

TABLE. I
DEMAND DEFICIT

Demand Deficit			
NW	11.08%	NE	12.58%
SW	5.16%	SE	5.30%

III. LNG TERMINAL CONCEPTS

A CONVENTIONAL LNG TERMINAL

Most of the LNG import terminals operating all over the world are conventional jetty along with onshore regasification terminal. The conventional terminal, as shown in Fig. 2, consists of a jetty for unloading of LNG from an LNG carrier and a regasification terminal. However, conventional onshore terminal are relatively expensive to build and also for a typical regasification plant with two storage tanks consume 3-4 years of construction time.

The design of an onshore LNG facility is influenced to a significant degree by its location. Also the detail design and layout of the terminal will be influenced by environmental condition, concentration and activities of the population around the site location. Generally, typical terminal layout is dominated by storage tanks, which are usually located near to the jetty as possible to reduce pipeline length. Another important factor which needs to be addressed while considering a location for a LNG import terminal is access to the commercial pipeline for gas distribution.

The standard LNG vessel carrying LNG shall be berthed in a jetty with proper mooring arrangement. For a typical conventional LNG terminal, the marine facility consists of loading platform, berthing dolphins and mooring dolphins. The Ship to Shore transfer of LNG is carried out through loading arms constructed over loading platform connected to the manifold of the standard LNG vessel.

Fig.2 Conventional jetty terminal (source: Futtsu LNG terminal, Japan)

From the carrier, the fluid shall be transported through offshore and onshore pipeline arrangement to conventional LNG tank terminal. Offshore part of pipeline shall be laid though trestle and onshore part shall be partially buried inside the ground with structural support arrangement. Advantage of conventional terminal is itslong term flexibility and that this is suitable for high through puts. But

it takes longer time to construct, requires more area and more expensive.

B. *FLOATING STORAGE AND REGASIFICATION UNIT (FSRU) / FLOATINGSTORAGE UNIT (FSU)*

To overcome conventional LNG concept, FSRU concept has been developed and is rapidly becoming popular amongst all potential LNG import terminal which is being planned and built. Typically, existing LNG ships are converted to FSRU by making necessary changes to accommodate unloading arms, Regasification system and utilizing the storage tank on the ship as storage media. Further to this, the concept of Floating Storage Unit (FSU) can be considered with Regasification unit located onshore and LNG carrier can be used as a storage medium in order to save considerable time and cost on the construction of onshore LNG storage tanks. Fig. 3 shows a picture of a FSRU unit.

At one end of the spectrum, the FSRU stands an alternative to a land based LNG receiving terminal. Combining the relative technologies, a safe, reliable and economic LNG FSRU may be consider as an alternative of the onshore LNG receiving Terminal. Existing LNG carriers can be converted into floating storage and regasification unit (FSRU). It may arise because a converted/modified LNG carrier can be seen as a possible solution where there is high value given to achieving early gas delivery into market.

The standard LNG vessel carrying LNG is moored adjacent to a permanently moored FSRU or an FSU. The mooring arrangement can be a stand-alone mooring facility or side by side mooring for transfer of LNG from carrier to the FSRU/FSU. The liquefied gas is regasified on the onboardregasification unit (or onshore regasification unit in case of an FSU) and transferred via high pressure pipelines to the end users. Fig. 4 shows the flow diagram indicating a typical LNG regasification process.

Fig. 3 Floating storage and Regasification unit (source: Aguirre Offshore GasPort)

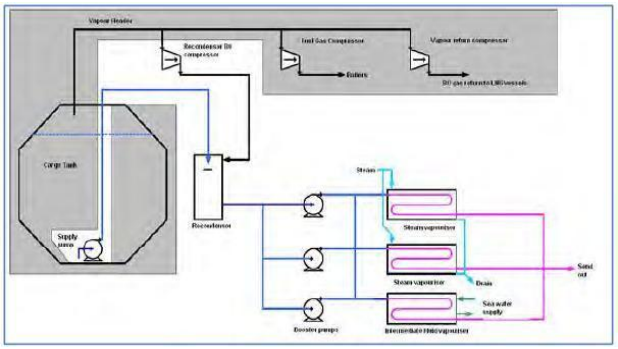

Fig. 4 Typical LNG regasification process flow diagram on a FSRU

IV SITE SELECTION

North-East region was found to be highest demand deficiency, therefore the alternative sites have been chosen on the East coast of India for the development of an LNG import terminal. The conceptual layout plans of marine facilities for the LNG import terminals have been considered on the East coasts of India for the purpose to assess the difference between the sites. This provides the good operating condition at the LNG berth mainly due to the offshore breakwater protection. Conventional jetty terminal is considered for the preferred site. Since, onshore based LNG receiving Terminal technologies are quite mature and have proved their reliabilities and flexibilities through decades of operation. The figure below shows the proposed locations of an LNG receiving terminals on east Coast.

Fig. 5 shows the sites that have been selected for the development of an LNG Terminal.

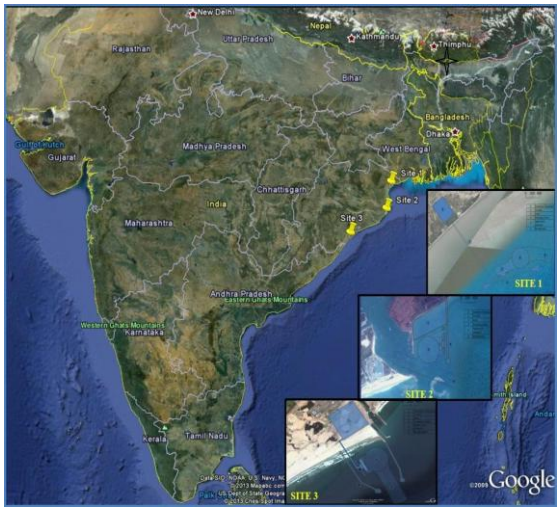

Fig.5 Proposed Locations for an LNG terminal on East coast

Site 1: Proposed LNG berth and offshore breakwater are parallel to coast line.

LNG Terminal is proposed on the East coast of India at latitude of 21°21'58.24" N and longitude of 86°56'8.17" E, about 50 km North of Dhamra Port in the state of Odisha. The length of the proposed breakwater on the offshore is about 1.5 km long to maintain tranquil condition near the LNG jetty. Space available for Onshore Terminal is around 25 ha can be extended up to 35 ha for future requirement. The proposed LNG berth location is situation about 2 km from the coast line. Dredging has to be carried out for developing a new turning basin. Main Gas pipeline connectivity is located approximately 25-30 km from the site. National Highway is 15 km far from the site. Environmental conditions are minimal since the depth of water is less near the jetty. The site layout concept is indicated in Fig. 6.

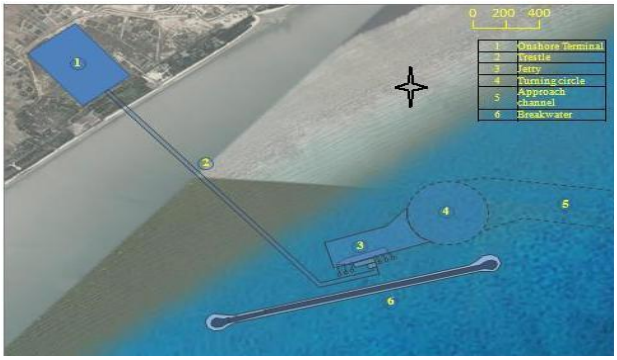

Fig. 6 Concept Layout Site – 1

Site 2: Proposed LNG berth and offshore breakwaters with onshore terminal on reclaimed area:

Proposed LNG terminal is located on the East coast of India at latitude of 20°16'7.37" N and longitude of 86°40'50.29" E, near Paradip port, Odisha. The length of proposed Breakwaters on the southern and northern side of the LNG terminal is approximately 1.5km. For LNG onshore terminal, the area of reclaimed area is about 25 ha. Dredging needs to be carried out for developing new turning basin inside the basin. The proposed jetty shall be of 300-400 m length. Existing port area can be used for material offloading. Due to the pressure of an existing operational port, utilities such as electrical and water supply are less complex. Environmental issues are less due to existing operational port. The Proposed Pipeline connectivity is located 100 Km from the site and the National Highway is approximately 120 km away. The site layout concept is indicated in Fig. 7.

Fig. 7 Concept Layout Site - 2

Site 3: Proposed LNG berth perpendicular to coastline and enclosed by two breakwaters:

Proposed location is located on the East coast of India at latitude of 19°18'6.34" N and longitude of 84°57'32.65" E, near Gopalpur port, Odisha. Length of the proposed breakwaters on northern and southern side is about 1.5km each. The space available for onshore terminal is around 25ha can be extended up to 35ha for future development. Dredging has to be carried out for developing new approach channel and turning basin. Electricity and water supply are less complex due to an existing port. Proposed LNG jetty Length is approximately 600 m from the coastline. The Proposed Pipeline connectivity is located at 25km from the site and the National Highway is approximately 10km away. The site layout concept is indicated in Fig. 8.

Fig.8 Concept Layout Site – 3

A. Selection of Preferred Location

The three concept plans are subjected to a Multi-Criteria Assessment (MCA), considering safety, cost and spatial aspects to arrive at technically and economically feasible concept layout plan.The location options will be set out in a Multi-Criteria Analysis (MCA) with a advantages (pros) and disadvantages (cons) listed out in Table II to provide a scoring system, in order that they can be compared and evaluated against the various criteria.

TABLE.II

MULTI CRITERIA ASSESSMENT

	SITE 1	SITE 2	SITE 3
Future expansion	+	-	0
Impact on surroundings	+	+	0
Emergency departure	++	++	-+
Manoeuvering	--	++	--
Land reclamation	++	-	+
Jetty length	-	++	+
Line length	-	++	+
Need for breakwater	+	++	-
Dredging	-	+	-
Site preparation	0	+	0
Basic infrastructure	0	+	+
Main Utilities	--	++	+
Material offloading facilities	--	++	-
Available safe distances	++	-	+
Land availability	++	-	+
Land access	+	+	+
Pipeline connectivity	+	+	+
Impact on environment	+	+	+
TOTAL	14 +, 9-, 2 '0' Total 5 +	21 +, 4 -, 0 '0' Total 17 +	11 +, 5 -, 3 '0' Total 6 +

Considering the overall scoring and the justification in the three most important aspects above, the preferred lay-out is Site 2.

B. *LIMITING CONDITIONS*

Maximum wind speed in relation to the operation of the jetty shall be in accordance with OCIMF recommendations For Safe Berthing of LNG Carriers. The wind speed should not be more than 15.0 m/s. Approximately 40 knots are the recommended safe wind limit for disconnection of loading arms. A maximum limiting wave height of Hs = 2.5m is considered. Access to the LNG terminal during wave heights exceeding 1.5 to 2.0m will need to be assessed by the terminal operator based on vessel size, water level and environmental conditions.

V. PLANNING CONSIDERATIONS

A. *DESIGN VESSEL*

The port designed to handle Qmax to Capesize vessels **LNG** tanker of 75,500m^3 and 125000m^3 and a Qmax vessel of266000m^3. The required berth occupancy for the facility is provided in Table III.

TABLE.III

BERTH OCCUPANCY

	LNG TANKER 75,500m^3	LNG TANKER125 ,000 m^3	Qmax 266000m^3
Yearly throughput (MMTPA)	5	5	5
LNG yearly throughput (MMm3)	11	11	11
Average parcel size	45300	108000	159600
No of vessel per year	245	103	70
Maximum offloading rate	12000	12000	12000
Ship turn around time	16.5	23.5	23.5
Effective offloading rate	7000	8000	12000
Total time at berths in hrs	4047	2418	1636
Port days	330	330	330
Port availability in hrs	7920	7920	7920
Berth occupancy	51%	31%	21%

B. *NAVIGATIONAL REQUIREMENTS*

The access channel shall provide safe access and exit to the vessel for to and from the port during day and night under all weather conditions. The entrance of the access channel from sea is marked by a safe water mark; the channel must be marked with lateral buoy. The breakwater head shall have a main lighted beacon and local flood lights to illuminate the slope of the breakwater when at the close range.

Safety Zoning

The distance between a moored LNG vessel and a passing ship should be of 200m (Minimum).Vessels travelling in the opposite direction would not be permitted. Safe tug manoeuvring allowance shall be at least 75m.It is preferred to have a buffer zone around terminal in order to have a level of control during emergencies. Within 400m exclusive there should not be any permanent housing.

Channel Geometry

Sufficient water depthwidth to provide safe access / departure for the 266,000 m^3 LNG vessel must be provided. The nautical depth of the access is

$$D_{act} = CD - D_s - UKC$$

where CD is chart datum taken as zero and D_S is the draught of design vessel and UKC is Under keel clearance, taken as $0.3*D_s$ [m]. As a result, the nautical channel depth is -15.8m CD.

The proposed outer channel length for the preferred location is approximately 1500m and the distance between breakwater head and centre of turning circle is 600m in length. A minimum turning circle diameter of 690m is required (2 times the length of the maximum design vessel) to cater to the needs of maximum design vessel. The nautical depth of the turning basin (similar to access channel depth) a minimum required nautical depth of -15.8m CD is provided. This means an over-depth of 0.5m is to be considered.

C. *FUNCTIONAL REQUIREMENTS*

Loading arms

The loading arms of an LNG terminal structure are usually at the centre between the breasting structures, which is in line with the manifold position about the mid-length of the LNG vessel. Three LNG unloading arms and one LNG return vapour arm are equipped with hydraulic coupler (QCDC) and emergency release systems including PERC (Power. Emergency Release Coupler) and double ball valves. One of the three liquid unloading arms shall be capable to be operated as a vapour (Boil off gas - BOG) return arm.

Mooring lines

Generally, mooring shall be by breast lines and spring lines. The structures for holding the mooring lines are arranged as symmetrically as possible about the centre of the loading arms and the OCIMF recommendations for mooring line angles. The minimum breaking load (MBL) of the line for the biggest ship is 1370kN. Allowable loads in any one mooring line should not exceed 55% of its minimum breaking load (MBL). A maximum of 16 breast lines (8 forward and 8 aft) and 4 spring lines are assumed for the larger vessels. Mooring lines should be within the range of 35 to 50m. Height of mooring points should not exceed 30^0 w.r.t horizontal.

Fender system design

A selected cell fender shall have minimum berthing energy absorption of 1850kN-m and a maximum reaction of 2585kN. To limit the hull pressures to 200kN/m2 and cater to wide range of vessels, a fender panel size of 3.0 x 5.5m shall be adopted.

D. *SAFETY REQUIREMENTS*

The design and layout of the facilities should adhere to the modern safety requirements as prepared by local government and international institutions, for instance the Indian codes governed by Oil Industry Safety Directorate (OISD).The operational safety of an LNG terminal shall be in accordance with OISD/ NFPA standards. During the study phase of the project, Environmental Impact Assessment (EIA) shall be carried out for the proposed location in accordance with local regulations. Whilst the ship is berthed at the terminal, fire-fighting equipment, both onboard and on shore, should be correctly positioned and ready for immediate use.

VI. CONCLUSIONS

Market study firmly concludes that LNG is the future source of energy in developing countries. Although the regional wise LNG demand is high, a throughput capacity of 5-10MMTPA is considered for the development of LNG receiving terminal to cater to the demand in the region. Demand assessment concludes that North-East region is found to be the highest demand deficiency in India, which is deciding factor to choose various alternatives for this study along the East coast of India. The LNG terminal in the preferred alternative can have an initial throughput of 5MMTPA to cater to the local demand and an earlier commissioning can be achieved by placement of an FSRU. The terminal can be expanded to 10 MMTPA by construction of onshore storage tanks at the later stage to fulfil its total regional demand. Based on the present LNG fleet operations, it is envisage that the marine facilities are designed with capacity for serving 125,000cum to 266,000cum vessels. Nautical facilities provided based on the maximum design vessels considered are of 1500m channel length, 300m channel width and 15.8m channel draft with 600m diameter turning circle.

The FSRU concept of LNG terminal has various valuable advantages over conventional type of concept on fasting installation on the flexibility of positioning in FSRU based on the regional demand. It can also be concluded that the development of LNG import terminals should give high importance over the other terminals to fulfil the future energy demand in India.

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Vegetation Monitoring through Unmanned aerial vehicles: a review

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Abstract- Unmanned Aerial Platform (UAV) is a valuable source of data collection. They are a low cost alternative to manned aerial photogrammetry. UAV's of various types and payloads are available off the shelf. They are capable of performing photogrammetric data collection with armature or SLR digital cameras. Following a UAV photogrammetry workflow Digital surface models, contours, volumetric estimations etc can be obtained with high resolution and accuracy. With different sensors mounted on the UAV it can be used for vegetation monitoring and other allied fields. There have been several recent studies in application of UAV's for vegetation monitoring and precision farming. This paper gives an overview of the technologies and a trend of UAV's used for vegetation monitoring and precision farming.

Keywords: UAV, photogrammetry, digital surface model, vegetation monitoring, precision farming.

I. INTRODUCTION

THESE days monitoring an agricultural field manually is a very tedious job. If one calls upon for the presently well established and available technologies we have to rely upon satellite imagery or manned aircraft imagery. Satellite imagery has the problems of low spatial resolution, inconvenient temporal resolution, and (Moran et al. 1997[1]; Stafford 2000[2]) problems of cloud cover and even if there are high spatial and spectral resolution satellite sensors available they are expensive, same holds good for manned aircrafts. Unmanned aerial systems (UAS) can provide a suitable solution for the above problem. UAS have been present since World War 1. But until a past few years they have been only used by the military for various tactical and combative operations. Nowadays the use UAS have become so prominent they are being tested and used in fields varying from surveying, mining, archaeological conservation, precision farming, Construction site management etc.

Precision farming is a site specific crop management system which is practiced with a degree of precision. Due this precision level one can reduce and optimize the harmful compounds applied on the field. Hence helping in achieving a healthier environment with the reduction of material costs. But there are certain constraints in achieving precision agriculture which needs to be addressed including scarcity of decision support systems and insufficient recognition of temporal variation. (McBratney et al. 2005[3]). In order to achieve precision farming through remote sensing we have to collect spatial and spectral data. From this data we have to compute and analyze the various vegetative indices such as Normalized difference vegetative index (NDVI), Red NDVI etc. Using this farmer or owner of the land can take appropriate actionable decisions. In this paper we review the technologies involving UAV platforms and sensors related to precision agriculture and vegetation monitoring.

II. METHODOLOGY

Acquisition of images from UAV has a similar work flow compared to satellite imagery. First step is to decide which UAV platform to use, which is rotary or fixed wing. These days UAV are available at various sizes and shapes. Some can carry higher payloads, some are designed to have high endurance others have high mobility etc. The autopilot in the UAV keeps track of all the flight parameters and it is integrated with the workstation via ground station. The mission planning software sets the waypoints based on the overlap and Ground sample distance required. Then the acquired images are stitched/mosaic with various software's available. This is done using the principle of image triangulation, from this ortho mosaic and digital elevation models can be prepared.

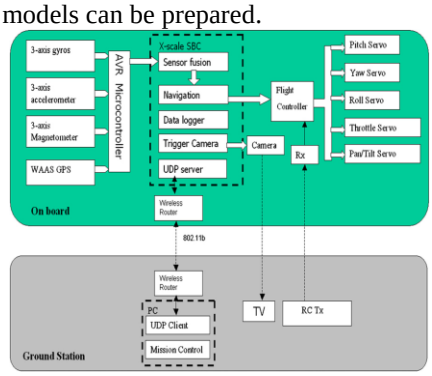


Figure 1: UAS scheme (Source: Haitao Xiang, Lei Tian 2011)

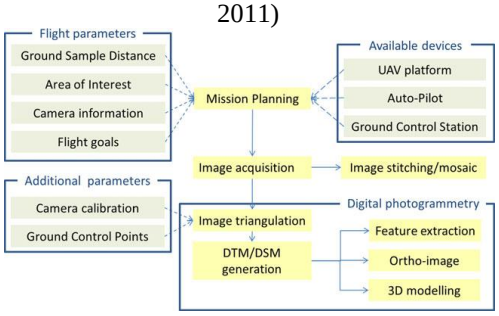


Figure 2: Image acquisition workflow of a UAS system (Source: Francesco Nex 2014)

Precision farming can be divided into four general stages such as data collection, field variability mapping, decision making and finally management practices. UAS platforms can solve the first three stages (Stafford 2000[2]; Warren and Metternicht 2005[4]). As mentioned earlier UAS acquired images have higher spatial resolution (e.g. centimeters) compared and temporal resolution (e.g. daily acquisitions). In regard to these high resolution there have been many studies examining crop condition especially concerning Leaf Area Index (LAI) as many of the crop growth models require LAI. It is the basic parameter which links crop growth to the multi spectral remote sensing data. (Wu et al. 2007[5]; Lopez-Lozano et al. 2009[6]).

Though there is high potential of remote sensing technologies in precision agriculture, the current applications are limited. According to a survey conducted in USA in 2009 the adoption of satellite imagery and aerial photographs in precision agriculture changed from 16.1 to 30.3 % between 2004 and 2009. The limitation of using remote sensing systems includes image collection and delivery to the clients in the time frame. Image interpretation and data extraction issues and integration of these with agronomic data. (Du et al. 2008[7]). The remote sensing data which is most easily available is medium resolution satellite imagery (e.g. Landsat TM, ASTER, SPOT5) are useful only for large area studies. The latest high resolution satellite imagery (e.g., WorldView-2 and GeoEye-1) cannot provide high frequency data for rising situation (e.g., nutrient stress monitoring, disease) with a limited 1–2 day revisit period. Weather conditions are also an important factor for satellite image acquisitions as the farming season is usually the rainy season.

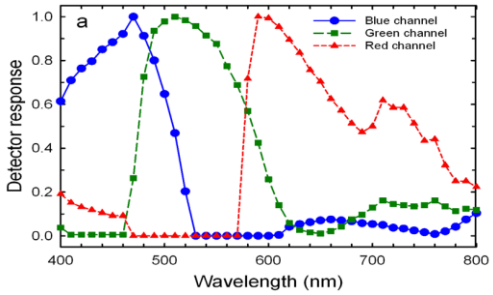
In order to compute NDVI we have to get spectral reflectance from Red and NIR bands. Normal cameras with their current configuration do not capture reflectance in the NIR region. Hence we need to go for multispectral cameras with near optical ranges which are at higher costs and payloads. Also converting these images into false color composites pose an extra step in post processing and with high amount of data it might cause delays in the entire workflow.

NDVI = (NIR - red)/ (NIR + red) (1)

There has been a new method lately which involves modifying and calibrating a normal optical range camera such that Red band captures NIR instead hence giving an output as Blue, Green and NIR bands. Though NDVI cannot be calculated as Red band is absent, Green NDVI can be computed and it can be correlated with the yield (Ziglado et al. 2001).

GNDVI = (NIR − green)/ (NIR + green) (2)

The method of converting a normal optical range camera into a camera which captures NIR band reflectance is very simple. The theory behind it is all bands in an optical range camera transmit significant amount of NIR light (E. Raymond Hunt et al. 2010). Hence there will be hot-mirror filter to block the NIR light. This hot-mirror filter is removed. Also a custom interference filter to block red light from 610 to 725 nm and transmit blue, green and NIR was placed. In the absence of the custom filter, the spectral response of optical range camera showed that the red band had a response larger in NIR band than compared to the blue and green band.



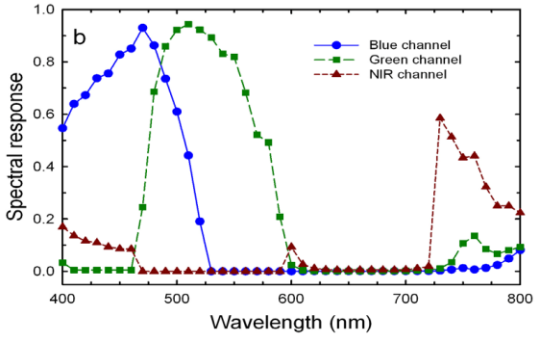


Figure 2. (a) Relative spectral response of optical range camera for the blue, green, and red/NIR channels. (b) Relative spectral response after a custom red-light-blocking filter (610–720 nm) was placed. (Source: E. Raymond Hunt et al. 2010).

Every crop has its own unique spectral reflectance which varies over the crop growth period. Hence its NDVI ranges also keep varying with growth period. Good amount of research has already been in exploring the relationship between multispectral data and crop yield. If we take the example of sugarcane in which India is the 2nd highest producer in the world (Source: FAO 2014) NDVI, GVI and reflectance of band 4 (0.76- 0.90um Landsat 7/ ETM+) were analyzed (Fernando Benvenuti and Mara Weill 2010). It was found out that the mean values of NDVI, GVI, and reflectance of band 4 reduced with time. The temporal changes were significant for GVI index and reflectance of band 4 and it wasn't significant for NDVI. Hence this says that for every crop has its own characteristics towards each vegetative indices and it must be studied in detail.

GVI = - 0.1603*b1 – 0.2819*b2 – 0.4934*b3 + 0.7940*b4 – 0.0002*b5 – 0.1446*b7 (3)

Where: b1(blue, 0,45-0,52Mm), b2 (green, 0,52-0,60Mm), b3 (red, 0,60-0,70Mm), b4 (NIR, 0,76-0,90Mm), b5 (MIR, 1,55-1,75Mm), and b7 (MIR, 2,08-2,35Mm) of Landsat 7/ ETM+sensor.

III. DISCUSSIONS

A number of vegetative types are surveyed using unmanned aerial systems but primarily studies have been focused on agricultural fields. Here the scan area is restricted and well defined. However in recent times there have been number of studies on wildlands where population density is low and limited access to movement of ground vehicles.

Experiments in wildlands include those conducted in rangelands and also closed canopy forests. The word rangelands are used for grasslands, shrublands, woodlands and tundra regions. Recent experiments show (Hung et al. 2012[12]) the potential to map the distribution of invasive weed over cattle farms in Queensland, Australia. Logistics constraints make detection of moss bed in Antarctica very difficult. This provides an ideal opportunity to showcase the potential of UAS for mapping moss beds (Lucieer et al. 2010[15]) In canopy mapping field experiments were conducted in Tansmania, Australia to map the growth of eucalyptus trees (Wallace et al. 2013[14]). UAS based

remote sensing experiments have been conducted on citrus, peach and olive oils trees in Spain (Calderón et al. 2013[16]). Similar experiments have also been conducted in vineyard canopy quantification (Mathews et al. 2013[17]).Also algae growth in rivers and lakes can also be monitored using UAS given the conditions that the river body is shallow and non turbid. In USA state of Montana studies have been conducted to detect the filamentous algae Cladophora glomerata which negatively affects the dissolved oxygen and pH of lakes and streams.

IV. CONCLUSION

UAS are an innovative and useful means of gathering valuable crop data for farmers and people who want to monitor vegetation in any form. As a relatively new technology, further development and optimization is certain but, even with existing platforms, there is tremendous opportunity for those in agriculture particularly those eager for crop data and new precision agriculture efficiencies.

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Studies on Urban Sprawl and Temperature using Remote sensing – a Review

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***Abstract*— Urban sprawl and temperature were getting much more attention because it will affect our future. There are many methods to know about the urban sprawl and temperature. We can use in-situ data or remote sensing data. Nowadays remote sensing is widely used because of its wide area coverage. Also it can reach even in remote areas. Urban growth and sprawl are somewhat similar. Urban growth has definite magnitude and direction. But urban sprawl does not have. It is an uncontrolled growth. It will happen because of population growth and will lead to reduction of vegetation cover which will cause increase of urban temperature. By land-use/land cover analysis we can study about urban sprawl and from Digital number of remote sensing data we can find the land surface temperature and can do further analysis.**

***Index Terms*—Diurnal Temperature Range, Land Surface Temperature, Land-use/land-cover, Urban heat Island**

II. INTRODUCTION

URBAN growth is an unplanned and non-directional growth which does not have any unique characteristics. It is an uneven growth and leads to improper utilization of available resources. We can study about sprawl by studying about the changes happened in land-use and land-cover which includes change in vegetation cover, built-up area, etc., urban sprawl and urban growth are similar, but not exactly the same. Urban growth is a planned and even growth and also has proper magnitude and direction. Determination, quantification, and modeling of sprawl is difficult. So, we can go for urban growth model for better understanding of sprawl model. The user can decide whether it is growth or sprawl by observing the results obtained from analysis.

Land Surface Temperature (LST) is the induced temperature from the land surface or it is the skin temperature of ground. It is one of the key parameter in defining the physical processes of land surface. Since vegetation cover is highly susceptible to change in LST, we can study about the indexes of vegetation cover to quantify the LST. Also we can use indexes of soil to study about LST. Also we can study the change in aerosol and diurnal temperature range to know about the LST.

III. LITERATURE REVIEW

Ji et al., (2006) explored and compared the various levels and patterns of urban sprawl in different areas say cities, villages, metropolitan areas, counties, coastal areas, etc. Remote sensing techniques are highly useful to estimate and characterize the different trends of urban sprawl by using its highly accurate and wide area image data. Using these worthy data they provided a basis so that we can predict about the future urbanization. They considered three factors mainly for analysis: Firstly, they considered socio-economic factors which drives urban sprawl. These parameters are closely associated with jurisdictions more than the spatial units such as census units or water sheds. Secondly, jurisdictional units are much large for a regional study to embrace different land cover types in order to reveal trends and patterns of urban growth effectively. Thirdly, much research efforts have not been done using remote sensing imagery to identify spatiotemporal patterns of landscape effects of urban growth. In this paper they used ArcGIS (ESRI, Inc.) and ERDAS IMAGINE (Leica, Inc.) software for performing image pre-processing, classification, and classification accuracy assessment. For analysis they used six Landsat images (1972, 1979, 1985, 1992, 1999, and 2001) from the US Geological Survey (USGS) covering Kansas City metropolitan area. Fast vegetation growth usually happens in mid-July to mid-August. So they chose images of this for better detection of land cover. The data sources used were Landsa-1 Multispectral Scanner (MSS) for 1972, Landsat-3 (MSS) for 1979, Landsat-5 Thematic Mapper (TM) for 1985 and 1992, and Landsat-7 Enhanced Thematic Mapper (ETM+) for 1999 and 2001. They conducted the land cover classification at the metropolitan level. They used supervised maximum likelihood classification method to classify these six Landsat images. They identified four major land cover types such as forestland, water body, built-up area, and non-forest vegetation to characterize the urban sprawl. From the Land Consumption Index (LCI) results they found that due to expansion of urban area, Metropolitan area has experienced significant land conversions.

Sudhira et al., (2004) studied about the dynamic behavior of urban sprawl. For this he analyzed the land use change, tried to identify the pattern of urban sprawl and computed the landscape metrics. Mainly they used Survey of India toposheets as primary data, of scale 1:50,000 of the study area. Also, they collected satellite data - multispectral satellite imagery of the Indian Remote Sensing (IRS) satellite, LISS-3 (29 March 1999) from the National Remote Sensing Agency, Hyderabad, India. The secondary data they used were the demographic details of all villages of the study area. They got it from the primary census abstracts of the years 1971, 1981, 1991, and 2001, from

the Directorate of Census Operations, Census of India. The highway passing between the two cities was digitized separately and a buffer region of 4 km on either side of the highway was created using MAPINFO 5.5 for detailed field investigations. They determined the urban sprawl of three decades (1972-1999) by comparing the built up area of all settlements with the obtained area from classified built up area of satellite imagery.

Kumar et al., (2008) tried to find the association of accelerated urban growth driven by the population concentration in an area. Urban sprawl monitoring and prediction are the basic information needed for this long term planning. They used Shannon's entropy in some of the studies to quantify the urban forms, such as impervious area in terms of spatial phenomenon. It is a measure of uncertainty about the realization of a random variable, like urban sprawl taking place in the form of impervious patches in newly developed areas. They collected the primary data from the Survey of India (SOI) topo-sheets (scale, 1:25,000) (No. 45J/10/5, 6 and 45J/ 11/1, 2, 3, 4) and multi-spectral Landsat Multispectral Scanner (MSS), Thematic Mapper (TM), Enhanced thematic mapper Plus (ETM+) and Indian Remote Sensing (IRS) LISS-III images for the years 1977, 1989, 2000 and 2002. The data collected from secondary sources include the demographic data (primary census abstracts for the years 1961, 1971, 1981, 1991 and 2001) from the Directorate of Census Operations, Census of India. They generated various thematic layers using the software ERDAS (Leica) and ArcGIS software (ESRI). The standard image processing techniques, such as image extraction, rectification, restoration, and classification have been used for the analysis of four satellite images for the years 1977, 1989, 2000 and 2002.

Mohan et al., (2015) studied about the Urban Heat Island (UHI). Due to urbanization the concentration of the tropospheric aerosols will increase which can influence the local climate and leads to decrease of the Diurnal Temperature (DTR). This happens because of the well-known 'urban heat island effect'. This phenomenon mainly happens at night when buildings and streets release the solar heat absorbed during the day and lower sky-view factor trapping that heat within the urban canopies thereby increasing the night-time temperatures. The slight cooling which happens in the daytime leads to the shading effect, presence of aerosols etc., further helps in inducing lower values of DTR. The annually averaged Land Surface Temperature (LST) data has been retrieved from the Monsoon Asia Integrated Regional Study program which utilizes Terra and Aqua Moderate-Resolution Imaging Spectroradiometer (MODIS) with 1 km spatial resolution from GIOVANNI of NASA. Then for detailed analysis the maps for the years 2001, 2004, 2008 and 2011 were used. 36 locations representing the 5 types of dominant LU/LC viz. urban built-up areas, green areas, open areas, riverside areas and urban outskirts existing in Delhi were considered for the detailed study. They created DTR anomaly maps for analyzing the impact of the changing LU/LC on DTR for the years 2004, 2008 and 2011. For this they took the DTR of the year 2001 as the reference. Mann–Kendall trend test at 95% confidence level has been performed on the computed annually averaged DTR values of these 36 stations using the Minitab 14 with the macro MKTREND.

From the studies of Thomas R. Karl (1999) it has been found that during the last five decades the diurnal range of surface air temperature (DTR) has decreased worldwide mainly because of changes in cloud cover. He determined how clouds and moisture affect DTR physically on daily bases. For this he analyzed 30-min averaged data of surface meteorological variables and energy fluxes from the First International Satellite Land Surface Climatology Project Field Experiment and the synoptic weather reports of 1980–1991 from about 6500 stations worldwide. He thoroughly examined the statistical relationships in the historical monthly records of DTR, and also examined the cloud cover, precipitation, and stream flow of this century.

Feizizadeh et al., (2013) proposed an integration of Spectral Mixture Analysis and Endmember Remote Sensing Indices to derive land surface temperature (LST), to identify urban heat islands (UHI) and to investigate their relationships to land use/land cover (LULC) and air-pollution. LST is considered as one of the important parameters in urban climate, which directly controls the UHI effect. Thermal remote sensing is regarded as an efficient technology which provides a good basis for studying UHI effects on a regional scale. In order to obtain LST and subsequently UHI zones, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images were acquired. Then they did atmospheric correction after layer stacking. After digitizing they found the Root Mean Square Error (RMSE) error. They used normalized difference vegetation index (NDVI) and found that NDVI is having negative correlation with LST.

Juan et al., (2003) proposed a generalized single-channel algorithm that only uses the total atmospheric water vapour content and the channel effective wavelength by assuming that emissivity is known, and can be applied to thermal sensors characterized with a FWHM (Full-Width Half-Maximum) of around 1 mm actually operative on board satellites. Usually the algorithm used for one thermal sensor (or a combination of thermal sensors) cannot be used for other thermal sensor. The data used were from the sensors Advanced Very High Resolution Radiometer (AVHRR) channels 4 and 5 onboard National Oceanic and Atmospheric Administration *(*NOAA*)* -11 and NOAA-12 (called as AVHRR-4 and AVHRR-5), ATSR2 channels 1 and 2 onboard European Remote Sensing (*ERS*)-2 (called as ATSR2-12 and ATSR2-11), and Landsat Thematic Mapper band 6 onboard LANDSAT (called as TM-6).

Using these they found the radiative transfer and LST from the brightness values obtained from the sensor.

Kumar et al., (2015) tried to find the correlation between LST and NDVI and also the occurrence of vegetative parameters which defines distribution of LST. They found that vegetation coverage has significant influence on LST distribution. For this they used Landsat TM data and found the correlation between vegetation and LST and also the occurrence of vegetation parameter, which defines distribution of LST. They used NDVI, *Soil-Adjusted Vegetation Index* (SAVI*)*, Normalized Difference Built-up *Index* (NDBI*)* and Relative Vigor Index (RVI). First they converted Digital Number (DN) values to Radiance and then Radiance to temperature. Then found the indexes and compared it with LST. They found that SAVI, RVI and NDVI were having negative correlation with LST and NDBI was having positive correlation with LST.

Olga et al., (2014) estimated urban growth dynamics through the validation and simulation of a spatial model of LUC, which integrated three techniques: cellular automata (CA), Markov Chains (MC) and logistic regression modeling. There are many models to analyze the urban growth such as logistic regression, cellular automata, and Markov Chains, etc. To construct the model they collected the data from multiple time scales. For this they used remote sensor data, census data, and data provided by private institutions. Calibration of the model was based on Land-Use Cover (LUC) data from 1975 to 2010, while simulations were conducted for the years 2030 and 2045.

Weng (2014) investigated about the application of the integration of remote sensing and geographic information systems (GIS) for detecting urban growth and assessing its impact on surface temperature in the region using multitemporal Landsat Thematic Mapper data. He extracted an image of urban and buit-up land from each original land cover image to analyse the nature, rate, and location of urban land change. The extracted images were then overlaid and recoded to obtain an urban land change (expansion) image. Using the buffer function in GIS, a buffer image was generated, showing the proximity to the major roads of the study area. He calculated the density of urban expansion by dividing the amount of urban expansion by the total amount of land in each buffer zone. These values of density were used to construct a distance decay function of urban expansion.

Arribas-Bel, et al (2011) addressed the issue of urban sprawl in Europe from a multidimensional point of view. They identified the most sprawled areas and characterized them in terms of population size. The analysis locates the hot-spots of urban sprawl in Europe in the centre of the continent, around Germany, and characterizes such urban areas as small, always half the size of the average city of the sample. They bought all these informations together and used the self-organizing map (SOM) algorithm to visualize and then studied by using its data reduction property as well as a clustering technique. There were six main dimensions that fall into two main conceptual categories. The first one was urban morphology, which includes as variables the scattering of urban development, the connectivity of the area, and the availability of open space. The second category referred the internal composition which includes three variables such as density, decentralization, and land-use mix. This variable represents different aspects of how the population is distributed across the patches. Statistical geo-referenced data of four periods 1989–1993, 1994–1998, 1999–2002, 2003–2006 were combined with raster and vector geospatial data, in a process that uses the database Urban Audit as a starting point, and complements it with spatial information on land-use provided by the Corine **(coordination of information on the environment)** and Urban Morphological Zones data sets. The Urban Audit database is a project coordinated by EUROSTAT (European Statistics). Self-organizing map combines both data projection (reduction of the number of attributes or dimensions of the data vectors) and quantization or clustering (reduction of the number of input vectors) of the input space without loss of useful information and the preservation of topological relationships in the output space.

IV. CONCLUSION

From the literature survey, it may be easily seen that as a multidisciplinary and broad issue, urban sprawl is a multidimensional topic that has been looked at from many different points of view and defined in several ways. It can be quantified conveniently using Remote sensing approach. Many methodologies and approaches are available for this purpose but studies have to be further conducted to find an appropriate and accurate method to quantify urban sprawl or each of the mentioned methods should be analyzed properly for knowing the best fitting method which will give the most accurate results. Along with the usage of Land surface temperature, relationships can be derived between LST and many indices corresponding to changes in the land use/ land cover.

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Wetland Change Detection – A Review

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Abstract – Remote sensing technology is used in various fields now a days, because of the advancement in satellite technology and the availability of more precise data which can be used for various studies and analysis. Wetland change detection is gaining very much importance currently because wetlands are being depleted at a vast rate which can adversely affect the whole balance of the ecosystem. Wetlands can be easily spotted by using remote sensing technology and by conducting various temporal analysis changes occurred on that particular wetland area can be easily detected. Microwave data are more efficient in identifying wetland in various weather conditions, as well as it helps in distinguishing various wetlands types. This paper reviews about various methodologies and data which can be used for wetland change detection using remote sensing technology.

Index Terms— Change detection, Normalized Difference Vegetation Index (NDVI), Remote sensing, Wetland.

I. INTRODUCTION

Wetlands are the link between land and water, and are some of the most productive ecosystems in the world. Wetland is a land area saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem. Wetlands are one of the world's most important environmental assets, containing a disproportionately high number of plant and animal species compared to other areas of the world. Throughout history they have been integral to human survival and development. The value of wetlands is recognized in terms of their primary productivity, their natural ability to protect coastal urban areas from storm events, their recreational attributes, and their capacity for waste assimilation. There are obvious advantages in using remote-sensing technology rather than conventional ground-survey techniques for wetland applications. First, it provides a method of feasible and practical data acquisition for these relatively inaccessible areas. Second, it provides a cost-effective method for continuous large area data coverage.

II. LITERATURE REVIEW

Butera (1983) demonstrated the capability to merge data from adjacent LANDSAT frames and combine it with other data with relatively high georeference accuracy. Initially, a multi-temporal merge of winter and fall data was created by combining bands 5 and 7 in a four-channel data file. Data were then destriped. Some of the training samples were grouped, depending on a scaled distance factor between spectral means**.** Applying a maximum-likelihood algorithm, all data were classified and then georeferenced to the Universal Transverse Mercator (UTM) System in 50-m cells. At this point, the west and east sides were joined geographically into one data file. Spectral classes were verified as surface-cover types using existing aerial photography and familiarity with the study area based on field experience. They could delineate 14% of the entire study area as wetland. The last step of the procedure involved an accuracy determination for the surface-cover classification a ground-truth field survey data. The overall identification accuracy they got was 78.2 percent.

The study by Tian (2015) analyzed the wetlands using remote sensing, image processing, and geographic information systems (GIS) techniques. Pre-processing of remote sensed data include rectification of image, pan-sharpened using the Brovey-transform resolution-merge method, bilinear interpolation resampling, edge matching, image enhancement etc on ERDAS imagine platform. The normalized difference vegetation index (NDVI) and modified normalized difference water index (MNDWI) were calculated for each image object (polygon) to pre-classify wetlands from non-wetlands. Then wetland habitat types are delineated using hybrid approaches, combining object-oriented image segmentation and human-expert visual classification. Procedural data verification, accuracy assessment, quality assurance, and control measures were performed to ensure the reliability of the wetland status data. In 2013, study is contained 376970.6 ha of wetlands, and 78.8% of all wetlands were in marine or estuarine systems. Between 2003 and 2013, lost is 50519.1 ha of wetlands, amounting to a mean annual loss rate of 1.2% or an 11.8% loss over the decade. The majority of marine and estuarine wetlands were lost or converted to uplands or constructed wetlands, through a combination of factors attributed to urban and rural development. Specific factors included erosion, sea level rise, decrease in discharge, reclamation, dredging, and sand trapping due to navigation channel deepening.

Betbeder et al. (2015) conducted a study to determine the optimal number and key dates of SAR images to be classified to map wetland vegetation formations. Image pre-processing was done using polSAR Pro v4.0 software. Then Shannon Entropy was calculated. Shannon entropy is a measure of disorder encountered in polarimetric SAR images. SE can be decomposed in to sum of two terms: intensity contribution, which depends on backscattered power and polarimetric contribution. Then 255 combinations of eight SE images were tested. Each subset of SE images were classified using SVM technique as it was commonly used and were known to efficiently classify remotely sensed time series data. Gaussian kernel was used to classify. Classification accuracy was defined using overall accuracy (OAA). All classification run were tested using McNemer test and a ratio of saturation is also used to determine the optimal number and key dates of SAR images to be classified to map wetland vegetation formation. The study explores the use of a complete monthly SAR time-series during a hydrological year to identify wetland vegetation formations. It highlights the periods (i.e. late winter and spring) relevant for mapping vegetation formations, in accordance with ecological studies

According to Klemas (2011). High-resolution imagery was more sensitive to within-class spectral variance, making separation of spectrally mixed land cover types more difficult than when using medium-resolution imagery. Therefore, pixel-based techniques are sometimes replaced by object-based methods. Before analysis, the multispectral imagery must be radiometrically and geometrically corrected. Image segmentation simplifies the analysis by first dividing the image into homogeneous patches or ecologically distinct areas. Supervised classification requires the analyst to select training samples from the data that represent the themes to be classified (Jensen, 1996). The training sites are geographic areas previously identified using field visits or other reference data, such as aerial photographs. The spectral reflectances of these training sites were then used to develop spectral ‘‘signatures,’’ which were used to assign each pixel in the image to a thematic class. Next, an unsupervised classification is performed to identify variations in the image not contained in the training sites. Multispectral images acquired are reduced to spectral information to a single index. Detecting changes between two registered and radiometrically corrected images from different dates can be accomplished by employing one of several techniques, including post-classification comparison and spectral image differencing (change detection).

Dabrowska-Zielinska (2009) in his study he used data from optical and microwave satellite images have been analyzed and compared with the detailed soil–vegetation ground measurements conducted in conjunction with overflights. Satellite data include Landsat ETM, ERS-2. ATSR and SAR, SPOT VEGETATION, ENVISAT MERIS and ASAR, and NOAA/AVHRR. They collected various ground data including VM (vegetation moisture), LAI (Leaf Area Index), and SM (soil moisture). The following indices, which included different bands, were calculated: ARVI (Atmospherically Resistant Vegetation Index), GEMI (Global Environment Monitoring Index), EVI (Enhanced Vegetation Index), MI (Medium Infrared Index), and NDVI. The aim of the study was to find the best vegetation index, which gives the largest number of classes to present variation of vegetation due to moisture conditions in the marshland area. Each index is calculated using suitable satellite data. Finally, they concluded that for characterizing marshland habitats best indices were GEMI and EVI from SPOT VEGETATION and EVI from ENVISAT MERIS.

Jones (2009) conducted study for assessing wetland using Earth Observation for the Global wetland project. An object based approach was selected. Optical imagery was used as a basis to perform classification. Multi-temporal remote-sensing imagery acquired at two different times over a geographical region of interest along with suitable ground truth data, ancillary data, other prior information. Data preprocessing and data analysis are performed for extraction of the required information about changes occurred in the area of interest between the two considered times using computer based semi-automatic techniques. The team first generated a land use - land cover map. Then water cycle regime, mapping peatland fire scars, water quality analysis, wetland identification and delineation are done using suitable data. Finally, for better understanding of topography and its dynamics a DEM was also produced. They found that, SAR data was best suited for wetland delineation and topographic analysis. The results were compared with field data using a GIS in which all geo-referenced remote-sensing data were integrated as well as available vector data from the end-user and GPS recorded field observations. The comparison showed that the total wetland area delineated by the Glob Wetland map using satellite imagery was 7159 ha and that derived from aerial photography was 6768 ha. This represents an accuracy of 94% in the identification of wetlands.

Land use change research was conducted by Zhang et al (2011) for the effective management and conservation of wetlands. He used Landsat TM and ASTER images of 1988, 1996 and 2004 as data source, based on the images interpretation by supervised classification, the land use changes during the period 1988 to 2004 were analyzed through land use dynamic degree. The land use change was determined using the land use dynamic degree model. And then the driving

forces of land use changes were analyzed based on natural and artificial factors. The results indicated that from 1988 to 2004, as the result of natural factors and human disturbances, the area of wetland shrunk, bringing the conversion from wetland to terrestrial land use types such as cultivated land and forest and grass land. Through the synthesis land use dynamic degree for the two sub-periods, the land use changes during the period 1996 to 2004 reduced comparing with that during the period 1988 to 1996.

Charles G studied the remote sensing application in mapping of wetland, its assessment and mitigation. The objective of his study was to point out the use and analysis of high resolution image and elevation data products in combination with digital soil data for prediction of areas with most possibility of being wetland. His study explains how image pixels classified for a particular land cover can be analyzed within a neighbouring area to determine if and how wetland vegetation criteria were met. The classified high spectral resolution data was stratified and were categorised into different groups. Then from them vegetation information product and non-vegetation information product was formulated. Then those clarified results were ranked by using an algorithm to formulate combined vegetation information. From this product the contextual analysis of vegetation, hydrology and soils were done to determine the possibility of occurrence of wetland. The validation was done by comparing the results with National Wetland Inventory Survey results and they were highly matching. From his results he concluded that high spatial and spectral resolution hyperspectral image data along with high resolution digital elevation data can provide the capability to detect wetland vegetation, provide improved detection of hydrologic features and conditions, and when combined with digital soils data, provide an improved contextual assessment for screening areas that have a high possibility of containing wetlands.

Bartsch (2009) studied about recent advance in the use of ScanSAR technologies for wetland related research. The objective of his study was to discuss the capabilities of medium resolution satellite microwave data for global monitoring of wetlands. The data used was ENVISAT ASAR image acquired in Global Monitoring mode which was available in C-HH polarization with 1 km resolution. A processing chain has been developed for ENVISAT ASAR which allows the analysis of GM (1 km) as well as Wide Swath (WS, 150 m) mode data over large regions. Average numbers of acquisitions for different wetland types have been derived from the wetland types outlined in the Global Lakes and Wetland Database. Normalized backscatter time series for peatland with small ponds, forest, peatland without ponds and open water from spring and summer were formulated. The onset of snowmelt was also indicated. This study showed that although ASAR Global mode data has a 1 km resolution it is capable of capturing not only the extent but also the dynamics of wetland areas.

Wang (2008) studied coastal wetland changes using remote sensing and GIS. Apart from the satellite remote sensing data, we use sea charts covering the last 100 years, topographic map and bathymetric data in different periods to study the changes of coastal wetlands. They divided coastal wetland changes into the following 4 periods: the period before 1950, 1950s 1976, 1993 and 2004. 1950s were gotten from the topographic map, 1970s the data of coastal lines were obtained from satellite remote sensing images, MSS data in 1976, TM data in 1993 and SPOT5 data in 2004 for the locations of coastal lines. The corresponding water depth data were also obtained from the sea map in 1976, and bathymetric data conducted in 1993 and 2004 respectively. All sea maps and topographic map were scanned and digitized in ArcGIS firstly, and transformed to the WGS84 projection. Then the remotely sensed data were geometrically corrected and projected to the WGS84 projection using ERDAS. The areas of coastal wetlands in different periods were determined with the assistance of ArcGIS. Finally, the areas of coastal wetlands were calculated using spatial analysis provided by ArcGIS. From his study he concluded that due to the large scale reclamation during the past 50 years, the coastal wetland decreased dramatically. The area of coastal wetlands changed from 79.3km2 to 33.3km2, 58% of area of wetlands lost.

III. CONCLUSION

In various parts of the world wetland studies are being conducted for its better management and preservation, since wetlands are over - exploited. Such studies mainly use satellite data and aerial photographs as this is economical and time saving. Presently, many methods are used to identify and delineate wetlands from remotely sensed data. Many difficulties have to be faced in various stages of processing like selection of suitable multi temporal data, accurate classification method and change detection method etc and further research is required in this area.

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A Study on Workflow Scheduling Algorithms in Cloud

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Abstract: Scientific workflows are represented by using directed acyclic graphs (DAGs) model. Since tasks are dependent on each other it requires an efficient task scheduling algorithm. In cloud, dynamically receives jobs and submits to the datacenter for the execution. Here jobs are submitted based on their dependencies. It submits the jobs only when all of its parent jobs completed execution successfully. These jobs will be listed in the scheduler. Scheduler will have the list of jobs which can be executed immediately. Since there is a limitation of number of resources available it requires an efficient task scheduling mechanism. In this paper, we have compared several tasks scheduling algorithm with respect to makespan of jobs in the workflow. The algorithms analysed using WorkflowSim simulator.
Key word: scheduling, workflow, makespan, level

1. INTRODUCTION

Cloud Computing is a latest trend in today's world. It provides on demand services like hardware, software, platform, infrastructure and storage etc. dynamically to the user according to the "pay per use" model by using virtualized resources over the internet. Cloud computing is able to host various applications such as business, social networks and scientific applications.

While Cloud computing provides various services like IaaS, PaaS and SaaS etc. to end users but due to novelty of cloud computing, it also suffers from many types of research issues such as security, performance, database management, virtual machine migration, server consolidation, fault tolerance and workflow scheduling etc. Among this workflow scheduling is major issue for scientific applications

2. LITERATURE SURVEY

2.1 Time Comparison Based Scheduling Heuristics

The main objective of scheduling algorithm is to achieve the best system throughput with proper resource utilization and high performance by obeying the user's specified QoS parameter. There are various time comparison based scheduling heuristics exists in the grid and Cloud computing environment, which schedules the tasks by comparing the arrival time or execution time of the tasks.

2.1.1. First Come First Serve (FCFS)

In this algorithm, tasks are compared on the basis of their arrival time and the task which comes first in the ready queue is served first. Advantage of this algorithm is its simplicity and fast execution behavior. But the main disadvantage of this algorithm is that sometimes due to the execution of a longer job, which comes in the queue first, small jobs have to wait for its completion. Due to this problem the waiting time of tasks increased and overall performance of the workflow execution decreases.

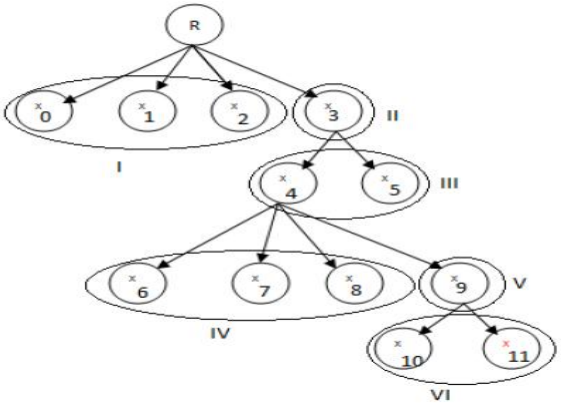

Fig 1: Scheduling with FCFS approach

When FCFS scheduling is implemented as shown in Figure 3.2 by consideration of three virtual machines at a time only. Now for first schedule, FCFS scheduler will schedule task 0, 1 and 2 at three virtual machines paralelly, so it will take X time to execute these three tasks. But for second schedule, only task 3 is available for execution because task 4 and task 5 can't be executed at this time since there parent has to be executed first. So it will take another X time to complete task 3 only. During this schedule, two virtual machines remain idle. Similarly for third and sixth schedule, one virtual machine remains idle in each case and for each schedule X time is consumed. Fourth schedule also behaves in the same way as first schedule does and this will also consume X time. Fifth schedule behaves like second schedule and it will also take X time to complete the execution of the single task 9. So in this manner resources are not utilized properly and a total of 6X time is required to complete the whole workflow execution

2.1.2 Min-min

In this algorithm, small task is executed first so that large task delays for long time. Algorithm begins with by sorting the set of all unmapped tasks in increasing order of their completion time. Then the tasks having the minimum completion is scheduled from the unmapped task set and the mapped task has been removed from unmapped task list, and the process repeats until all the tasks of unmapped list is mapped to the corresponding available resources [1].

2.1.3 Max-min

In this algorithm, large task is executed first so that small task delays for long time. This algorithm is very similar to Min-min algorithm, instead of sorting the task in the increasing order of completion time. This algorithm sorts the tasks in decreasing order of their completion time. Then the task with the overall maximum completion time is selected from this task list and scheduled to the corresponding available resource. Then the scheduled task has been removed from unmapped task set and the process repeats until all tasks of unmapped list is mapped

2.1.4 Minimum Completion Time (MCT)

In this algorithm, task that takes least time to complete is allocated to a machine randomly. So MCT behaves somewhat like Min-min. However, Min-min algorithm considers all the unmapped tasks during each mapping decision but on the other hand MCT considers only one task at a time [2]

2.1.5 MaxChild

In this algorithm, the task which has maximum number of Childs will be scheduled first, so that maximum number of tasks can be available for the next schedules and resource are utilized properly.

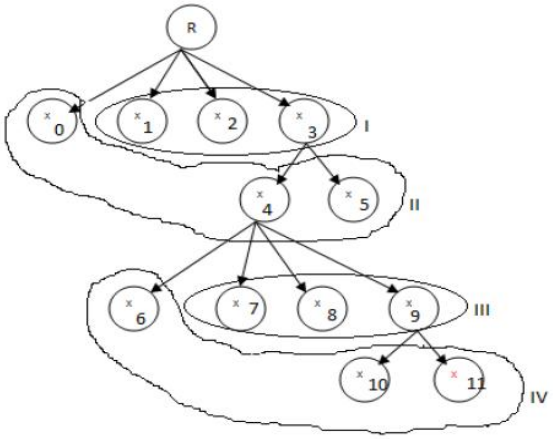

Fig 2: Scheduling with MaxChild approach

MaxChild Scheduler will schedule task 3 prior to all the other tasks at level 1on any of three virtual machines along with any 2 tasks from the remaining task of that level. So X time is consumed for these three tasks of level one. Now at the second schedule, MaxChild scheduler will schedule task 4 and task 5 of level 2, along with the remaining one task (task 0) of level 1. To execute these three tasks another X time is consumed. Similarly at the third schedule MaxChild scheduler will schedule task 9 prior to all the other tasks of level 3 along with task 8 and task 9. And in the final schedule, it will schedule task 10 and task 11 of level 4 along with the remaining one task of level 3. So in this way resource are utilized properly and the given workflow will be executed completely in 4X time

3 EXPERIMENTAL RESULTS

The paper uses simulation to test and verify the efficiency and correctness of the scheduling algorithm

3.1 Simulation setup

The proposed algorithm is simulated in a simulation toolkit workflowsim[3].We have created a datacenter with the following properties and created 20 virtual machines. Here we have considered 5 virtual machines with processing capability 100,300,200,500 and 600 MIPS respectively

The summary of the experimental results are given in the bellow table

Scheduling Algorithm	Cybershake_50.xml dataset	Montage_100.xml dataset
FCFS	1249.39	1024.66
MINMIN	1484.82	724.43
MAXMIN	1111.31	724.25
MAXCHILD	1040.84	719.81

Table 1: MakeSpan of scheduling algorithms wrto the data sets Cybershake_50 and Montage_100

The experimental results clearly show MaxChild algorithm is more efficient with respect to makespan compared to FCFS, MINMIN and MAXMIN.

CONCLUSIONS

Minimizing Makspan is one of the objectives in scheduling algorithm. The Experiments shown MAXCHILD is the most efficient with respect to the makespan in comparison to the other algorithms FCFS, MAXMIN and MINMIN. These algorithms still can be improved by considering multiple objective functions, fault tolerance. because after a job is submitted to the resource , if the resource becomes unavailable it may affect the makespan

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3.2 Results

Experimental result of MINMIN with respect to Cybershake_50 data set

Cloudlet ID	STATUS	Data center ID	VM ID	Time	Start Time	Finish Time	Depth
50	SUCCESS	2	4	0.18	0.1	0.28	0
2	SUCCESS	2	4	121.9	0.28	122.18	1
22	SUCCESS	2	3	181.12	0.28	181.4	1
5	SUCCESS	2	4	66.5	122.18	188.68	2
25	SUCCESS	2	4	49.4	188.68	238.08	2
6	SUCCESS	2	4	1.68	238.08	239.77	3
26	SUCCESS	2	4	1.28	239.77	241.05	3
9	SUCCESS	2	3	122.42	181.4	303.82	2
27	SUCCESS	2	4	65.5	241.05	306.55	2
10	SUCCESS	2	4	1.65	306.55	308.2	3
28	SUCCESS	2	4	2.3	308.2	310.5	3
23	SUCCESS	2	4	71.27	310.5	381.77	2

31	SUCCESS	2	3	83.44	303.82	387.26	2
24	SUCCESS	2	3	2.06	387.26	389.32	3
32	SUCCESS	2	3	1.36	389.32	390.68	3
35	SUCCESS	2	1	415.6	0.28	415.88	1
29	SUCCESS	2	4	90.4	381.77	472.16	2
36	SUCCESS	2	4	38.55	472.16	510.71	2
30	SUCCESS	2	4	2.18	510.71	512.9	3
37	SUCCESS	2	4	1.28	512.9	514.18	3
33	SUCCESS	2	3	128.12	390.68	518.8	2
40	SUCCESS	2	4	63.05	514.18	577.23	2
34	SUCCESS	2	4	2.13	577.23	579.36	3
41	SUCCESS	2	4	2.57	579.36	581.93	3
46	SUCCESS	2	3	79.4	518.8	598.2	2
7	SUCCESS	2	1	214.03	415.88	629.91	2
47	SUCCESS	2	1	4.3	629.91	634.21	3
8	SUCCESS	2	1	4.4	634.21	638.61	3
38	SUCCESS	2	4	72.88	581.93	654.81	2
44	SUCCESS	2	3	88.8	598.2	687	2
39	SUCCESS	2	3	2.74	687	689.74	3
45	SUCCESS	2	3	2.5	689.74	692.24	3
3	SUCCESS	2	0	595.69	122.18	717.88	2
4	SUCCESS	2	3	2.8	717.88	720.68	3
42	SUCCESS	2	4	96.62	654.81	751.43	2
43	SUCCESS	2	4	2.27	751.43	753.69	3
48	SUCCESS	2	1	154.07	638.61	792.67	2
49	SUCCESS	2	4	2.02	792.67	794.69	3
11	SUCCESS	2	2	929.9	0.28	930.18	1
20	SUCCESS	2	4	61.08	930.18	991.26	2
21	SUCCESS	2	4	2.6	991.26	993.86	3
14	SUCCESS	2	3	82.8	930.18	1012.98	2
15	SUCCESS	2	4	2.17	1012.98	1015.15	3
12	SUCCESS	2	1	164.57	930.18	1094.75	2
13	SUCCESS	2	4	1.47	1094.75	1096.21	3
18	SUCCESS	2	2	254.8	930.18	1184.98	2
19	SUCCESS	2	4	2.4	1184.98	1187.38	3
16	SUCCESS	2	0	551.1	930.18	1481.28	2
1	SUCCESS	2	4	0.28	1481.28	1481.56	3
17	SUCCESS	2	3	3.14	1481.28	1484.42	3
0	SUCCESS	2	4	0.4	1484.42	1484.82	4

Experimental result of MAXCHILD with respect to Cybershake_50 data set

Cloudlet ID	STATUS	Data center ID	VM ID	Time	Start Time	Finish Time	Depth
50	SUCCESS	2	4	0.18	0.1	0.28	0
2	SUCCESS	2	4	121.9	0.28	122.18	1
3	SUCCESS	2	4	99.28	122.18	221.47	2
22	SUCCESS	2	1	301.87	0.28	302.15	1
7	SUCCESS	2	4	107.01	221.47	328.48	2
4	SUCCESS	2	4	2.33	328.48	330.81	3
11	SUCCESS	2	3	371.96	0.28	372.24	1
23	SUCCESS	2	4	71.27	330.81	402.08	2
25	SUCCESS	2	3	59.28	372.24	431.52	2
27	SUCCESS	2	4	65.5	402.08	467.58	2

9	SUCCESS	2	1	204.03	302.15	506.18	2
5	SUCCESS	2	0	399	122.18	521.18	2
8	SUCCESS	2	0	13.2	521.18	534.38	3
31	SUCCESS	2	4	69.53	467.58	537.11	2
29	SUCCESS	2	3	108.48	431.52	540	2
14	SUCCESS	2	4	69	537.11	606.11	2
35	SUCCESS	2	2	623.4	0.28	623.68	1
16	SUCCESS	2	3	110.22	540	650.22	2
24	SUCCESS	2	3	2.06	650.22	652.28	3
26	SUCCESS	2	3	1.54	652.28	653.82	3
28	SUCCESS	2	3	2.76	653.82	656.58	3
10	SUCCESS	2	3	1.98	656.58	658.56	3
6	SUCCESS	2	3	2.02	658.56	660.58	3
32	SUCCESS	2	3	1.36	660.58	661.94	3
30	SUCCESS	2	3	2.62	661.94	664.56	3
15	SUCCESS	2	3	2.6	664.56	667.16	3
18	SUCCESS	2	4	84.93	606.11	691.05	2
36	SUCCESS	2	3	46.26	667.16	713.42	2
33	SUCCESS	2	1	213.53	506.18	719.71	2
38	SUCCESS	2	4	72.88	691.05	763.93	2
40	SUCCESS	2	3	75.66	713.42	789.08	2
20	SUCCESS	2	2	183.25	623.68	806.93	2
44	SUCCESS	2	4	74	763.93	837.93	2
17	SUCCESS	2	4	2.62	837.93	840.55	3
19	SUCCESS	2	4	2.4	840.55	842.95	3
37	SUCCESS	2	4	1.28	842.95	844.23	3
34	SUCCESS	2	4	2.13	844.23	846.36	3
39	SUCCESS	2	4	2.28	846.36	848.65	3
41	SUCCESS	2	4	2.57	848.65	851.21	3
21	SUCCESS	2	4	2.6	851.21	853.81	3
45	SUCCESS	2	4	2.08	853.81	855.9	3
46	SUCCESS	2	3	79.4	789.08	868.48	2
47	SUCCESS	2	4	2.15	868.48	870.63	3
42	SUCCESS	2	1	193.23	719.71	912.95	2
43	SUCCESS	2	4	2.27	912.95	915.21	3
12	SUCCESS	2	0	493.69	534.38	1028.07	2
13	SUCCESS	2	4	1.47	1028.07	1029.54	3
48	SUCCESS	2	2	231.1	806.93	1038.02	2
1	SUCCESS	2	4	0.28	1038.02	1038.31	3
49	SUCCESS	2	3	2.42	1038.02	1040.44	3
0	SUCCESS	2	4	0.4	1040.44	1040.84	4

UAVs for Ecological Conservation in India

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***Abstract*— This paper looks into the feasibility of UAVs in India, their application and design metrics specific to India**
Key words: UAV, India, Forest

I. INTRODUCTION

UAVs provide us with a second pair of eyes in the sky. They can access terrain that no human can and are capable of surveillance in the most hostile environments. Virtually undetectable, they can be used for lethal and non lethal purposes. This paper looks at some features of these micro drones, their feasibility and their application in non lethal applications.

II. UNDERSTANDING UAV SPECIFICATIONS

The points below list some specifications for UAVs (refer figure 1).

A. Selecting the right UAV

UAVs come in many forms, Fixed Wing, Quad-Copters & Multi- Rotors. Quad-Copters are more unstable when compared to fixed wing aircraft, yet they are known for their agility and hence useful in monitoring and surveillance.

B. Size & Weight

For monitoring, a UAV with a diagonal length of 60cm and a weight of 1.5Kgs (including battery and camera) would be ideal.

C. Electronic Specifications

1. A 1000-1500KV motor. KV stands for RPM/V. When 1 Volt is applied across the motor, it rotates with an RPM of 1000. Similarly, if 8V is applied across the motor, it will rotate with an RPM of 8000. They have a maximum current rating of 10-18A and a maximum voltage rating of 8-18V.
2. The Electronic Speed Controller (ESC) controls the amount of current going into the motor. There are 4 ESCs, one for each motor. An ESC with a maximum current rating of 25A would be ideal.
3. The battery for this UAV must power the four motors as well as the embedded system (if any). A lithium polymer battery would be ideal. It is capable of providing a high voltage per cell (3.7V). A 4S (4 cells in series) battery will provide us with an ample voltage of 15V. The battery will have a capacity of 5000mAh and a C rating of 10C. A 5000mAh battery can provide a constant current of 5A for 1 hour. It can provide a constant current of 10A for 30 min. But there is a limit to the maximum current that it can provide. The maximum limit is given by the C rating of the battery. A 5000mAh battery with a C rating of 10C can provide a maximum current of 50A (5A * 10C).
4. Other optional electronics include Proportion Integral Derivative (PID) controllers. These come in packaged chips such as 'KK2.0'. An addition of embedded systems such as Arduino or Raspberry Pi will allow for live streaming of video as well as GPS modules.

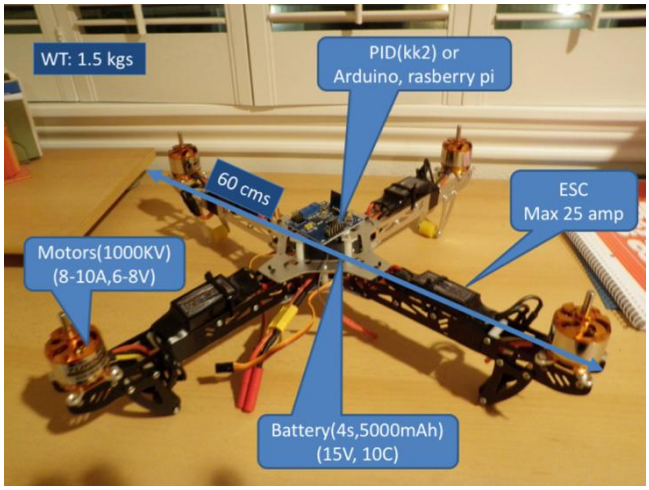

FIGURE 1: AN EXAMPLE OF A UAV SETUP [1]

III. FEASIBILITY OF UAVS IN INDIA

In order to use UAVs in India we need to look at some primary factors

A. Low cost

In order to ensure the mass utilization of these machines in every sphere we must fabricate them ourselves relying on a 'do it yourself'(DIY) approach rather than buying it from companies that specialize in them.

B. Repairability

The UAV must be repairable and parts interchangeable. When a component such as an Electronics System Control (ESC) fails, it must be replaceable without the need to replace any other component (refer figure 2)

C. Ease and quickness of repairability

When a UAV is 'downed' or damaged, one should immediately be able to replace the part quickly. The damaged module should be replaced easily and detailed

analysis and repair of damaged module could be done at a later stage when time permits (refer figure 3).

D. Ease of flying

In order to make flying of the UAV effortless for the men on the ground, it must employ Proportional Integral Derivative (PID) controllers (refer figure 4) for increased flight stability or must employ the use of micro-controllers (such as Arduino or Raspberry Pi) to make the flying experience as autonomous as possible. It should include auto take off and auto landing in addition to autopilot capabilities with an onboard GPS (refer figure 5).

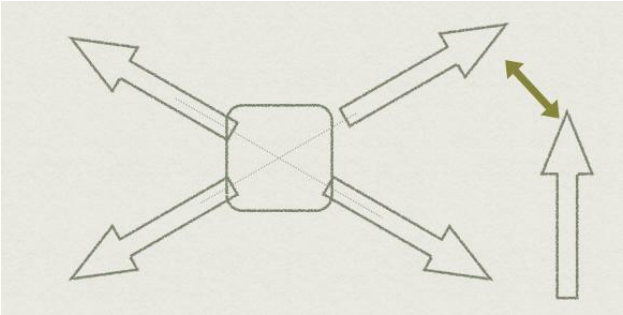

FIGURE 2: REPLACEMENT ARM FOR DAMAGED PROPELLOR

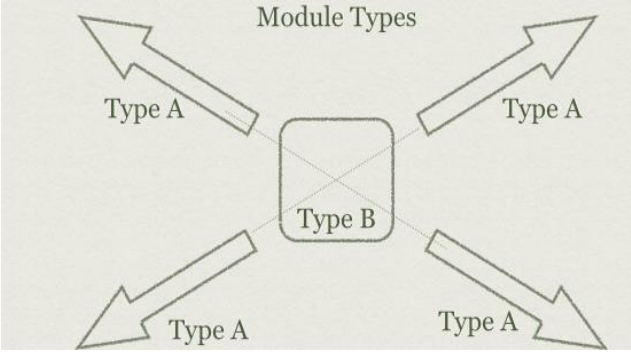

FIGURE 3: DIFFERENT TYPES OF MODULES

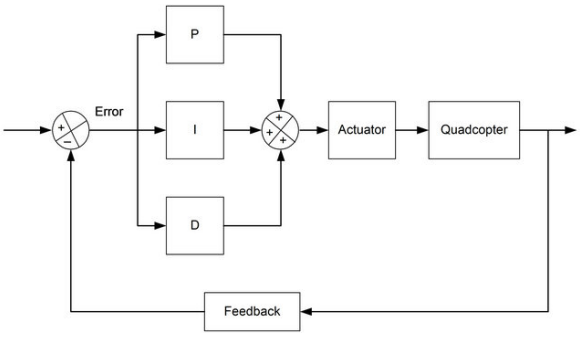

FIGURE 4: PID CONTROLLER FOR STABILITY [2]

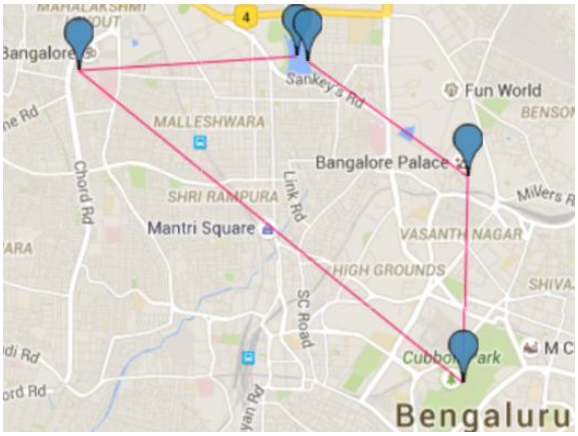

FIGURE 5: AUTOPILOT SYSTEM FOR SELECTING WAYPOINTS

IV. WHERE CAN IT BE USED?

This section looks at some of the uses of UAVs in India

A. Education

In order to conserve wildlife and our ecosystem, in addition to stringent laws and monitoring, we should educate the people. Footage from these drones can and should be used to educate the people about the importance of ecological balance as well as the role of wildlife. We need to convince poachers to become wildlife conservationists.

B. Wildlife Monitoring

There was a time when interaction between man and animals was at a minimum, but in recent times increase in population combined with activities like deforestation, land encroachment has caused many species in India to go extinct or has driven them to the verge of extinction (refer figure 6). With the help of UAVs we can monitor these animals and the ecosystem without the intervention of humans. This in turn will minimize interaction between the two species.

C. Smuggling

Sandalwood smuggling has become a big issue in many parts of India. A UAV could provide security personnel with more eyes in the sky. The high definition video from the UAV will further help in prosecution of suspected smugglers and will eliminate the need for further investigation or tall claims of mistaken identity.

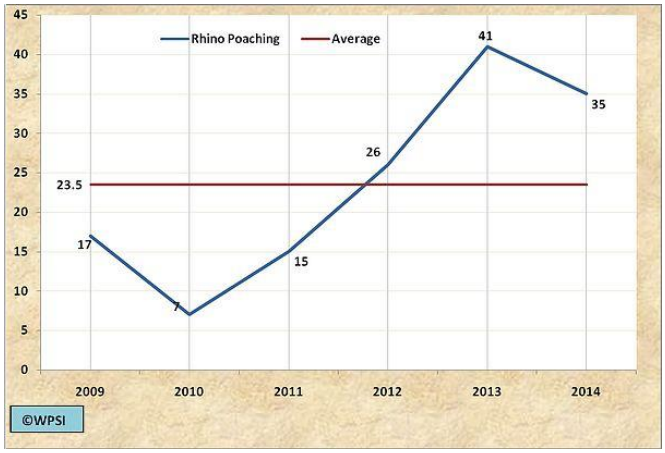

FIGURE 6: INCREASE IN RHINO POACHING IN INDIA [3]

FEATURES ESSENTIAL FOR ECOLOGICAL CONSERVATION

The following are a few features essential for a successful project

A. High definition Camera

The 'go-pro hero 4' camera can shoot 4k video at 30fps, 2.7k at 60fps and 1080p at 120 fps. At this frame rates and this level of clarity, there will be no room for error in identifying miscreants. This would also prevent the need for further investigations caused by tall claims of 'mistaken identity'. Further this camera should be capable of pan and auto stabilization in flight in order to obtain a still video. The arms of the quad-copter should be placed 120 and 60 degrees apart to prevent the rotors from coming into view and will also prevent video distortion (refer figure 7).

B. Real time video streaming

In order to ensure quick action by officials the drones must not only record but also stream back live video in real time.

C. Thermal Imaging camera

Most Indian forests (with exception of the North East) have thick canopies which obstruct the view of the drones making it exceptionally hard to see the forest floor. A thermal imaging camera is one which detects images based on their heat signatures (refer figure 8). This will help us look through canopies and also distinguish between wildlife

D. Drone Noise

The noise signature of the drone needs to be kept minimum in order to prevent any disturbance caused to wildlife as well as prevent miscreants from evading the drone. Small motors and more aerodynamic blades that 'cut' through the air will reduce the noise signature.

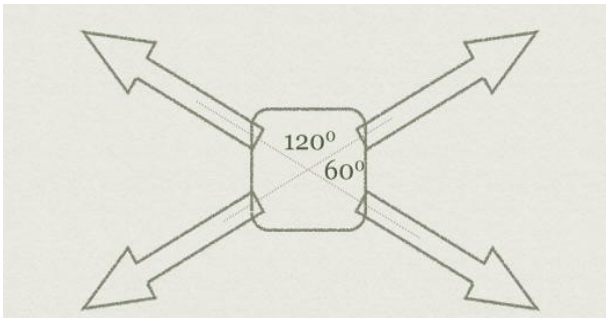

FIGURE 7: ARMS PLACED, 120 AND 60 DEGREES APART

IV. ALGORITHMS

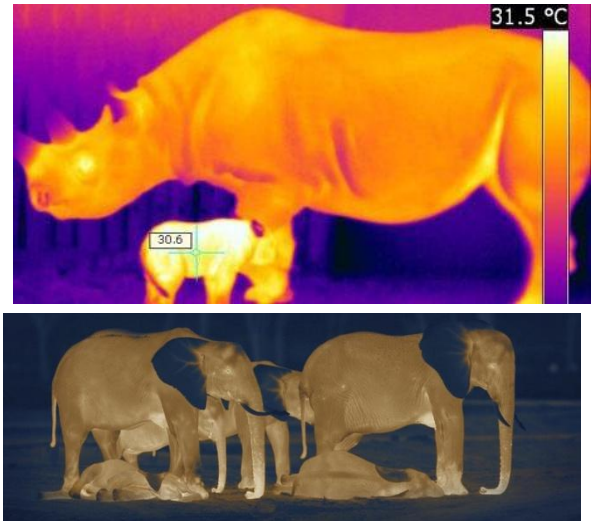

FIGURE 9: ALGORITHM SIMULATION EXAMPLE

In order to cover more areas and keep them under surveillance, rather than employing more drones we need to make our drones smarter. By employing statistics and data from tagged animals it is possible for us to predict animal behavior and the routes they take (refer figure 9).

This method was pioneered by Tom Snitch & and his team at University of Maryland [6]. They first helped the US Army to detect the location of IED 'factories' in Baghdad and to help determine the location of the people building them. They did this by eliminating areas where there would be no chance of an IED being placed (refer figure 10). They then collected data of IED explosions dating back to 5 years and superimposed it on this map. They were successfully able to put an end to this phenomenon.

The same technique was then applied to Wildlife Conservation. In Africa they are monitoring the dwindling Rhino population by predicting the location of poaching with 93% [7] accuracy. This has also been successfully tried in Nepal, by giving camera phones to all the trackers of the region. The tracker can immediately click a picture of a Tiger snare with the location data of the said snare.

In India we have a general idea about the routes taken by Elephants. However, often some of the Elephants tend to get detached from their herd, and these are the ones that get hunted (refer figure 11). We can predict the location of these elephants by following a similar approach.

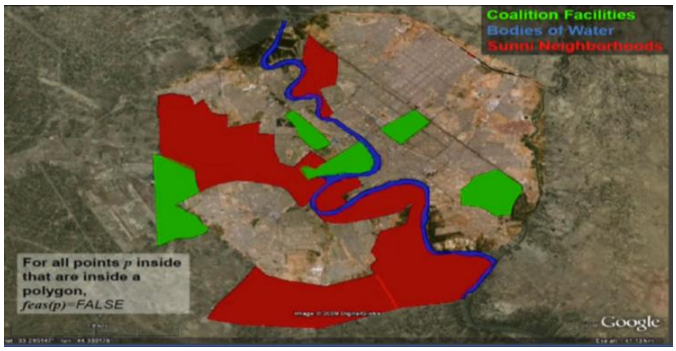

FIGURE 10: MAP OF BAGHDAD [6]

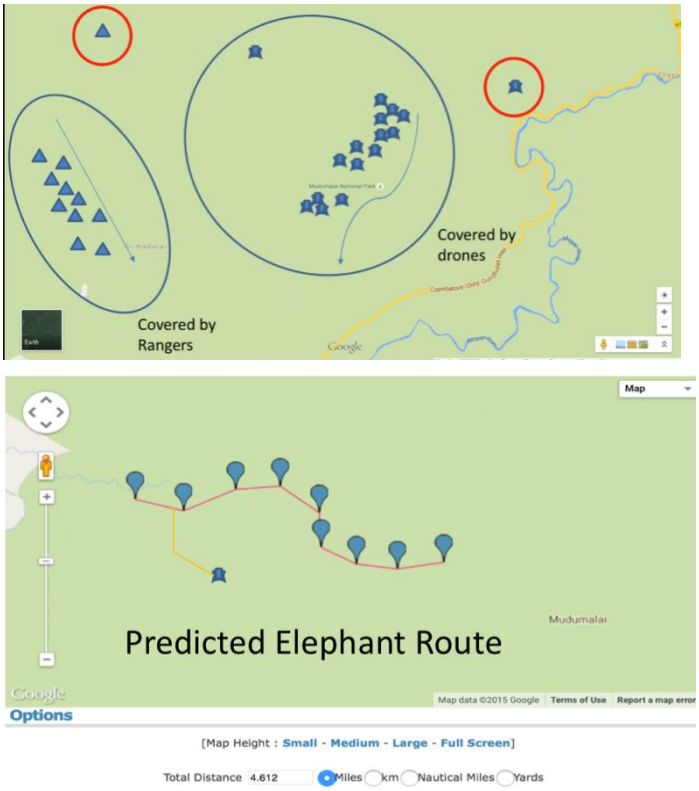

FIGURE 11: ANIMALS THAT GET DETACHED FROM THEIR HERDS

V. CONCLUSION

UAVs can cover more ground than a ranger can. They have the ability to truly make a difference. Programs like this are crucial in preserving our forests and ecosystem.

ACKNOWLEDGMENTS

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