land subsidence, two years data is not enough. Hence to predict rate of land subsidence over the study area, extensive study and consistent monitoring will be carried out in future.

It is clearly seen from the location of deformation stations that change in elevation is more on north side of the study area during May 2004 to May 2006. More numbers of gas extracting wells are located on the north side of the reservoir. Maximum pressure is depleted 0.804 N/mm^{2}at R2 station and maximum subsidence is also observed 12.9 cm at R2 station. Hence, it can be concluded that maximum subsidence is experienced where maximum pressure depletion is observed. On the south side of the reservoir boundary, less gas extraction was recorded compared to north side. Only one gas producing well is situated on south side of the reservoir, hence less subsidence is observed on south side compared to north side. Central part of the reservoir is showing less subsidence compared to north and south side of the reservoir boundary. Pressure depletion at R7 well point is the lowest 0.396 N/mm^2. Therefore it is established that subsidence is less, where the pressure depletion is less. From the locations of the well points, it is clear that, gas is being produced from two regions, which shows more subsidence compared to surrounding area. It is confirmed from literature, that the central area of the reservoir generally shows more subsidence compared to surrounding region. Gambolati (2005) mentioned that over the gas/oil fields, the subsidence usually takes on a bowl-shape appearance with the largest downward displacement occurring near the centre of the field. The border of the boundary roughly resembles the shape of the field although it may extend up to twice or more the area encompassed by the outline of the underlying reservoir. The same results have been observed with GPS over the study area. Hence, it is confirmed that GPS is efficient and effective technique to measure and monitor land subsidence.

Table: 2 Effective Local Subsidences

Campaigns	**5-May - May 06**	**4-May - May 05**	**4-May - May 06**
Effective Local Subsidence for points within Reservoir Boundary	26 ± 5 mm	41 ± 5 mm	67 ± 5 mm

Relation between Pressure Change and Cumulative Gas Extraction

The aim of this study is to monitor and measure land subsidence over the gas reservoir. Over this region, gas extraction is one of the major causes of land subsidence. Hence for this study, gas extraction, pressure depletion and temperature of reservoir are collected time to time to see the effect of cumulative gas extraction and pressure depletion on land subsidence. It is observed that the pressure depletion of gas wells is varying between 0.398 N/mm^2 and 0.804 N/mm^2 during two years May 2004 to May 2006. Average pressure depletion over the gas reservoir is about 0.634 N/mm^2. The highest-pressure depletion of 0.804 N/mm^2 was recorded in R2 well while; the low-pressure depletion value of 0.398 N/mm^2 was witnessed in R7 well. It is observed that the well points, which have shown maximum pressure depletion, have also shown maximum subsidence. It is clearly seen from the data that pressure is consistently decreasing with increase in cumulative gas extraction. The correlation coefficient is found to be 0.99. Hence it can be concluded that there is good correlation between these two parameters and pressure is decreasing with increase in gas extraction. Pressure depletion is one of the main causes of the land subsidence. Hence the subsidence observed over the reservoir boundary might have caused due to gas extraction.

Relation between Rate of Subsidence and Rate of Gas Extraction,

Many researchers have tried and established the correlation between hydrocarbon production and subsidence (Mayuga & Allen, 1969). They found very high correlation between cumulative subsidence and cumulative extraction of gas and oil. In our work, attempt has been made to find out correlation between rate of land subsidence and rate of gas extraction. To find correlation between rate of cumulative gas extraction and rate of subsidence, parameters are calculated and tabulated in Table : 3 and graph is plotted in Figure 5. From Figure, it is clearly seen that, initially, during May 2004 to October 2004, average rate of land subsidence was almost nil; subsidence do not starts immediately after gas extraction. But during October 2004 to February 2005, average rate of subsidence was found maximum with maximum value of average rate of gas extraction. During February 2005 to May 2005, rate of subsidence was slightly decreased with decrease in value of rate of gas extraction. During

Table 4. 21 Average Rate of Gas Extraction and Average Rate of Subsidence/Upliftment

Campaigns	May 04-Oct 04	Oct 04-Feb 05	Feb 05-May 05	May 05-Jan 06	Jan 06-Mar 06
Av. Rate of Gas Extraction in cum per month for all Points	6060348	8296707	8086306	7805948	7797616
Av. Rate of height Change in mm per month	-0.3	-5.9	-4.4	-1.8	8.5

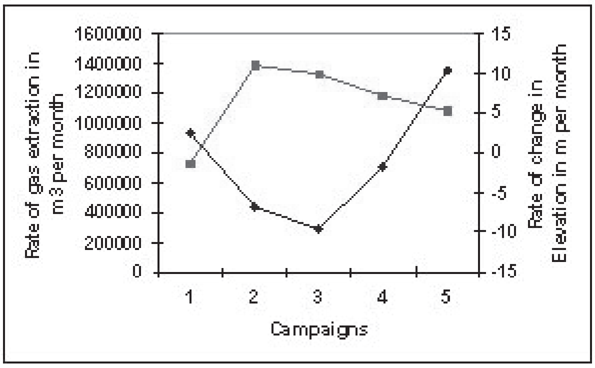

Fig : 5 Relation between Rate of Gas extraction & Rate of Subsidence

May 2005 to January 2006, average rate of subsidence decreased with decrease in average rate of gas extraction. During January 2006 to March 2006, ground showed upliftment with decrease in rate of gas extraction and during March 2006 to May 2006, rate of subsidence increased as gas of extraction decreases, hence we can concluded that there are very close correlations between these two parameters. It is also observed from temperature data, that there is no significant change in temperature during two years.

Change in Elevation and Change in Water Level

The abnormal reduction in ground water level besides seasonal level changes is responsible for land subsidence. Hence to study the change in water level, water level measurements have been taken over 30 points and four tube wells about 8 m deep are drilled around four sides of deformation stations within the reservoir boundary. In addition to this three dug wells of three villages on the reservoir boundary have been selected to study change in water level. From the water level data, it has been observed that change in water level is seasonal and no permanent depletion is observed in water level. from GPS derived height, it has been also observed that, during pre monsoon period all points are showing subsidence compared to previous campaign, while in post monsoon period, all points are showing upliftment compared to previous campaign. Hence the change in elevation and water level is seasonal. In general, the study area is waterlogged, and no permanent water depletion is found over the study area. The use of ground water is very less over this area. Canal water is being used to irrigate the field as well as for other purposes. Rate of ground water extraction is very less in this area. Hence, there is very less chance to have subsidence due to ground water extraction. The subsidence measured by GPS or any geodetic techniques represents a total subsidence associated with hydrocarbon production and other contributors like natural causes: water table changes, tectonic activities; and man made causes: changing infrastructure, ground water withdrawal, mining, landfill etc. Therefore in future land subsidence due to hydrocarbon will be separated out from total subsidence.

Conclusions

GPS has overcome the limitations of conventional levelling, hence is widely used for precise geodetic work. In India GPS is being used for crustal deformation studies, but till date land subsidence monitoring has not been done with GPS over the shallow gas reservoir. Probably, this is the first attempt in India to measure land subsidence with GPS. The accuracy of GPS derived vertical components is adequate to detect and monitor subsidence rates that are usually measured in the magnitude range of centimeters per year.

From GPS derived elevations, it is concluded that deformation stations within the reservoir boundary are showing significant vertical deformations compared to the stations outside the reservoir boundary. Average subsidence over the study area is found to be 49 mm while subsidence within reservoir boundary is found to be 81 mm during two years. Two subsidence bowls were observed, a big subsidence bowl was observed in the area, where more numbers of gas extracting wells are situated.

Correlation coefficient between cumulative gas extraction and cumulative changes in elevations is found to be very high and linear relationship is estimated. Hence, land subsidence found with GPS method might be due to extraction of gas. From the consistent monitoring of deformation stations over nine campaigns, it has been observed that, in general land is showing downward movement before monsoon and showing upward movement after monsoon. This can be attributed to seasonal change in water level. No permanent depletion in water level has been observed over the study area. So observed subsidence can not be attributed to ground water extraction.

To study and monitor subsidence and to find the rate of subsidence, extensive monitoring for longer duration is required. These are the preliminary results of the studies; hence the rate of subsidence in this area has not been established. In future, rigorous monitoring will be done to find the rate of subsidence and other geodetic techniques like levelling and InSAR techniques will be implemented to validate GPS derived results.

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Mining and Clustering Images to Improve Image Search Engines for Geo-Informatics Database

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Abstract

Images can be reordered with the use of k-means and LGB clustering method to present the image in groups in more presentable manner for the user. We believe that the integration of this method with search engine will improve the performance of searching module of the search engine.

Keywords*: Image Mining, Geo-Informatics, Image Searching, Clustering.*

Introduction

Image mining from Geospatial Database is very important as images are the major part of the database. Determining the likely image that constitute the correct description of the picture is considered to be a challenging problem by the computer vision, text mining, and the multimedia data mining communities. Knowledge derived from these two domains i.e., image and text data together is more descriptive compared to when each domain is considered in isolation from one another. Data mining, which is defined as the process of extracting previously unknown knowledge, and detecting interesting patterns from a massive set of data, has been a very active research area. Multimedia data mining methods includes Statistics, Machine Learning, Decision Trees, Hidden Markov Models, Artificial Neural Networks, Genetic Algorithms and Meta Learning., etc which were developed for mining information from structured data such as relational, transactional and data warehouse data. However, in reality not all data types are very structured and a substantial amount of information is available as semi-structured or unstructured multimedia data. Images forms major role in Geo-Informatics databases. Similarity search method searches for the similarity among the images in database whereas multidimensional analysis method mines the images from the large databases based on the data cubes. Images can also be mined based on decision tree using Classification and prediction method. Association Rules are also developed for mining image. Image mining is mainly done based on clustering of images. Searching image using the search engines has two typical outputs i.e. group of image that meets requirement and other group of images which do not meet requirement. Most of the search engines works based on the text retrieval method.

The paper is organized as below:

The first section introduces the topic, the second section deals with the literature survey that is restrictive due to the space problem and third section deals with the method used to reorder the images with the use of k-means and LGB clustering method.

Literature Survey

Most of the activities on mining image data and retrieval of images are based on the analysis of a query image or its feature(s) with the entries in the image database. The image retrieval systems can be broadly categorized into two categories based on the type of searches, using either description of an image or its visual content. In the first category, the images are described based on user-defined text. The images are indexed and retrieved based on these rudimentary descriptions, such as their size, type, date and time of capture, identity of owner, keywords, or some text description of the image. As a result, this is often called description based or text based image retrieval process. Second category is based on the image retrieval system. There are several methods and algorithms for the Content Based Image Retrieval. Clustering is used widely to mine image and search the image from the database. Clustering is the unsupervised classification of patterns into groups (clusters). The clustering problem has been addressed in many contexts and has shown to be useful in many applications. However, clustering of an image is a difficult problem, which is sorted out with the help of the proposed algorithm.

Method Used

The following algorithm is useful to reorder images with the use of k-means and LGB clustering method to present the image in groups in more presentable manner for the user.

To cluster images into groups of visually similar images, use of feature histograms is proposed to represent the images with two well known clustering methods: k-means and LBG clustering. The k-means is a simple algorithm and uses a squared error criterion. It starts with a random initial partition and keeps reassigning the patterns to cluster centers based on the similarity between the pattern and the cluster centers until a convergence criterion is fulfilled. A problem with this algorithm is that it is sensitive to the selection of the initial partition and that it might converge to a local minimum. Also the user has to specify the number of clusters. The result can be interpreted as a mixture of Gaussians (normal distributions). The LBG clustering algorithm is an expansion of the k-means algorithm to overcome the problem of choosing an initial partition [7, 9]. This is important here, because when searching for images, the user is not able to foresee how many clusters are needed. Initially the algorithm sees the data as one large Gaussian which is iteratively split and re-estimated to yield a mixture of Gaussians [7]. Use of features invariant is also proposed against translation and rotation to retrieve images from a general image database to describe the content of the images[7,9,10].

A feature F(X) is constructed from an image X by integration over a transformation group G:

$$F(X) := \frac{1}{|G|} \int_{g \in G} f(gX) dg$$

Where gX is the image transformed by the transformation $g \in G$ and F(X) is an arbitrary function depending on the pixel values of X. Applied to the group of translations and rotations G_{rt} this results in

$$F(X) = \frac{1}{2\pi N_0 N_1} \int_{t_0=0}^{N_0} \int_{t_1=0}^{N_1} \int_{\phi=0}^{2\pi} f\left(g_{t_0,t_1,\varphi} X\right) d\phi \, dt_1 \, dt_0$$

And choosing for example *f(*X*(i,j)*) = X(1,0) . X(0,2) this results in

$$F(X) = \frac{1}{2\pi N_0 N_1} \int_{t_0=0}^{N_0} \int_{t_1=0}^{N_1} \int_{\phi=0}^{2\pi} X(\sin\phi + t_0, \cos\phi + t_1) \cdot X(2\cos\phi + t_0, -2\sin\phi + t_1) d\phi \, dt_1 \, dt_0.$$

Usually the integrals are replaced by sums to achieve discrimination. The feature F(X) is invariant against rotation and translation, but only results in one value per image. This is not discriminative enough, that is this one value does not contain enough information to distinguish between different images. This problem can be avoided by replacing one (or more) of the sums by histogramization. Here replace the sums accounting for translations by histogramization. This yields the histogram

$$H_F(X) = \operatorname*{hist}_{t_0=1}^{N_0} \operatorname*{hist}_{t_1=1}^{N_1} \frac{1}{R} \sum_{r=1}^{R} f\left(g_{t_0,t_1,\frac{2\pi r}{R}} X\right)$$

Here histogramization is denoted by the operator hist and rotation is carried out in R steps. A histogram is an estimation of the distribution of a variable. For this the feature space S is divided into M regions S^m. Usually these region form a regularly spaced grid, e.g. the regions S^m are hypercubes of the same size, but this is not a requirement. Formally:

$$\mathcal{S}^m \subset \mathcal{S} \quad \text{with} \quad \bigcup_{m=1}^{M} \mathcal{S}^m = \mathcal{S}$$
$$\text{and} \quad \mathcal{S}^m \cap \mathcal{S}^{m'} = \emptyset \quad \forall m \neq m'$$

The probability for data points falling into one of these regions is determined by counting. Let K^m be the number of data points falling into region S^m, then the probability for any data point falling into this region is given by

$$P(m) = P(x \in \mathcal{S}^m) = \frac{K^m}{N}.$$

Because this features account mainly for color and in computer vision texture is very important we also use texture features. We calculate coarseness, contrast and directionality for every pixel and create a histogram of these values. This histogram is then combined with the invariant feature histogram. These features will not directly model objects but instead the global appearance of the images is modeled [1, 5, 10].

Conclusion

The algorithm studied can improve the image search engine. This can be used to mine multimedia databases. It will further be useful to search the geo-informatics database. This can be further improved considering other image feature extractions like shape, topology, etc. Thus we believe that integrating this method with the searching module of the search engine, the performance of the search engine can be improved to search the images database.

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Water Quality Analysis of Water Bodies in Mumbai and Thane District using Remote Sensing and GIS Techniques

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Abstract

The experimental study was conducted for surface water quality analysis which includes water bodies such as Thane Creek, Vasai Creek, Pawai Lake, Vihar Lake in Mumbai & Thane district of Maharashtra, India using Remote Sensing and GIS techniques.

The study area is around 246517 hectares and located between 72^0 38' to 73^0 East Longitudes and 18^0 to 19^0 32' North Latitudes. It falls on Survey of India Toposheet No. 47a. This study was carried out on LISS-III data of November 2002 and November 2004.

The study includes the present water quality and an attempt was also made to detect the change from past. It also includes which are the factors to be considered while studying of seawater and fresh water such as effect of salinity & tides while doing seawater analysis and effect of sedimentation & vegetation in lake water bodies. Though the water absorbs the electromagnetic energy, each band (visible and NIR) has its own significance in water quality analysis.

It was also concluded that Remote Sensing Techniques are also cost effective to detect the changes in and around water bodies over a large area due to natural and human activities.

Keywords: *Water quality – seawater and fresh water - suspended sediments – tidal effect- salinity-vegetation - remote sensing - LISS-III data.*

Introduction

The conventional measurement of water quality requires in situ sampling and expensive and time-consuming laboratory work. Due to these limitations, the sampling effort often does not represent the condition of an entire water body. Therefore, the difficulty of overall and successive water quality sampling becomes a barrier to water quality monitoring.

Remote sensing techniques for monitoring coast and inland waters have been under development since the early 1980's. Remote sensing could overcome these constraints by providing an alternative means of water quality monitoring over a greater range of temporal and spatial scales (Shafique et al.2001). Remote sensing is the science of measuring the properties of objects by measuring the amount of radiation they absorb, emit, or reflect at various wavelengths along the electromagnetic spectrum. Optical water quality research has a broad scope for developing environmental indicators that are useful in assessing, quantifying and monitoring water quality (Shafique et al.2002). Measurable parameters for optical water quality include turbidity, concentrations of algal chlorophyll, suspended sediments, and dissolved organic matter. More fundamentally, the absorption and scattering of light by components of a water column provide basic information from which relationship with other water quality indicators (such as water clarity from Secchi disk readings) can be derived (Jupp et al. 1994a, Dekker 1997).

Objective

The Objectives of the present study are:

1. To analyze the water quality with help of Remotely Sensed data.
2. To understand the effect of High tide and Low tide while analyzing water quality with Remotely Sensed data
3. To compare & equate this data with the data collected from other traditional sources to prove its compatibility.

Satellite Data Used
IRS-1D of Nov 2002.
IRS-P6 of 27th Nov2004 at 17:54

Satellite	**IRS-1D**	**IRS-P6**
Spectral Bands (in µm)	LISS-III Green (B2) 0.52-0.59 Red (B3) 0.62-0.68 NIR (B4) 0.77-0.86	LISS-III Green (B2) 0.52-0.59 Red (B3) 0.62-0.68 NIR (B4) 0.77-0.86 MIR (B5) 1.55-1.70
Spatial resolution	21.2 to 23.5 m (Visible and near IR region)	23.5 m
Swath width (Repeat/ Revisit cycle)	141 km 25 days	141 km 24 days
Quantization	7 bits	7 bits SWIR band has 10 bit quantization, selected 7 bits out of 10 bits will be transmitted by the data handling system

Relationship between Suspended Sediments & Reflectance

The electromagnetic (EM) energy incident on water body is partly absorbed, partly reflected and partly scattered. Any primary signal from water body is due to the total reflectance and back scattered energy caused by the impurities in the water; these signals are used for water quality analysis. Further, the measured signal is dependent on the wavelength used, the size and shape of the particles present, and their reflectance, absorption and refraction properties. A decrease in particle size results in an increase I reflective area. Hence reflectance of water bodies can be studied to assess the dispersal pattern of suspended sediments in it. It has been demonstrated that turbid water is more reflective than clear water both in visible and near-infrared regions of the EM spectrum (Moore, 1978).

Ground Truth

Ground truth or Ground verification form an important and integral part of the interpretation methodology of Remotely Sense data. Ground truth is attributed to verification and measurement of the information about surface features on the earth.

Data Processing & Analysis

Digital satellite data were processed by using Erdas Imagine 8.6 system. Data processing was carried out to correct for geometric distortion, to calibrate the data radiometrically and to eliminate noise. Digital data was registered using SOI topomaps (47a) as a reference. After the georeferencing classification of image was carried out by Unsupervised Classification.

Figure 1 and 2 are the post-monsoon images of the study area. Image shown in Figure 1 was acquired during low tide time in November 2002 and the image in Figure 2 was acquired during high tide time in November 2004.

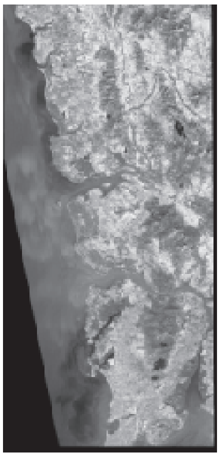

Fig.- 1 IRS-1D LISS III data year Nov 2002

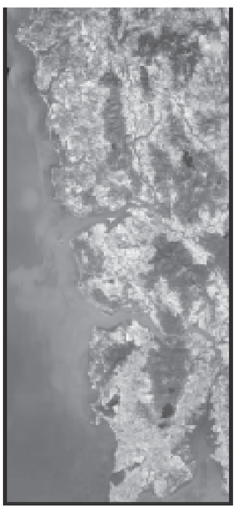

Fig.- 2 IRS-P6 LISS III data year Nov 2004

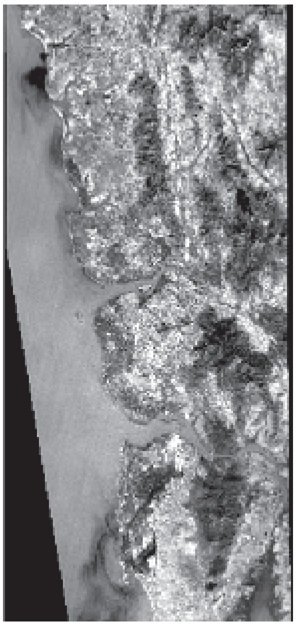

Fig.- 3 IRS-P6 Green Band (0.52µm-0.59µm)

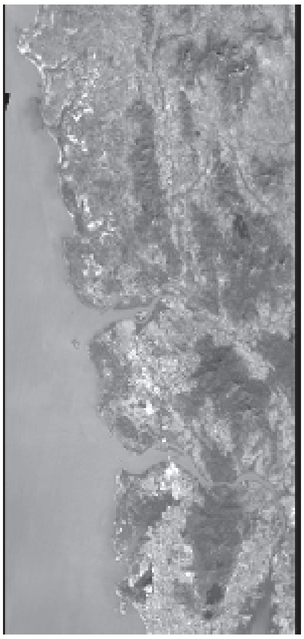

Fig.- 4 IRS-1D Green Band (0.52µm-0.59µm)

In general, most of the sunlight that enters a clear water body is absorbed within about 2m of the surface. The degree of absorption is highly dependent on wavelength. Near-infrared wavelengths are absorbed in only a few tenths of a meter of water, resulting in very dark image tones of even shallow water bodies on near-infrared images. Absorption in the visible portion of the spectrum varies quite dramatically with the characteristics of the water body under study. The best light penetration is achieved between the wavelengths of 0.48µm and 0.60µm.

Analysis of IRS -1D data of Nov 2002 indicates water pollution. Black areas are seen near the Manori creek, Meethi creek and near Uchallpada at Tarapur point which indicates poor water quality. Sky blue areas indicate sedimentation / turbidity in water near Vaitarana river and Vasai Creek occurring due to dredging activity.

Although these images are covering the same area in same time period, the difference in the images is clearly visible. It does not mean that the water quality has improved from 2002 to 2004. The effect of polluted water can be captured by satellites only during low tide time. It's very important to know the tidal condition at the time of analyzing satellite image. From image it's clearly visible that the sea water body pollution as well as the effect of dredging activities.

Conclusions

Mapping or monitoring water quality is considerably complex because the signal from water body is composed of many components. The Primary signal that is indicative of water quality is the volume reflectance or backscattered energy caused by the materials added to water. As suspended material is added to the volume of pure water, the only reflectance and depends on the type and amount of material added. Each type of material such as red soil, blue algae, Industrial effluents, Domestic sewage, and storm water reflect differently at different wavelengths. For a particular size and shape of particle, the back scattered energy increases with the concentration that can be related to the remotely sensed signal strength.

Periodic geospatial data capture and analysis offers as effective tool for monitoring and mapping of sea water quality near Mumbai and Thane costal area. It will also help in identifying the most water polluting locations as well as the effect of pollutants in sea water in short the assimilating capacity of water body.

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