International Journal of Science and Engineering Applications (IJSEA)
Volume 2 Issue 1, 2013, ISSN - 2319-7560 (online)

Medium optimization for production of L-Glutaminase (EC 3.5.1.2) by *Streptomyces griseus* under submerged fermentation

Suresh kumar.S
Department of Chemical Engg,
Annamalai University,
Annamalai nagar, India.

R. Muthuvelayudham
Department of Chemical Engg,
Annamalai University,
Annamalai nagar, India.

T. Viruthagiri
Department of Chemical Engg,
Annamalai University,
Annamalai nagar, India.

Abstract: L-Glutaminase is widely distributed in microorganisms including bacteria, yeast and fungi. The enzyme mainly catalyzes the hydrolysis of γ-amido bond of l-glutamine. In this report medium optimization was conducted through one -factor -at -a -time approach for the submerged production of L-Glutaminase by *Streptomyces griseus* using different additional carbon, nitrogen, amino acids, mineral salts and was treated with different concentration sodium chloride. A significant influence of medium components (g/l) Galactose 10.0,Yeast extract 10.0,L-Glutamine 10.0,Magnesium sulphate 0.5, KH_2PO_4 0.5 , K_2HPO_4 0.5, NaCl 40 on L-Glutaminase production was noted. The applied methodology was validated using this optimized media, the enzyme activity 45 IU/ml in 48h of incubation was obtained.

Keywords*:* L-Glutaminase; Production; Optimization; One factor at a time; Streptomyces griseus

1. INTRODUCTION

Microbial L-Glutaminases or Glutaminases (L-glutamine amido hydrolase EC 3.5.1.2) have found applications in several fields. L-Glutaminase activity is widely distributed in plants, animal tissues and microorganisms including bacteria, yeast and fungi. L-Glutaminase has an essential role in cellular nitrogen metabolism (1, 2, 11, 15). This enzyme gained importance in industrial and pharmaceutical sectors as an effective therapeutic agent in the treatment of HIV (16, 27) and acute lymphocytic leukaemia (22). The enzyme causes selective death of glutamine-dependent tumor cells by depriving these cells of glutamine. The use of enzymes to deprive neoplasms of essential nutrients helps in the treatment of malignancies (22) and as an analytical agent in determination of glutamine and glutamate (8, 24), as a biosensing agent in biosensor (19). L-Glutaminase enhances the flavor of fermented foods by increasing their glutamic acid content and thereby imparting a palatable taste. (6, 9) The use of L-Glutaminase as a flavour enhancing agent in Chinese foods has replaced the use of monosodium glutamate, which is considered allergic to some individuals (20). and in the production of specialty chemicals like threonine by gamma glutamyl transfer reactions (23). Its commercial importance demands the search for new and better yielding microbial strains and economically viable bioprocesses for its large-scale production (10).

Hence, Researchers are involved in the screening of microbial strains and developing different fermentation strategies to improved productivity. Bioprocess is one of the key processes which helps in enhancing the metabolite productivity under a given set of fermentation environment (12, 13). Improvement in microbial metabolite production is generally attempted by manipulating the nutritional and incubational parameters of the organism. Combinatorial interactions of medium components with the cell metabolism towards the production of the desired compound are plentiful, and the optimum processes may be developed using an effective experimental design procedure.

To our knowledge reports on the production of L-Glutaminase from *Streptomyces griseus* is scanty. It's an aerobic gram positive filamentous bacteria .In the present investigation, one-factor-at-a-time approach was used to select the best combination of carbon, nitrogen, amino acids, sodium chloride and minerals salts sources and validated the impact of mixed sources on production by *Streptomyces griseus* under submerged fermentation.

2. MATERIALS AND METHODS

2.1 Medium Components

Nutrient broth, L-glutamine, Nessler's reagent and other media components and chemicals were procured from Hi-Media Limited, Mumbai, India. For optical density

measurements, the absorbance was read using UV/Vis Bio Spectrophotometer (EliCo Pvt. Ltd., India).

2.2 Microorganism and Culture maintenance

Streptomyces griseus NCIM 2622 procured from NCIM, National Chemical Laboratory, India, was used in the study. The culture was maintained on Nutrient agar medium slants. Inoculated slants were grown in an incubator at 33 ^{o}C for 4 days. After that the slants were stored at 4 ^{o}C in a refrigerator for short-term preservation and sub-cultured every 15 days in the above-mentioned media.

2.3 Inoculum preparation

Inoculum was prepared in 250 ml Erlenmeyer flasks containing 100 ml of Nutrient broth liquid medium (pH 7.0). Prepared medium was autoclaved at 121 ^{o}C (15 lb) for 20 min and then inoculated with *Streptomyces griseus* raised from Nutrient agar slants. The inoculated flasks were kept on a shaker at 150 rpm for 48h, and used as the inoculum.

2.4 Identification of medium components

Initially optimization of media components required for maximum L-Glutaminase production by *Streptomyces griseus* was evaluated in 100ml of 250 ml Erlenmeyer flasks at 33 ^{o}C for 48 hr at 150 rpm by adding 0.002% of inoculum. The L-Glutaminase production on nutrient broth was used as a control .Subsequently the medium component studied included the effect of different additional carbon sources (Malt extract, D-glucose, Sucrose, Starch soluble, Tri sodium citrate, Cellobiose Cellulose, D-mannitol, Lactose, Galactose, D-fructose, Maltose) at10 g/l, effect of additional nitrogen sources (Peptone, Sodium sulphite, Yeast extract , Urea, Tryptone, Gelatin, Sodium nitrate) at 10 g/l, effect of additional amino acids (L–glutamic acid, Glycine, L –ascorbic acid, L –glutamine, Cysteine, Alanine) at 10 g/l,effect of additional minerals(Zinc sulphate, Mercuric sulphate, Manganous sulphate, Copper sulphate, Ferrous sulphate, Magnesium sulphate , Potassium di hydrogen phosphate, Di potassium hydrogen phosphate, Calcium chloride) at 0.5g/l . After identifying the nutrients improving L-Glutaminase production by 'one factor-at-a-time' approach, the four most important nutrients, viz. Galactose, yeast extract, glutamine and Magnesium sulphate were selected as a medium components and finally the effect of sodium chloride concentration (10–50g/l) on above said medium was studied. All the fermentation experiments were carried out in triplicate. The optimum media was identified as (g/l) Galactose10.0, yeast extract 10.0, glutamine 10.0, Magnesium sulphate 0.5, Potassium di hydrogen phosphate 0.5, Di Potassium hydrogen phosphate 0.5 and Sodium chloride 40.0, on L-Glutaminase production was observed at 48 h.

2.5 Analytical determinations

At appropriate time intervals the fermentation broths were harvested for the L-Glutaminase enzyme. The broth was centrifuged at 10000 rpm for 20 min at 4 ^{o}C in a refrigerated centrifuge and the supernatant obtained was used for further enzyme assay procedures.

2.6 Determination of Enzyme activity

L-Glutaminase was assayed according to Imada et al (7). The reaction mixture, containing 0.5ml of an enzyme preparation ,0.5 ml of L-glutamine(0.04 M), 0.5 ml of phosphate buffer 0.1 M (pH 8.0), and 0.5 ml of distilled water to a total volume of 2ml solution was incubated at 37°C for 30 min. The reaction was stopped by addition of 0.5 ml of 1.5 M Tri chloro acetic acid. Then to 3.7 ml of distilled water, 0.1 ml of the above mixture and 0.2 ml of Nessler's reagent were added and colour developed was read after keeping the mixture at 20°C for 20 min at 450 nm in a spectrophotometer .Enzyme and substrate blanks were used as controls. One unit of L-Glutaminase activity was defined as the amount of enzyme that liberated 1µmol of ammonia per1min under optimal assay conditions. Assays were done in triplicate and the mean enzyme activity was expressed as International unit per ml (IU/ml).

3. RESULTS AND DISCUSSION

3.1 Identification of medium components

L-Glutaminase production by a *Streptomyces griseus* under submerged fermentation condition was observed during the course of study and the observation led to an investigation of the potential of L-Glutaminase synthesis towards developing an ideal bioprocess for industrial production of this enzyme. Hence initially the various nutrients and process parameters, which influence L-Glutaminase production by *Streptomyces griseus* under submerged fermentation conditions, were optimized.

3.2 Effect of additional carbon sources

Carbon source represents the energy source that will be available for growth of the microorganism. Carbohydrates and related compounds are superior carbon sources for many genera of microbes (18). However, in some cases, addition of a small amount of external carbon may lead to an increase in

enzyme production. Fig.1 showed the effect of additional carbon source for yield of L-Glutaminase from *Streptomyces griseus* was variably changed, when the carbon source changed. In this work, we found yield of L-Glutaminase was high as 26.3 IU/ml by utilized the Galactose as the carbon source.

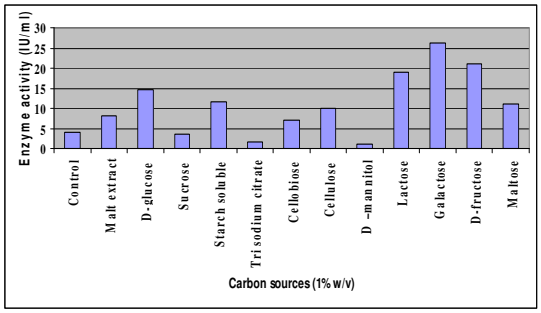

Figure 1: Yield of L-Glutaminase in different carbon source.

3.3 Effect of additional Nitrogen sources

Effect of different nitrogen sources (Fig.2) showed that the maximum yield was obtained as 17.5 IU/ml in presence of yeast extract, because the yeast extract serves as complex Nitrogen source for the metabolic activity. Universal ingredient yeast extract was normally added to media for routine growth and amino acid supplementation was not required in complex media containing yeast extract.

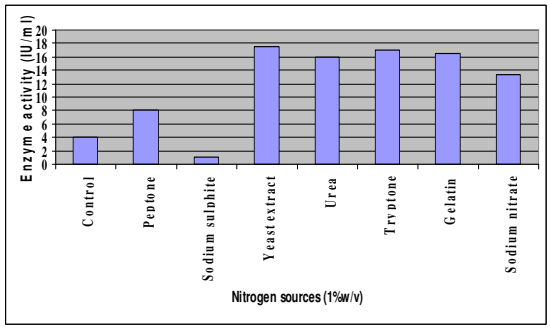

Figure 2: Yield of L-Glutaminase in different Nitrogen source.

3.4 Effect of additional amino acids sources

Amino acids were common growth factor required for the synthesis of enzyme as major nitrogen source (4); hence the yield of L-Glutaminase was varied, when the amino acid was changed. Even though each and every amino acid was interchanged by other amino acids, the L-Glutaminase yield was varied according to the nature of amino acids (Fig.3). Yield of L- Glutaminase from the *Streptomyces griseus* was high as 32.7 IU/ml in L-glutamine. Since L-glutamine is the substrate of L-Glutaminase, the addition to fermentation medium might stimulate enzyme production. It also serves as source of energy and carbon.

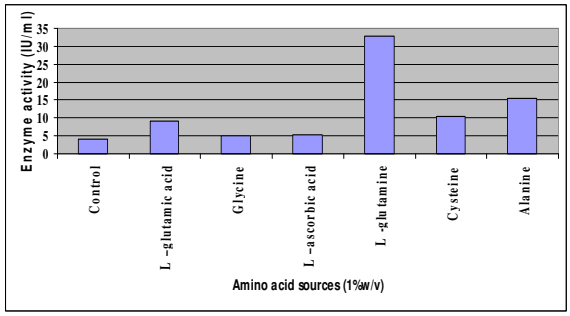

Figure 3: Yield of L-Glutaminase in different Amino acid sources.

3.5 Effect of additional mineral salt sources

All the living organisms need some inorganic nutrient for their growth, that do not usually contain the element carbon and when it dissolve in water they separate into ions.L-Glutaminase yield obtained from *Streptomyces griseus* in the presence of different mineral salts (Fig.4) showed that the maximum yield was 35 IU/ml in the presence of Magnesium sulphate, $KH_2PO_4$and K_2HPO_4 which is supported both enzyme production and the bacterial growth (5, 14, 21, 25, 26).

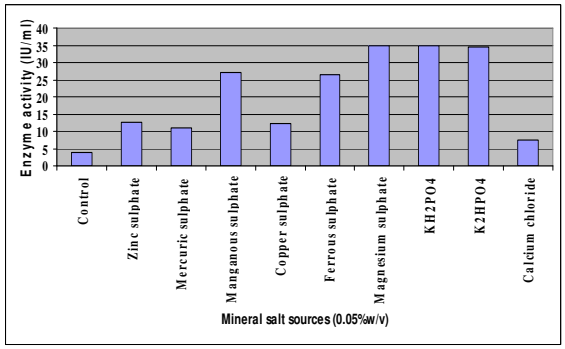

Figure 4: Yield of L-Glutaminase in different Mineral salt sources.

3.6 Effect of additional sodium chloride

Yield of L-Glutaminase was increased, when increased the NaCl concentration up to 4% as maximum as 45 IU/ml and it was low in 1%, 2%and 3% of NaCl concentrations (Fig.5). Yield was suddenly decreased, when the concentration was increased above the 4%.Hence, 4% of NaCl concentration was the optimum for the production of L-Glutaminase from *Streptomyces griseus*. The bacteria didn't

produce more L-Glutaminase without the NaCl because the *Streptomyces griseus* were halophilic, the bacteria were unable or try to grow in the low NaCl concentration, hence there was very low L-Glutaminase production and also the high concentration of NaCl was also affect the growth of bacteria.

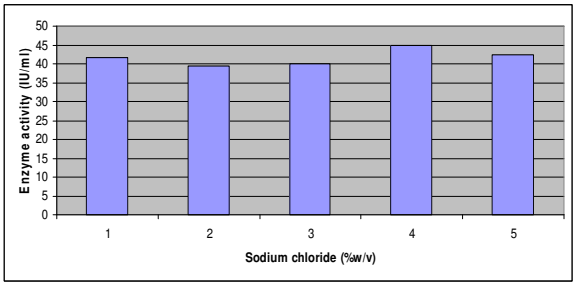

Figure 5: Yield of L-Glutaminase in different concentration of Sodium chloride.

Optimum levels of these significant sources and the effect of their interactions on L-Glutaminase productions were determined by the one –factor- at -a time. The optimized medium components (g/l) Galactose 10.0, Yeast extract10.0, L-Glutamine10.0, Magnesium sulphate 0.5, KH_2PO_4 0.5, K_2HPO_4 0.5, NaCl 40.0 on L-Glutaminase production was noted, which gave the maximum enzyme yield of 45 IU/ml.

4. CONCLUSION

In this work medium components for higher L-Glutaminase production from *Streptomyces griseus* were optimized by one- factor- at -a time approach. Using one factor at a time approach (g/l)Galactose 10.0,Yeast extract 10.0,L-Glutamine 10.0,Magnesium sulphate 0.5, KH_2PO_4 0.5 , K_2HPO_4 0.5 NaCl 40.0 were found to be the most significant variables, which significantly enhanced L-Glutaminase production. Using these optimized conditions, the produced enzyme activity of L-Glutaminase reaches 45 IU/ml.

5. ACKNOWLEDGMENT

The authors gratefully acknowledge UGC, New Delhi, India for providing financial support to carry out this research work under UGC –Non SAP fellowship scheme. The authors also wish to express their gratitude for the support extended by the authorities of Annamalai University, Annamalainagar, India, in carrying out the research work in Bioprocess Laboratory, Department of Chemical Engineering.

6. REFERENCES

[1] Brosnan, J.T., Ewart, H.S. and Squires, S.A. (1995) Hormonal control of hepatic glutaminase. Adv Enzyme Regul 35,131–146.

[2] Carter, P. and Welbourne, T.G. (1997) Glutamate transport regulation of renal glutaminase flux in vivo. J Physiol 273,521–527.

[3] Cavalitto, S.F., Mignone, C.F., 2007. Application of factorial and Doehlert designs for optimization of protopectinase production by a Geotrichum klebahnii strain. Proc. Biochem. 42, 175–179.

[4] Cruz Soto, R., Muhammed, S. A., Newbold, C. J., Stewart, C. S., and Wallace,R. J., 1994, Influence of peptides, amino acids and urea on microbial activity in sheep receiving grass hay and on the growth of rumen bacteria *in vitro*, Animal Feed Sci. Tech., 49, pp. 151-161.

[5] Clyde Eyster, 1959, Growth inhibition of *Chlorella pyrenoidosa* produced by sodium dihydrogen phosphate and its reversal by calcium, Plant and Soil,11(3), pp. 207-214.

[6] Chou, C.C. and Hwan, C.H. (1994) Effect of ethanol on the hydrolysis of protein and lipid during the ageing of a Chinese fermented soya bean curd-sufu. J Sci Food Agric66, 393–398.

[7] Imada A, Igarasi S, Nakahama K, Isono M. Asparaginase and Glutaminase activities of microrganisms. J Gen Microbiol 1973;76:85–99.

[8] Mulchandani, A. and Bassi, A.S. (1996) Determination of glutamine and glutamic acid in mammalian cell cultures using tetrathiafulvalene modified enzyme electrodes. Biosensor Bioelectron 11, 271–280.

[9] Nakadai, T. and Nasuno, S. (1989) Use of glutaminase for soy sauce made by Koji or a preparation of proteases from Aspergillus oryzae. J Ferment Bioeng 67, 158–162.

[10] Nagendra Prabhu, G., & Chandrasekaran, M. (1997). Impact of process parameters on L-glutaminase production by marine *Vibrio costicola* in solid state fermentation using polystyrene as an inert support Process Biochemistry, 32, 285–289.

[11] Padma ,I and Singhal, R.S. (2007) Production of glutaminase(E.C.3.5.1.2) from Zygosaccharomyces rouxii: statisticaloptimization using response surface methodology. Bioresource Technology 99, 4300–4307.

[12] Prakasham, R.S., Rao, Ch.S., Rao, R.S., Lakshmi, G.S. and Sarma, P.N. (2007a) L-asparaginase production by isolated Staphylococcus sp. – 6A: design of experiment considering interaction effect for process parameter optimization.J Appl Microbiol 102, 1382–1391.

[13] Park, Y., Kang, S., Lee, J., Hong, I., Kim, W., 2002. Xylanase production in solid state fermentation by Aspergillus niger mutant using statistical experimental designs. Appl. Microbiol. Biotechnol. 58, 761–766.

[14] Pandey, D. K., and Gupta, S. C., 1966, Studies in pectic enzymes of parasitic fungi-VI. Factors affecting the secretion of pectic enzymes by *Alternaria tenuis*, Biologia Plantarum, 8(2), pp. 131-141.

[15] Riberg, B., Torgner, I.A. and Kvamme, E. (1995) The orientationof phosphate activated glutaminase in the inner mitochondrial membrane of synaptic and non-synaptic rat brain mitochondria. Neurochem Int 27, 367–376.

[16] Roberts, J., MacAllister, T.W., Sethuraman, N. and Freeman,A.G. (2001) Genetically engineered glutaminase and its use in antiviral and anticancer therapy. US Patent, 6312939.

[17] Rathi, P., Saxena, R., Gupta, R., 2001. A novel alkaline lipase from Burkholderia cepacia for detergent formulation. Proc. Biochem. 37,187–192.

[18] Rosalie J. Cote, 1999, Media composition, microbial and Laboratory scale,In: Encyclopedia of bioprocess technology: Fermentation, biocatalysis and bioseparation, Michael and Stephen, eds., John Wiley & Sons Inc., New York,Volume 1-5: 1640-1660

[19] Sabu, A., Keerthi, T.R., Kumar, S.R. and Chandrasekaran, M.(2000b) L-Glutaminase production by marine Beauveria sp. under solid state fermentation. Process Biochem 35,705–710.

[20] Sabu, A., Chandrasekaran, M., Pandey, A., 2000. Biopotential of microbial glutaminases. Chem. Today 18, 21–25.

[21] Salwa Khalaf and Ashraf El-Sayed, 2009, Methioninase production by filamentous fungi: I-screening and optimization under submerged conditions, Curr. Microbiol., 58(3), pp. 219-226. DOI: 10.1007/s00284-008-9311-9.

[22] Schmid, F.A. and Roberts, J. (1974) Antineoplastic and toxic effects of Acinetobacter and Pseudomonas glutaminase-asparaginases. Cancer Chemother Rep 58, 829–840.

[23] Tachiki, T., Yamada, T., Mizuno, K., Ueda, M., Shiode, J. and Fukami, H. (1998) γ -Glutamyl transfer reactions by glutaminase from Pseudomonas nitroreducens IFO 12694 and their application for the syntheses of theanine and γ -glutamylmethylamide. Biosci Biotechnol Biochem 62,1279–1283.

[24] Villarta, R.L, Palleschi, G., Suleiman, A. and Guilbault, G.G.(1992) Determination of glutamine in serum using an amperometric enzyme electrode. Electroanalysis 4, 27–31.

[25] Yugandhar, N. M., Ravi Kumar, D.V. R., Prasanthi, V., Kiran Kumar, N., and Sri Rami Reddy, D., 2008, Optimization of pectinase production from *Manihot utilissima* by *Aspergillus niger* NCIM 548 using statistical experimental design, Res. J. Microbiol., 3(1), pp. 9-16.

[26] Yousuke Taoka, Naoki Nagano, Yuji Okita, Hitoshi Izumida, Shinichi Sugimoto and Masahiro Hayashi, 2008, Effect of addition of Tween 80 and Potassium dihydrogen phosphate to basal medium on the isolation of marine eukaryotes, Thraustochytrids, J. Biosci. Bioeng., 105(5), pp. 562-565.

[27] Zhao, J., Lopez, A.L., Erichsen, D., Herek, S., Cotter, R.L., Curthoys, N.P. and Zheng, J. (2004) Mitochondrial glutaminase enhances extracellular glutamate production in HIV-1-infected macrophages: Linkage to HIV-1 associated dementia. J Neurochem 88, 169–180.

International Journal of Science and Engineering Applications (IJSEA)
Volume 2 Issue 1, 2013, ISSN - 2319-7560 (online)

DISPERSION COMPENSATION IN OPTICAL COMMUNICATION LINK USING APF'S

Sandeep Singh
Vidya College of Engineering, Meerut, U.P., India-250005

Vaibhav Bhushan Tyagi
Vidya College of Engineering, Meerut, U.P., India-250005

Anuj Bhardwaj
Hindustan Institute Of Technology & Management, Agra, U.P, India-282007

Neeraj Gupta
Anand Engineering College, Agra, U.P, India-282007

Abstract: All pass filters (APFs) are used in dispersion compensation which is the foremost requirement in an optical fiber link. All pass filters can correct any order of dispersion by the careful design of multistage all pass filters starting from very simple components with the use of N port devices. Multiple channels, as in wavelength division multiplexed (WDM) system, can be compensated with a single device since these filters are periodic in phase response. In this paper we have designed and implemented these filters to compensate dispersion an some results has shown.

Keywords: Optical communication, optical fibers, wavelength division multiplexed systems, dispersion compensation all pass filters.

1. INTRODUCTION

All Pass filters are used to compensate the chromatic dispersion in wavelength division multiplexed (WDM) optical fiber communication system [1]. Optical fiber communication is a way of transmitting the information from one place to another by modulating the light signal with the information signal. The light signal required for communication is generated using the spontaneous and stimulated emission occurring in light emitting diodes (LEDs) and LASERs [2]. Since the energy levels are not discrete so mono-chromaticity of the light signal is lost and it introduces chromatic dispersion. The number of compensating techniques has been reported in the literature [3], [4], [5], [6] including dispersion compensating fibers (DCFs), Fiber Bragg gratings (FBGs), Electronic Dispersion compensation (EDC) each having its own advantages and disadvantages. In WDM system where a number of frequencies are interleaved, dispersion is compensated using all pass filters [7]. All pass filters are linear systems having variable phase response and constant amplitude response. The variable phase response of the APFs makes them to be used as the phase equalizers to compensate the chromatic dispersion. The need of dispersion compensation, general properties of all pass filters, the design and implementation of all pass filters along with tunable dispersion compensation all pass filters have been discussed in this paper.

2. NEED

Due to the presence of chromatic dispersion the light pulse carrying the required information is spread into various components and each component travel differently along the optical fiber with different velocity and hence reach at the receiver at different times which distorts the information and can't be interpreted in the correct manner This is called group velocity dispersion (GVD) which cause the light pulses to spread in fibers, degrading signals over long distances [8-11]. In order to remove the spreading of the optical or light pulses, the dispersion compensation is the most key feature required in optical fiber communication system.

The traditional techniques like DCFs, FBGs, and EDC are not suitable for dispersion compensation in WDM system. DCFs give high insertion loss, large footprint, and non-linear distortions when the input signal is high etc. Also for the multiple channels in WDM system, the number of DCFs has to be installed making the system complex and costly. The same problem is with the FBGs which compensate the dispersion by the recompression of an optical signal. For different frequencies different architectures of the FBGs have to be introduced along the fiber link. EDC is rendered ineffective for WDM system since it is complex and also not a direct method of compensation as it involve the optical to electronic and electrical to optical conversions making the WDM communication slow which can't be tolerated in this growing world hence the need of all pass filters is realized by which the multiple channels can be compensated with a single device because of the periodic properties of the phase response of these filters [12-15].

3. ALL PASS FILTERS (APF)

The dispersion compensation using digital filters is a new technique for the removal of phase distortions of an optical signal. After the various channels have been multiplexed by the wavelength interleaver over the single fiber the next step is to compensate the phase distortions due to different group delays for different channels [1], [7]. Dispersion compensating fibers [2], [3] (with opposite chromatic dispersion as that of channels) are not used these days as

they introduce large footprint, high insertion loss, introduce nonlinear distortion etc, hence they have been replaced by all pass filter structure. It is a special filter with flat magnitude spectrum and non-linear phase spectrum, so it compensates phase distortion without affecting magnitude spectrum of signals [8], [9]. These all pass filters (APF's) are linear systems, which have an amplitude response that is constant over all frequencies and a phase response that varies with frequency. The period of frequency response of all pass filters is usually referred to as free spectral range (FSR). Mathematically, the frequency response of a filter is written as

$$H(\omega) = |H(\omega)| \exp[\, j\Phi(\omega)\,] \quad (1)$$

then for an APF $|H(\omega)| = c$ where c is a constant and $\Phi(\omega)$ can be made arbitrarily close to any desired phase response. With this characteristic the nth-order dispersion is evaluated as 1/ FSRn, further group delay can be enhanced by adding more number of stages [12]. However it increases loss in the system. Adding stages to the APF help in recovering group delay that is lost when the FSR is increased [12], [13].

The dispersion compensation obtained experimentally is

$$D \sim N/\ FSR^2\ \Delta^{\,2} \quad (2)$$

Where N is number of channels and Δ is distance of poles and zeros of the unit circle. The dispersion may be increased by reducing the FSR with the introduction of more number of stages or by reducing the Δ.

4. APF DESIGN AND IMPLEMENTATION

For the design of an APF, a four port device with frequency independent matrix elements can be considered. By connecting any one of the outputs through a delay to any one of the inputs a single stage APF can be realized [12]. APF may be implemented using Directional couplers, Mach-Zehnder interferometer, and thin film filter as shown below in Fig.1-4:

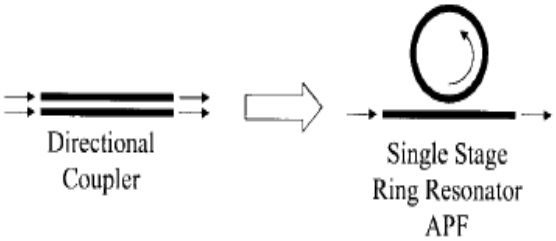

Fig 1. Single stage APF using directional coupler [12].

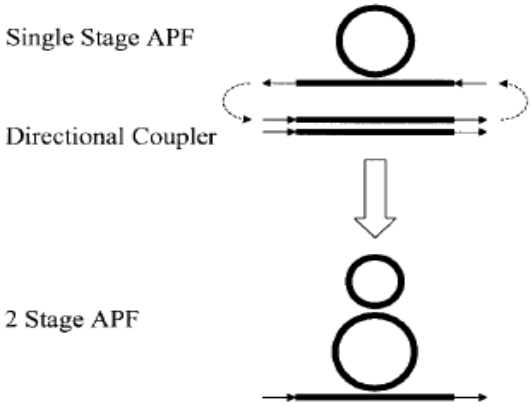

Fig 2. Two stage APF [12].

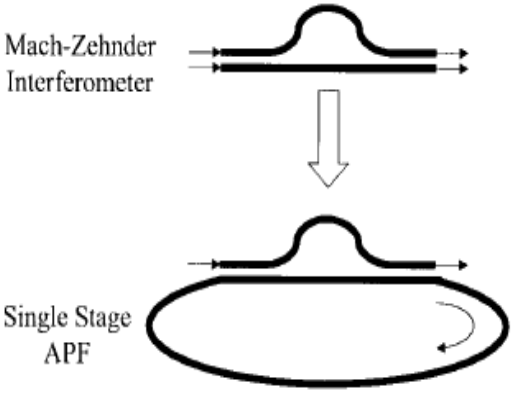

Fig 3.Single stage APF using Mach-Zehnder interferometer [12]

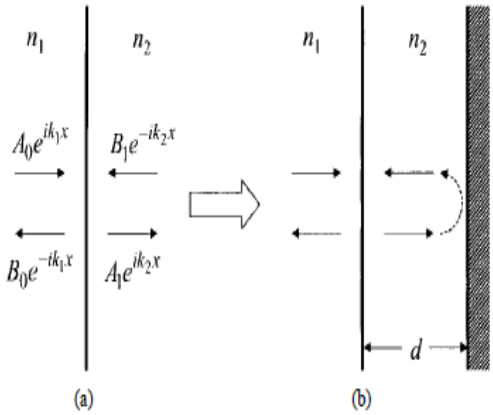

Fig 4. Thin-film example: (a) Interface between two dielectrics. The scattering matrix relates the "input" amplitudes A0 and B1 to the "output" amplitudes A1 and B0. (b) By connecting the "output" A1 to the "input" B1 through a delay (using a 100% reflector a distance d away), a single-stage APF is obtained. This is exactly the familiar Gires–Tournois interferometer [12].

5. TUNABLE DISPERSION COMPENSATION ALL PASS FILTERS

Chromatic dispersion compensation is critical for high bit rate light wave systems. Reconfigurable optical networks introduce a need for tunable dispersion compensation since different routes may have different cumulative dispersions [14]. In addition, tunable dispersion compensation is required for high bit rate nonlinear systems whose optimal dispersion depends on the channel power which may fluctuate over time. Different wavelengths have different cumulative dispersions at the receiver, and a device capable of applying varying amounts of dispersion compensation to each channel is needed. Because of the large number of channels in dense wavelength-division-multiplexed (WDM) systems, periodic filters are advantageous compared to single channel devices which require a unique filter for every WDM channel [14], [15]. Tunable dispersion compensation filters are of two types:

5.1 MEMS Compensation All Pass Filters

The tunable all-pass filter is based on the mechanical antireflection switch (MARS) device, which is a variable-thickness Fabry–Perot cavity consisting of a silicon substrate, an air gap, and a quarter-wave thick dielectric membrane. A silicon nitride layer is used for the membrane, and the gap is nominally 3λ o/4. The cavity formed by the membrane and top surface of the substrate yields a reflection of about 70%. The gap is varied from 3λ o/4 to λ o/4 by applying a voltage to electrodes on top of the membrane as shown in Fig.5.

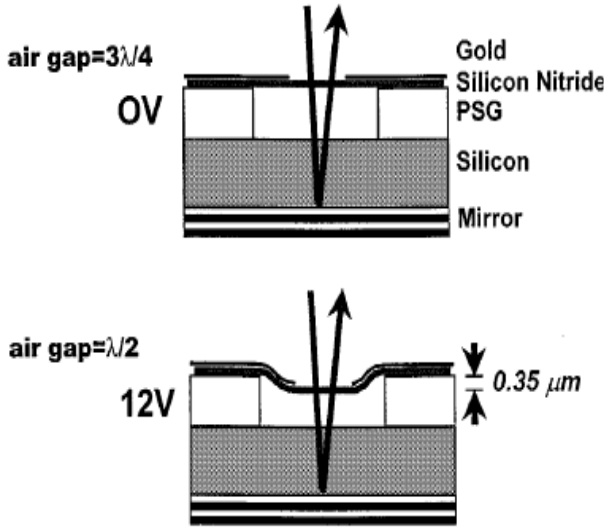

Fig 5. MEMS all-pass filter schematic showing the change in air gap with applied voltage [14].

The voltage creates an electrostatic force that pulls the membrane closer to the substrate surface, while the membrane tension provides a linear restoring force. At a gap of λ o/4, the reflection is reduced to ~ 0% since the silicon nitride acts as an antireflection coating for the silicon substrate. To make an all-pass filter, the aim is to use Fabry–Perot cavity as a tunable, partial reflector and add a high reflectance coating to the back side of the substrate [14]. A reflectivity > 97% is obtained using a multi-layer stack. The substrate thickness L determines the free spectral range FSR = c / 2ngL, where ng is the group index. For a 100-GHz FSR, the silicon thickness is 411 m. By selecting the filter period equal the channel spacing in a WDM system, multiple channels can be compensated. The filter dispersion is D = dτ /d λ (ps/nm). For a completely tunable all-pass filter, both the partial reflector and the cavity optical length must be tunable. By varying the applied voltage, the partial reflectance of the front mirror is changed. For tuning Φ n, the substrate is mounted on a thermo-electric cooler, and the cavity optical thickness is tuned via the thermooptic effect. Tuning of the cavity length can also be used to compensate for variations in the fabricated cavity length from the design nominal [14].

5.2 Integrated All Pass Filters for Tunable Dispersion Compensation

Two parameters control its group delay response, the phase Φand power coupling ratio kr. By using a multistage filter where the parameters are chosen optimally for each stage, a constant dispersion (or any desired response) can be approximated over a large portion of the FSR, thus yielding a large bandwidth utilization factor [15]. It is critical to achieve the design values for these parameters, and fabrication-induced variations on the coupling ratios must be minimized. The new all-pass filter architectures are shown in Fig.6 (a), (b) and (c).

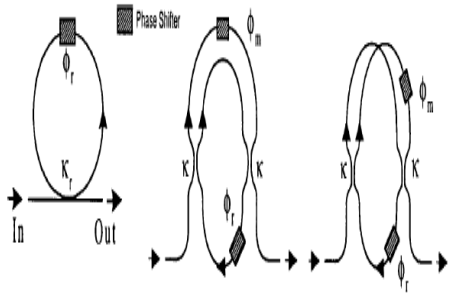

Fig 6. (a) Ring resonator all-pass filter with a fixed coupling ratio, and fully tunable ring
resonator all-pass filters with (b) an asymmetric MZI and (c) a symmetric MZI [15].

The single coupler is replaced with a Mach–Zehnder interferometer (MZI). The MZI is curved to minimize any increase in the feedback path length. The advantage is that a phase shifter can be used to tune the effective coupling ke into the feedback path, thus a completely tunable all-pass filter is easily realized with two phase shifters, one to set ke and one to tune the resonant wavelength. The tolerances on the couplers k composing the MZI are substantially relaxed compared to the tolerance on kr. In Fig. (b), the MZI path lengths are different by a length Δ L = π dsep where dsep is the separation of the MZI arms. The effective coupling is given by ke which can be set to zero at a given wavelength by choosing Φm appropriately [15].

$$k_e = 4k(1 - k) \cos^2 ([2\pi n_g \Delta L/\lambda + \Phi_m] /2) \quad (3)$$

In Fig. (c),

$$k_e = 1 - 4 k(1 - k) \cos^2 (\Phi_m /2) \quad (4)$$

Hence ke= 1 can be achieved by the proper choice of Φm .

6. CONCLUSION

There are number of techniques to compensate the chromatic dispersion of an optical signal travelling along the optical fiber. The dispersion compensation using digital filters is the most effective way of compensating it. It is a new class of digital filters implemented in the optical domain called all pass filters. All pass filters are lossless filters which offer the flexibility to tune a desired phase response arbitrarily close by increasing the number of stages keeping magnitude response of a system unchanged. The fully tunable all pass filters having 100 GHz FSR and negligible polarization dependence have been fabricated with tuning range of + 100 ps/nm, a pass band width of 50 GHz and group delay ripple of <3-ps peak are demonstrated. With the careful design of APF's together with the feedback equalization used at the receiver, the 10Gbps WDM system with FSR = 50GHz, OSNR = 22.7 at BER of 10- 9 may be realized.

7. REFERENCES

[1] C.H. Cheng, "Signal Processing for Optical Communication," IEEE Signal Processing Magazine, vol. 23, no. 1, pp. 88-96, 2006.

[2] G. Keiser, "Optical Fiber Communication," McGraw-Hill International series, Third Edition, 2000.

[3] C.D. Poole, J.M. Wiesenfeld, D.J. DiGiovanni, A.M. Vengsarkar, "Optical fiber-based dispersion compensation using higher order modes near cutoff," Journal of Lightwave Technology, vol. 12, no. 10, pp. 1746-1758, 1994.

[4] N.M. litchinitser, D.B. Patterson, "Analysis of Fiber Bragg Gratings for Dispersion Compensation in Reflective and Transmissive Geometries," Journal of Lightwave Technology, vol. 15, no. 8, pp. 1303-1313, 1997.

[5] D. Pastor, J. Capmany, D. Ortega, V. Tatay, and J. Marti, "Design of Apodized Linearly Chirped Fiber Gratings for Dispersion Compensation," Journal of Lightwave Technology, vol. 14, no. 11, pp. 2581–2588, 1996.

[6] P.M. Watts, V. Mikhailov, S. Savory, P. Bayvel, M. Glick, M. Lobel, B. Christinsin, P. Krikpatrick, S. Shange, and R.I. Killey, "Performance of Single-Mode Fibers Links using Electronic Feed-Forward and Decision Feedback Equalizers," IEEE Photonics Technology Letter, vol. 17, no. 10, pp. 2206-2208, 2005.

[7] S. Cao, J. Chen, J.N. Damask, C.R. Doerr, L. Guiziou, G. Harvey, Y. Hibino, H.Li, S. Suzuki, K.Y. Wu, and P. Xie, "Interleaver Technology: Comparisons and Applications Requirements," Journal of Lightwave Technology, vol. 22, no. 1, pp. 281-289, 2004.

[8] P.A. Regalia, S.K. Mitra, P.P. Vaidyanathan, "The Digital All Pass Filter: A versatile Signal Processing building Block," Proceedings of the IEEE, vol. 76, no. 1, pp. 19-37, 1988.

[9] S.K. Mitra, K. Hirano, "Digital All Pass Filters," IEEE transaction circuits and systems, vol. CAS 21, no. 9, pp. 688-700, 1974.

[10] en.wikipedia.org/wiki/Fiber-optic communication.

[11] J.M. Senior, "Optical Fiber Communications Principles and Practice" Harlow Pearson 2005 Prentice Hall International Series in optoelectronics", second edition, no. 3, 2005.

[12] G. Lenz and C.K. Madsen, "General Optical All-Pass Filter Structures for Dispersion Control in WDM Systems," Journal of Lightwave Technology, vol. 17, no. 7, pp. 1248-1254, 1999.

[13] C.K. Madsen and G. Lenz, "Optical All Pass Filters for Phase Response Design with Applications for Dispersion Compensation," IEEE Photonics Technology Letter, vol. 10, no. 7, pp. 994-996, 1998.

[14] C.K. Madsen, J.A. Walker, J.E. Ford, K.W. Goossen, T.N. Nielsen, and G. Lenz, "A Tunable Dispersion Compensating MEMS All-Pass Filter," IEEE Photonics Technology Letter, vol. 12, no. 6, pp. 651-653, 2000.

[15] C.K. Madsen, G. Lenz, A.J. Bruce, M.A. Cappuzzo, L.T. Gomez, and R.E. Scotti et al., "Integrated All Pass Filters for Tunable Dispersion and Dispersion Slope Compensation," IEEE Photonics Technology Letter, vol. 11, no. 12, pp. 1623-1625, 1999.

International Journal of Science and Engineering Applications (IJSEA)
Volume 2 Issue 1, 2013, ISSN - 2319-7560 (online)

Estimation and Modeling of Shoreline Changes by the year 1970-2100 between Portonova to Mallipattinam coast using Remote Sensing and GIS

N. Muthukrishnan
Department of Earth sciences
Tamil University,
Thanjavur, TamilNadu, India

R. Mahesh
Department of Earth sciences
Tamil University,
Thanjavur, TamilNadu, India

SK Chaturvedi
Department of Civil Engg.,
SASTRA University
Thanjavur, TamilNadu, India

Abstract: Changes in shoreline configurations accelerated due to global warming are world wide concern. Such changes not only affect the flora and fauna of those regions but also the livelihood of the coastal population. In the context, the 7517km long coastline of Indian coast behaves differently in different regions. Therefore, in order to assess the shoreline changes taking place in particular coastal regions and predicting the long-term changes in shoreline, there is an urgent need to monitor shoreline changes in different sector of Indian coast. The data generated through such can be very much helpful in taking the policy decision in establishing the various coast facilities in those regions. Shoreline Oscillation map of Bay of Bengal and Palk Strait area on 1:50,000 scale was prepared. In view of the above 1970 Topographic Sheets of Survey of India (SOI) and the National Remote Sensing Agency (NRSA), Hyderabad, India, Landsat TM 5, IRS P6 Imagery of the year 2000, 2008, IRS LISS - III P6 Feb 2005, April 2006, March 2008 Satellite Imageries and Modeling 2100 are utilized to study a 200 kilometer long coastline of central Tamil Nadu Coast between Portonova and Mallipattinam to understand the shoreline changes taken place within a time span of 38 years.
Comparative Shoreline Oscillation map reveal high erosional sedimentation ratio to the extent 73.24 in the sector of Thirumullaivasal to Topputurai during 1970 to 2000. Based on this study it can be concluded that remote sensing technique will be useful in long term qualitative monitoring of shoreline oscillations. Further the remote sensing study has a good agreement with the physical and observation of shoreline oscillation. The coastal stretch at Portonova, Kodiyampalaiyam, Kameswaram, Naluvedapathi, Periyaguttagai, Muttupet, Mallipattinam were in accretion and quite suitable for tourism like activities where as Killai, Thirumullaivasal, Poompuhar, Tharangambadi, Karaikkal, Nagore, Nagapattinam, Velanganni, Kodiyakkarai, and Atirampattinam and shorelines were in erosion and require attention from coastal authorities. The difference of rate of erosion/ accretion between the remote sensing study and physical observation was due to the coarser resolution of satellite images.
The research deals in detail the sector wise shoreline variation along the 200 km long coastline of central TamilNadu. This study future emphasizes the need to extend similar studies along the other parts of the Indian Coast.

Keywords: Shoreline changes, East coast of India, Sea level variation, TamilNadu coast

1. INTRODUCTION

Any changes in sea floor may be the result of sea-level variation or to a change in the elevation of land surface. Changes in absolute water-surface levels are worldwide due to the interconnectivity of the oceans and are termed eustatic changes. Changes in the absolute level of the land are localized. They may be due to tectonic adjustments or due to adjustments caused by their distribution of weight on the land surface. As and when sedimentation or ice build-up occurs, such changes are known as isostatic. A rise in the sea level or down warping of land would involve the opposite movements of sea and land. Synonymous with positive and negative changes are the forms of sea-level transgression and regression, although in many cases these terms also refer to the horizontal movement of the shoreline associated with vertical changes of sea level. Indian shore has experienced submergence and emergence due to global as well as local oscillations of the sea level by multivariate tectonic, fluvial and marine geomorphic processes. The repeated emergence and submergence of coast have been instrumental in shaping the morphological expressions of the continental shelves in general and shoreline in particular (Jayaprakash et al. 2002) proved that the coast is going on emerging by tectonic movement. There is a remarkable difference in the extent of continental shelf of the east coast of India when compared to west coast of India. The shelf on the west coast is broad with thin layer of sediment, while the eastern shelf is narrow with thick layer of sediment (Agarwal 1990). The main objective of the research is to generate the pattern of erosion versus accretion along the coast between Portonova and Mallipattinam over period of time (1970, 2008 and Modeling 2100) and preparation of Shoreline Oscillation maps using multi band satellite data and topographic Sheets data.

An idealized definition of *shoreline* is that it coincides with the physical interface of land and water. Despite its apparent simplicity, this definition is in practice a challenge to apply. In reality, the shoreline position changes continually through time, because of cross-shore and alongshore sediment movement in the littoral zone and especially because of the dynamic nature of water levels at the coastal boundary (*e.g.,* waves, tides, groundwater, storm surge, setup, run up, *etc.*).

Sandy beaches are common along many of the world's coastlines, yet our understanding of the behavior of beach and nearshore sediment systems on scales of years to decades remains limited. Movement of sediment by waves and currents is both complex and difficult to measure 1970, 2000 and 2008.

Coastal erosion is a source of widespread concern because of threats to abutting private lands and loss of beach resources. Estimates of beach loss related to shoreline armoring on chronically eroding lands.

2. STUDY AREA

The Cauvery delta shoreline (Central east coast of Tamilnadu, India) (Fig 1), Bay of Bengal, extending between Portonova and Naluvedapati11°30'32.162" N latitudes to 10°30' 22.619" N and 79°44'38.427" E to 79°53'15.836" E longitudes - Naluvedapati and Mallipattinam10°30' 22.619" N latitudes to 10°14' 46.355" N and 79°53'15.836" E to 79°14'39.816" E longitudes to a length of about 200 km. This area is endowed with a combination of ecosystems including mangroves, sea grass, seaweeds and corals reefs (Ramanujam and Mukesh 1998). Different types of land features formations have also been observed. The coast of Bay of Bengal is mostly underling by Quaternary to Recent formation (Meijerink 1971). One port near Periapattinam had submerged under sea due progradation found in this area (Loveson & Rajamanickam 1988). The west of this coastal area is bound by heavy delta formations underlined by metamorphic rocks of Pre Cambrian. Being a gradient coast it has developed well fabricated network of deltas, backwater, creeks, protruding deltas, estuaries, back swamps and coral reef etc. The morphogenic disturbances of coral reefs observed at Gulf of Mannar (Jayprakash et al 2002). Anthropogenic disturbances on coral reefs are quit common (Grigg & Dollar 1990) but by using GIS technology Thanickachalam & Ramachandran (2002) found that the coral reefs of Mannar were severely suffered by means of shoreline oscillation. Morphological variations in the islands were noticed in these areas (Ramanujam et al 1995). and also entire coastal areas of India (Anjali Bahuguna and Nayak 1994).

Generally, the coastal physiography of the regions around Portonova, Chidambaram and Kodiyakkarai is found to be of moderately undulated in and around the concave swaps (Fig 2). In between such swaps and the shoreline, an undulated plain comprised mainly of alluvium, is noticed. Tidal mudflats are associated with swamps and salt pans. The Coastline between Portonova and kodiayakkarai shows a vast stretch of sandy tract with sand dunes mostly of undulating nature. There are also back water swamps especially near the village killai, Pichavaram and at the mouths of Coleroon river. The terrain is nearly level to very gently sloping one. The gradient is 0 - 3 °, that too, only seawards. The western limit of the coastal belt is the Cauvery delta.

3. MATERIALS AND METHODS

Nayak 1991 and SAC 1991 Manual for mapping of coastal wetlands / Landforms and shorelone changes using satellite data were utilized to delineate the features of coastline. Over all coastal geomorphology of India has been published by Ahmed (1972) presents the over all ideas about the features present before 1971. Sea level variation-through bathymetric data (Agarwal 1990) and coastal erosion and accretion (Kalianasundaram et al 1991) were also observed in the imageries. The coastal dynamic maps of east coast of India prepared by Gurugnanam et al 2000 and coastal zone management in India given by Nayak, S.R (2002) gave a vast idea about the oscillation of shoreline of east coast of India.

Survey of India Topographic Sheets (SOI-1970) and Global Position System (GPS) were used in this study. Shoreline Oscillation map of study area on 1: 50,000 scale was prepared manually using 1970 Topographic Sheets. The prepared Shoreline oscillation map was digitized by using ARC-INFO (Arc Map) and a digital Shoreline Oscillation model was prepared using (ArcGIS & ENVI 4.7) software. March 2008 Satellite Imagery was used and Global Position System was also used to locate the Ground Control Points (GCP). The distance in meters were measured at a particular location with reference to Topographic Sheets and Satellite Imagery shore lines (1970, 2000 & 2008).

Survey of India toposheet for the year 1970 was used as base map and Landsat TM 5 2000,IRS LISS III P6 image (2005, 2006, 2007 and 2008), were used for delineation of coastline during respective years. The satellite data received from NRSC Hyderabad with radiometric corrections were geometrically corrected using ENVI 4.7, ArcGIS 9.2 software verified with ground truth. Then the shorelines had been digitized for further analysis.

The exact locations of these points were observed and respective latitude and longitude were recorded using Sokkia Totalstation Survey, Dump Level Survey, Global Positioning System (GPS).

Then the coastline was monitored from this Different Satellite Imageries. The average coastline changes were computed in year-wise during 1970, 2005, 2006 and 2008 and modeling 2100.

4. RESULT AND DISCUSSION

4.1 Changes in Shoreline Between Portonova and Mallipattinam

Geocoded FCC of IRS LISS - III P6 (Landsat TM 5 2000), 2005, 2006 and 2008 satellite data on 1:50,000 scale belonging to low tide period and Survey of India Topographic map (SOI 1970) on 1: 50000 scale were used to prepare shore line change map. The low tide line (as shore line) from SOI topographical sheet and satellite image were extracted and mapped on 1: 50,000 scale by visual techniques. After identification and delineation, coastal villages, some monuments, lighthouse etc were selected as sample points on SOI topographic sheet for ground truth checking. During the time of ground truth study the entire coast was checked with local people and some necessary corrections were carried out on primary shoreline map. The georeferenced multi date shoreline maps were carefully digitized in ENVI 4.7 ARC/INFO 9.2 and were overlaid using TIC coordinates of the study area. Digitized maps were edited and labels assigned to the polygons. Finally a temporal shoreline change map was generated using intercept operation of ENVI 4.7 ARC/INFO 9.2 and summary statistic was generated for erosion and accretion areas. The changes were estimated for a period of 38 years between 1970 and modeling 2100.

4.2 Land use/land cover changes

The major land use/land cover change has occurred in the following classes:

The sandy beaches are extensively developed along the entire coast of Portonova area. Naluvedapatti, Periyaguttagai is covered by long and extensive sandy beach. Beach ridges are moderately undulating terrain features of marine depositional type, formed during pliestocene to recent age, in the plains of the Kodiyampalaiyam, Kameswaram area. They are low, essentially continuous beach or beach dune materials (sand, gravel and shingle) heaped up by the action of wave and currents on the backshore of a beach beyond the present limit of storm waves or the reach of ordinary tides, and occurring as a single or as one of a series of approximately parallel deposits

1. Sandy, mangroves, Builtup land area has reduced in Killai, Pillumedu
2. Beaches, Beach Ridged Plains, Dunes Vegetations, Cropland, Builtup land area has reduced in Thirumullaivasal, Poompuhar, Tharangambadi
3. Beaches, Beach Ridged Plains, Dunes Vegetations, Paleolagoonal Plains, Mudflats, Point bars, Alluvial Plains,

Builtup land area has reduced in Karaikkal, Nagore, Nagapattinam,
4. Beaches, Beach Ridged Plains, Dunes Vegetations area has reduced in Velanganni, Naluvedapatti
5. Beaches, Beach Ridged Plains, Dunes Vegetations, Cropland, Mudflats, Salt swamp, Creek, mangroves area has reduced in Kodiyakkarai, Muthupet, Atirampattinam and Mallipattinam. The difference of rate of erosion / accretion between the remote sensing study and physical observation was due to the coarser resolution of satellite images.

5. CONCLUSION

The coastal processes in Portonova and Mallipattinam coastal area, the shoreline change, wave action, bathymetry and coastal geomorphology were analysed using Remote Sensing and GIS tools. The erosion and accretion observed at Portonova and Mallipattinam using temporal satellite imageries show that the shoreline dynamics is natural. Coastal processes play a major role in shaping the coastal configuration of this area. The integrative approach using Remote Sensing and GIS tools clearly illustrates both the cause and reasons for the shoreline change. The results of this study will be more useful for shoreline management.
Based on this study, it can be concluded that remote sensing technique will be useful in long term qualitative monitoring of shoreline oscillations. The coastal stretch at Portonova, Kodiyampalaiyam, Kameswaram, Naluvedapatti, Periyaguttagai, Muttupet, Mallipattinam were in accretion and quite suitable for tourism like activities where as Killai, Thirumullaivasal, Poompuhar, Tharangambadi, Karaikkal, Nagore, Nagapattinam, Velanganni, Kodiyakkarai and Atirampattinam and shorelines were in erosion and require attention from coastal authorities.

6. ACKNOWLEDGMENTS

Author sincerely acknowledges DST for providing financial assistance in the sea level variation project. He also thanks to the co-author who provide valuable guidance through his wonderful experience in the applied geology field. He thanks the Research Assistant in the project and also acknowledged the SASTRA University for providing necessary infrastructure facilities for the research. The author acknowledges the co-workers of the same project R.Sivasamandy and Mr.R.VijayAnand.

7. REFERENCES

[1] Agarwal J.M. (1990), 'Sea level variation-through bathymetric data example: Azhikkal on west coast of India', In: Sea Level Variation and its Impact on Coastal Environment, (ed) Rajamanickam G.V, Tamil University, Thanjavur, pp.1-5.
[2] Ahmad, E., 1972. Coastal geomorphology of India. Orient Longman, New Delhi, 222 p.
[3] Anjali Bahuguna, and Nayak, S.R., (1994). Coral mapping of India. In: Scientific Note SAC/RAS/RASG/DOD-COS/SN/07/94), Space Application Center, Ahmedabad, India.
[4] Grigg, R.W. and Dollar, S.J., (1990). Natural and anthropogenic disturbance on coral reefs. Ecosystem of the world, Elsevier Science Publishing, New York, pp.439-452.
[5] Gurugnanam B, Gokulakrishnan R, Ramkumar T and Manoharan K (2000) *Coastal Zone Dynamics of the central part of east coast, Tamilnadu- A case studythrough integrated remote sensing.* Marine Remote Sensing Applications (Eds: Ramachandran S), pp 235 – 249.
[6] Jayprakash C, Maran N, Jayakumar R and Kumaran K. (2002), ' Imprints of sea evel oscillation in the continental shelf of Gulf of Mannar', Newsletter, Geological Survey of India, Vol.XVI, pp.8-10.
[7] Kaliasundaram G, Govindasamy S and Ganesan R (1991) *Coastal erosions and accretions. Coastal zone management (Tamilnadu State, India)* (Eds: Natarajan.
[8] Loveson V.J. and Rajamanickam G.V. (1988a), 'Progradation as evidenced around as evidenced around a submerged ancient port, Periapatnam, Tamilnadu, India', International Journal of Land.Sys.Eclo.Studies, Vol.12, pp.94-98.
[9] Meijerink AMG (1971) Reconnaissance survey of the Quaternary Geology of the Cauvery delta. *J Geological Society of India* 12: 113–124 .
[10] Nayak, S.R., (1991). Manul for mapping of coastal wetlands/landforms and shoreline changes using satellite data. Technical Note: IRS-UP/SAC/MCE/TN/32/91, Space Application Center, Ahmedabad, India.
[11] Nayak, S.R., (2002). Application of remote sensing to coastal zone management in India. Paper presented in ISPRS Technical Commission VII Symposium on Remote Sensing and Environment Monitoring and ISRS Annual Convension held at Hyderabad, India.
[12] Ramanujam, N. and Mukesh, M.V., (1998). Geomorphology of Tuticorin Group of Island. In: Biodiversity of Gulf of Mannar Marine Biosphere Reserve. (Eds.: M. Rajeswari, K. Anand, Dorairaj and A. Parida). M.S. Swaminathan Research Foundation, Chennai. pp.32-37.
[13] Ramanujam, N., Mukesh, M.V., Sabeen, H.M. and Preeja, N.B., (1995). Morphological variation in some islands in the Gulf of Mannar. Journal of Geogical Survey of India, Vol.45, pp.703-708.
[14] SAC, (1991). Manual for mapping coastal wetlands / landform and shoreline changes using satellite data. Space Application Center, Ahmedabad, India, No: IRS-UP/SAC/MCE/TN/32/91, 63p.
[15] Thanikachalam, M.and Ramachandran, S., (2003). Shoreline changes along the coast of Gulf of Mannar and its Influence on Coral Reefs: A Remote Sensing and GIS Approach Journal of the Indian Society of Remote Sensing, Vol.31, No.3, 2003.

Table 1. Shoreline Changes Observed at Portonova and Mallipattinam

1970-2000	Erosion	Deposition	Ratio E/D
Portonova to Tirumullaivasal	0.459359	3.533769	1:8
Tirumullaivasal to Karaikal	3.638784	0.022915	1:0
Karaikal to Velanganni	2.713319	0.136106	1:0
Velanganni to Topputturai	3.208456	0.078283	1:0
Topputturai to Kodiyakkarai	0.174301	0.495079	1:3
Kodiyakkarai to Muttupet	5.975625	5.66344	1:1
Muttupet to Mallipattinam	3.819934	0.632900	1:0
Overall	19.98978	10.56249	1:1
1970-2008			
Portonova to Tirumullaivasal	1.144509	3.244258	1:0
Tirumullaivasal to Karaikal	1.760481	0.113573	1:16
Karaikal to Velanganni	1.720385	0.182227	1:9
Velanganni to Topputturai	1.565419	0.614851	1:3
Topputturai to Kodiyakkarai	4.041669	0.230403	1:18
Kodiyakkarai to Muttupet	1.104402	9.624153	1:0
Muttupet to Mallipattinam	1.057505	1.438159	1:1
Overall	12.39437	15.44762	1:1
2000-2008			
Portonova to Tirumullaivasal	1	1	1:1
Tirumullaivasal to Karaikal	0.076119	1.703509	1:0
Karaikal to Velanganni	0.136434	0.996138	1:0
Velanganni to Topputturai	0.167031	2.614992	1:0
Topputturai to Kodiyakkarai	3.947309	0.117502	1:34
Kodiyakkarai to Muttupet	0	1.199296	1:0
Muttupet to Mallipattinam	0.244695	10.05343	1:0
Overall	5.571589	17.68487	1:0
2008-2100			
Portonova to Tirumullaivasal	2.63884	8.165299	1:0
Tirumullaivasal to Karaikal	4.131833	0.754894	1:5
Karaikal to Velanganni	7.144319	0.168238	1:42
Velanganni to Topputturai	4.193459	2.180861	1:2
Topputturai to Kodiyakkarai	15.75625	3.266962	1:5
Kodiyakkarai to Muttupet	0.700251	9.101234	1:0
Muttupet to Mallipattinam	3.206589	7.213719	1:0
Overall	37.77154	30.85121	1:1

Table 2 Average Shoreline Changes Observed at Portonova and Mallipattinam Coast during 1970, 2000, 2008 from Satellite Imageries and proposed line at 2100

Location Name	1970-2000 Erosion in Sq Km (-)	1970-2000 Deposition in Sq Km (+)	1970-2008 Erosion in Sq Km (-)	1970-2008 Deposition in Sq Km (+)	2000-2008 Erosion in Sq Km (-)	2000-2008 Deposition in Sq Km (+)	2008-2100 Erosion in Sq Km (-)	2008-2100 Deposition in Sq Km (+)
Portonova to Tirumullaivasal	-0.45935906	3.53376866	-1.144509	3.244258	-1.448667	0.828352	-2.63884	8.165299
Tirumullaivasal to Karaikal	-3.63878389	0.022914884	-1.760481	0.113573	-0.076119	1.703509	-4.131833	0.754894
Karaikal to Velanganni	-2.71331889	0.136106147	-1.720385	0.182227	-0.136434	0.996138	-7.144319	0.168238
Velanganni to Topputturai	-3.20845582	0.078283102	-1.565419	0.614851	-0.167031	2.614992	-4.193459	2.180861
Topputturai to Kodiyakkarai	-0.1743012	0.495079108	-4.041669	0.230403	-3.947309	0.117502	-15.75625	3.266962
Kodiyakkarai to Muttupet	-5.97562469	5.663440399	-4.041669	0.230403	0	1.199296	-0.700251	9.101234
Muttupet to Mallipattinam	-3.81993436	0.632900155	-1.057505	1.438159	-0.244695	10.05343	-3.206589	7.213719
Overall	-19.9897779	10.56249246	-15.33164	6.053874	-6.020255	17.51322	-37.77154	30.85121

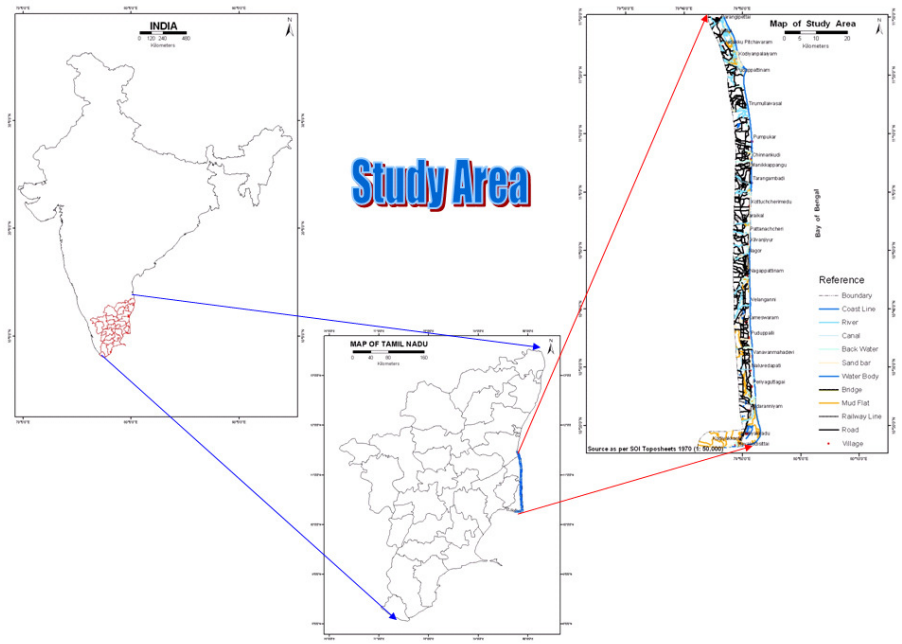

Fig – 1 Study Area

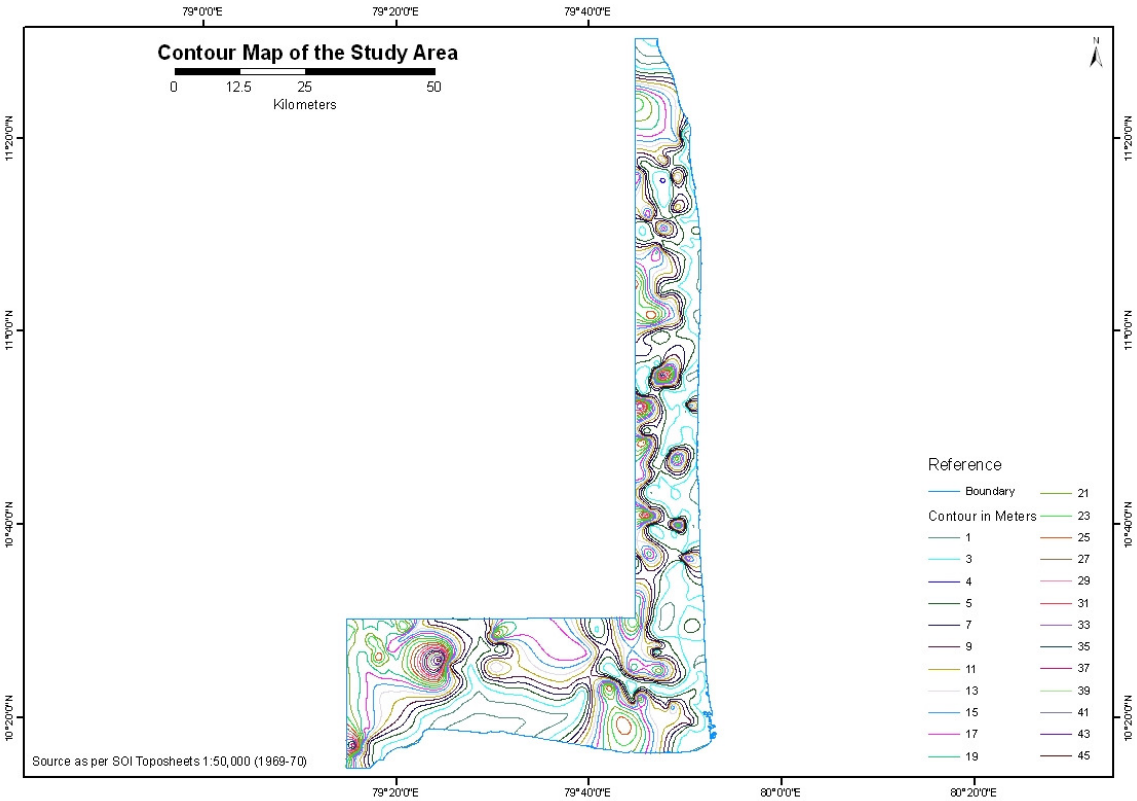

Fig – 2 Contour Map of study area

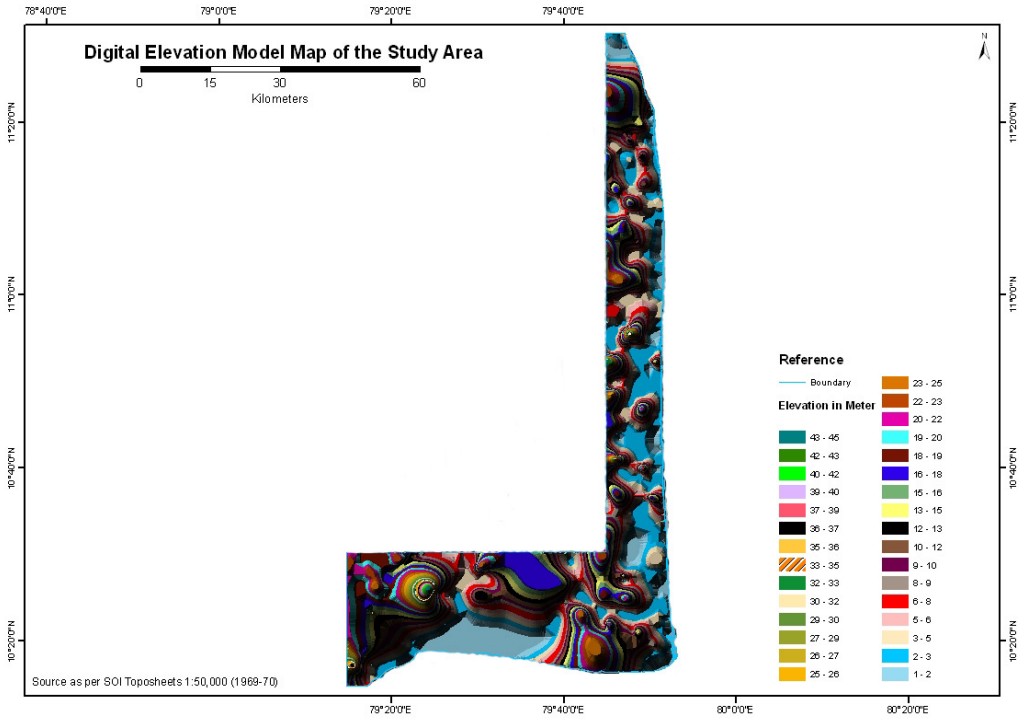

Fig – 3 Contour Map of study area

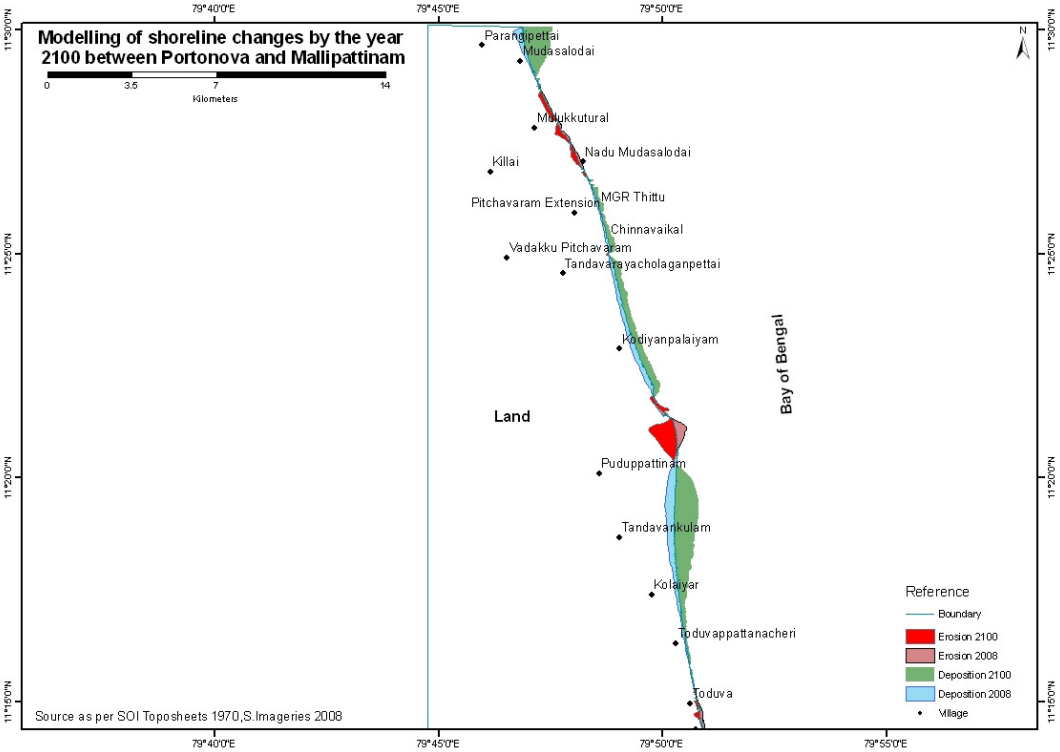

Fig – 4 Portonova to Toduvai

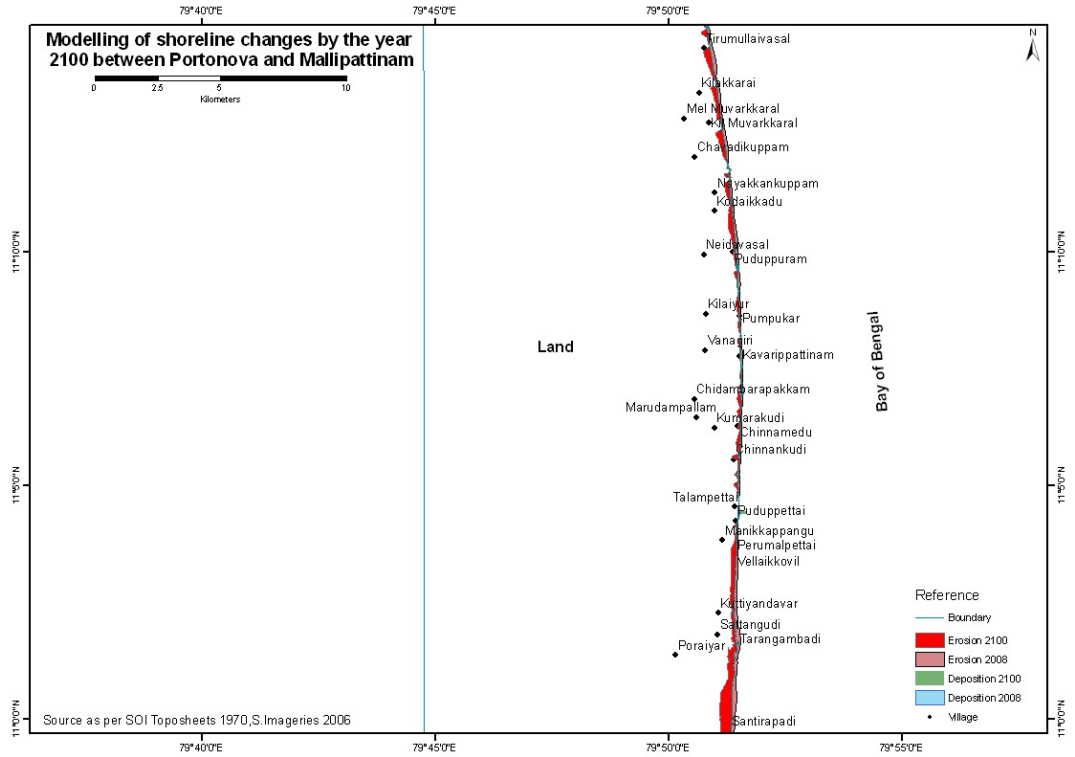

Fig – 5 Thirumullaivasal to Chandrapadi

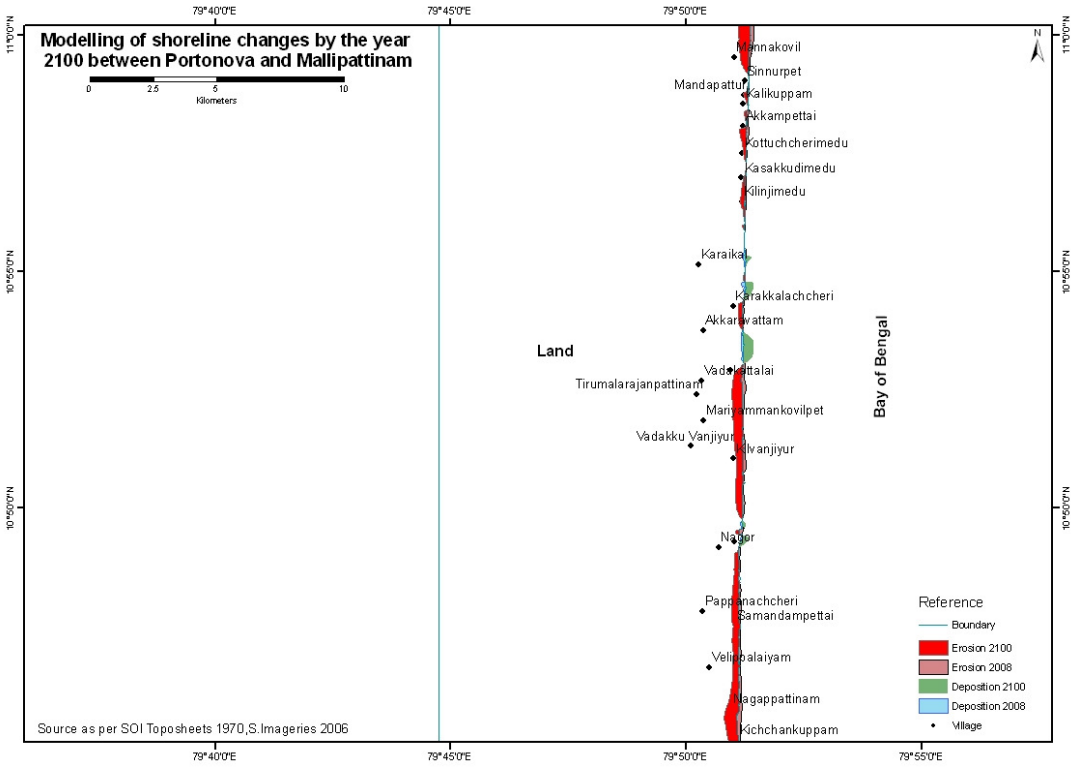

Fig -6 Manakovil Nagapattinam

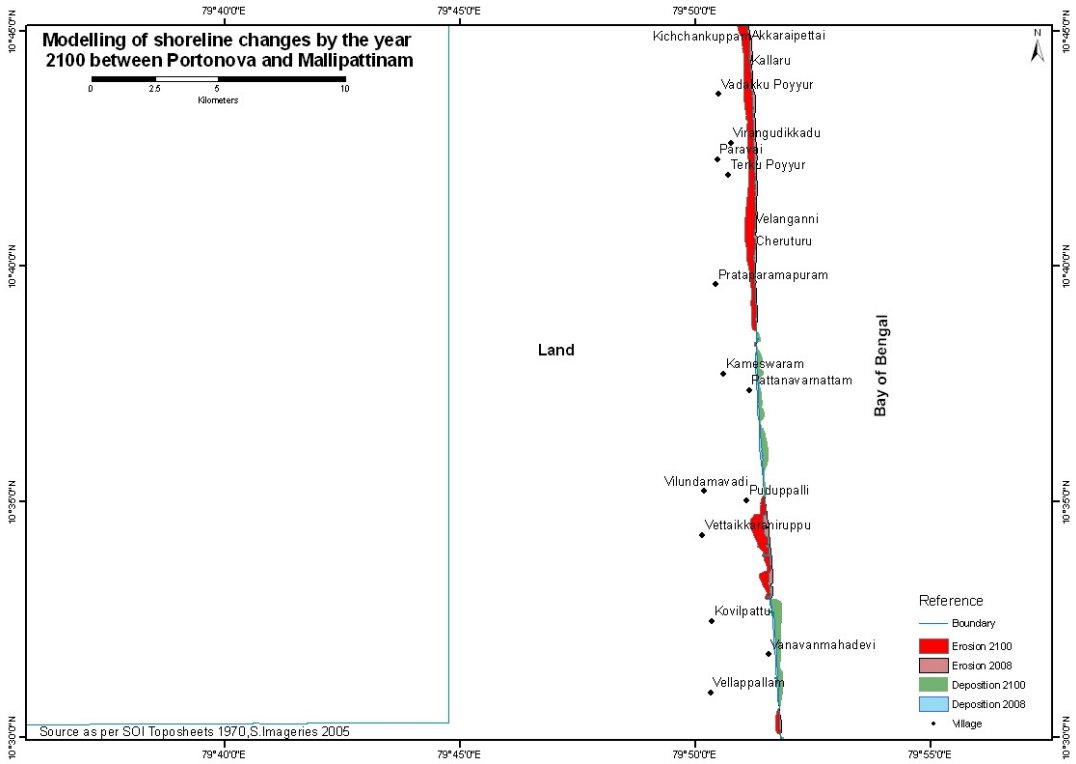

Fig – 7 Kichankuppam to Vellapallam

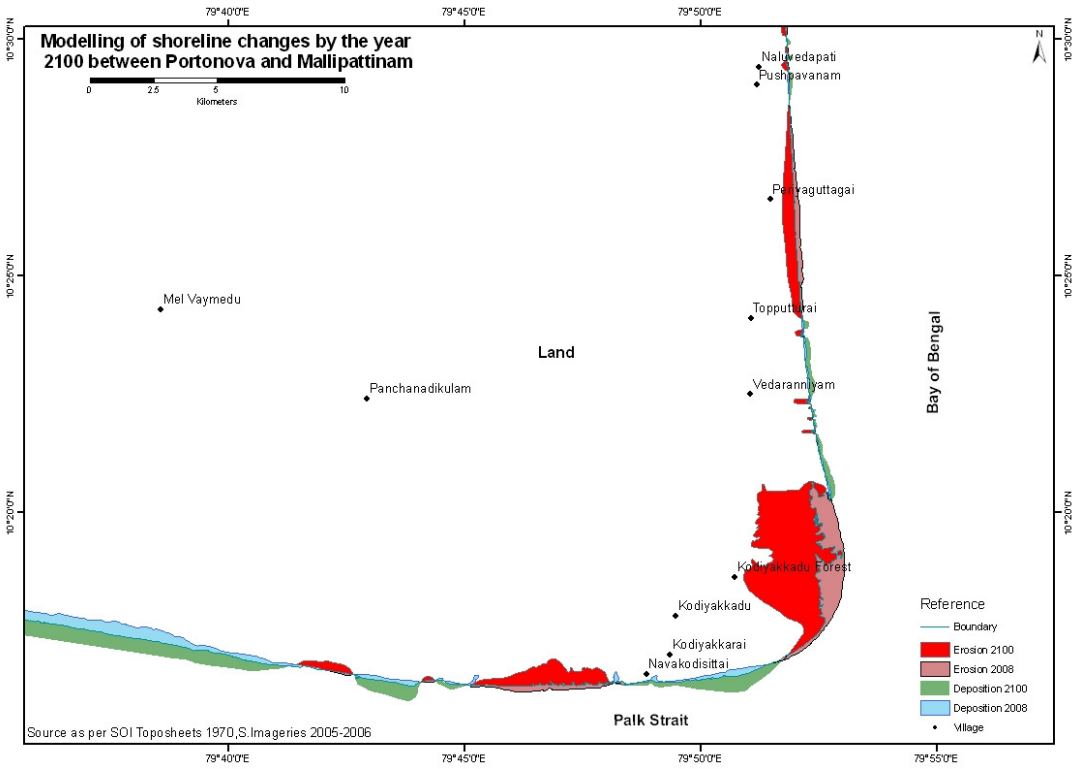

Fig – 8 Naluvedapatti to Kodiyakkarai

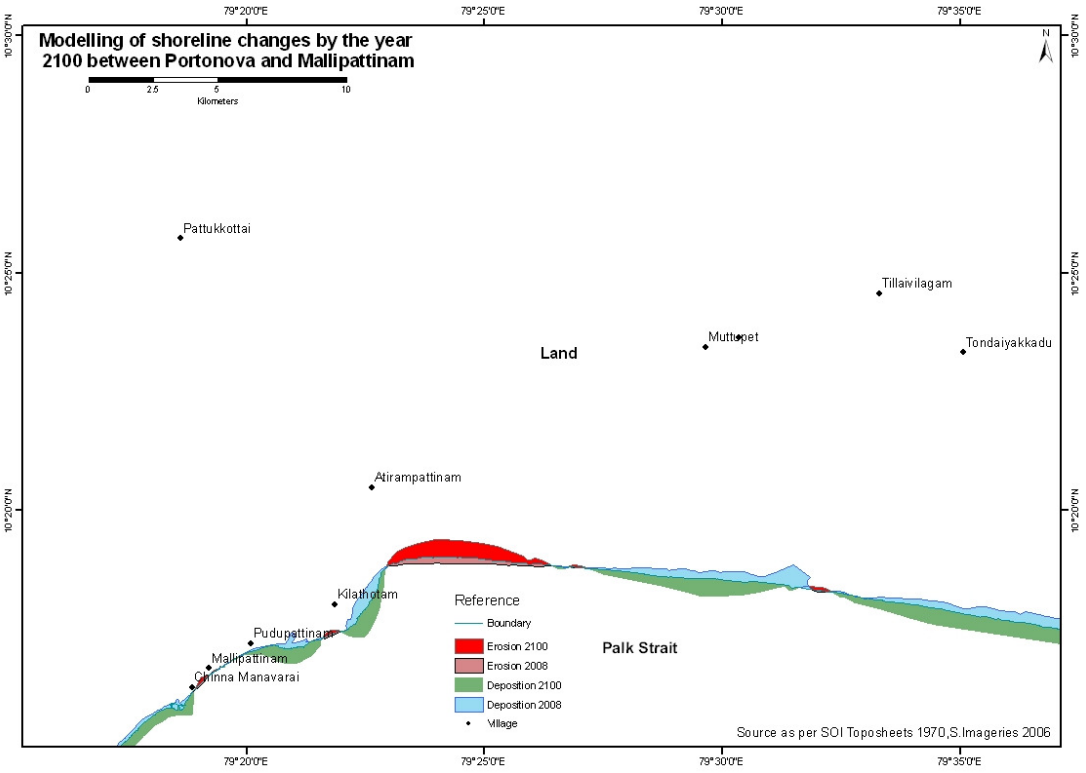

Fig 9 Thillaivilagam to Mallipattinam

International Journal of Science and Engineering Applications (IJSEA)
Volume 2 Issue 1, 2013, ISSN - 2319-7560 (online)

Development and testing of natural draught desert cooler

Ashok Kumar Sharma
Department of Mech. Engineering
Yagyavalkya Institute of Technology
Jaipur, India

Pawan Bishnoi
Department of Mech. Engineering
Yagyavalkya Institute of Technology
Jaipur, India

Abstract: To save the environment it is primarily required to save electricity. Since, generation of electricity add pollutants to the environment. The developed desert cooler which is described in this paper uses naturally blowing air to provide the cooling effect. It allows air to enter inside the cooler from four sides while allows outgoing of air only through a passage in bottom. Thus naturally blown air is circulated inside the room through desert cooler, which requires no electricity to blow the air as in conventional desert coolers. The paper describes the methods of designing and manufacturing of this desert cooler. A test setup is presented which was prepared to test the effectiveness of this developed cooler. The methodology of testing and test data are also presented. The results show that this device is effective in providing cooling without using electricity for blowing the air.

Keywords: Desert cooler, natural draught, cellulose cooler pads, air retainers

1. INTRODUCTION

In the recent decades the demand for air cooling has increased due to high dry bulb temperature and low humidity of air in Rajasthan, specially in Jaisalmer and Barmer districts where during summar dry bulb temperature of air reached up to 50^{o}C while relative humidity is below 48%. This climate is suitable for evaporative cooling. In a conventional air cooler a motor is used to drive the fan and to pump water for cooling and humidification of air. In this paper a modified cooler is presented with low electric energy consumption using natural draft system for air flow through the cooler. The major advantage of this equipment is to eliminate the fan used for air flow through cooler and thus reducing the electricity requirement.

2. LITERATURE REVIEW

Literature review reveals that lot of efforts have been made to make the desert cooler energy efficient as Faleh Al-Sulaiman [1] used various fibers like date palm fibers , jute and luffa for wetted cooler pads and evaluated the performance resulted jute has maximum cooling efficiency. Kothare and Borker [2] presented a “Modified Desert Cooler (MDC)” which cools the air more efficiently than the conventional desert cooler as well as provide cold-pure water for drinking purpose. It also decreased moisture content of the air coming through desert cooler upto some extent. Poonia M.P. et al. [3] have developed a cooler cum refrigerator which provides air cooling, cold drinking water and stores the vegetables and medicines without affecting the performance of desert cooler. This is energy saver useful equipment.

Khond [4] has investigated a performance of Desert Cooler using four different pad materials i.e. stainless steel wire mesh, coconut coir, khus and wood wool. They observed that minimum water consumption was in stainless steel wire mesh and maximum cooling efficiency was found using wood wool pads.

Many researchers have presented analytical models and methods to calculate and optimized the performance of desert cooler. Erens and Dreyer [5] presented three analytical models and optimized the shape of the cooler. Guo and Zhao [6] numerically analyzed the thermal performance of an indirect evaporative air cooler. Ren and Yang [7] developed an analytical model for the coupled heat and mass transfer processes under real operating conditions with parallel counter-flow configurations. Shariaty-Niassaṛ & Gilani [8] have applied CFD technique to examine the different types of indirect evaporative coolers. Navon and Arkin [9] were focused on providing thermal comfort using direct-indirect evaporative cooler. In their studies Amr Sayed et al. [10] have considered housing problems and indoor environment which attributed to thermal comfort.

3. DESIGN AND DEVEOPMENT OF IMPROVED DESERT COOLER

As shown in figures 1 & 3 a modified cooler has been manufactured which has cooler grills on four sides of the cooler. The grills are provided with the arrangement to receive maximum naturally blowing air. The outlet of air from the cooler is facilitated at the bottom along with water tank as shown in figure 1 & 4 which will convey that air to test chamber / room where cooling is required. The cooler grills are provided with cellulose pads. Inside the cooler the pads are facilitated with baffles as shown in figures 2 & 4 which allow naturally blowing air inside the cooler and prevent exit from grills to direct air to pass through conical receiver. Since this cooler uses only naturally blowing air for cooling purpose therefore, no blower is required. Electric power will be used only for

circulating water from water tank to grills with the help of electric pump.

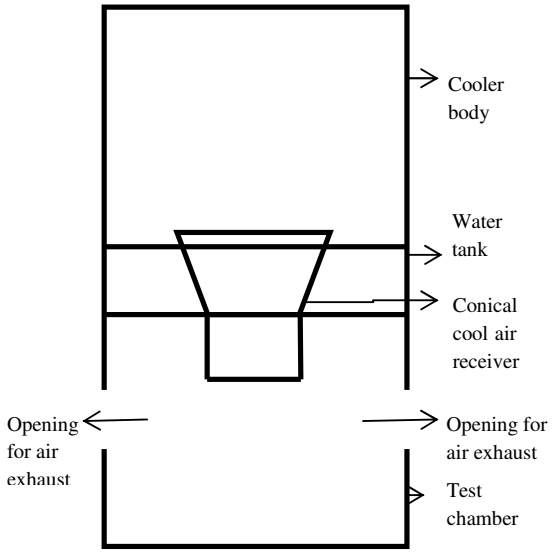

Figure 1 Arrangement of cooler body and test chamber

This modified cooler can be placed on the roof of any building to receive maximum naturally blowing air 24 hours. The air is than, can be circulated to the rooms where cooling required through duct after passed through the cooler.

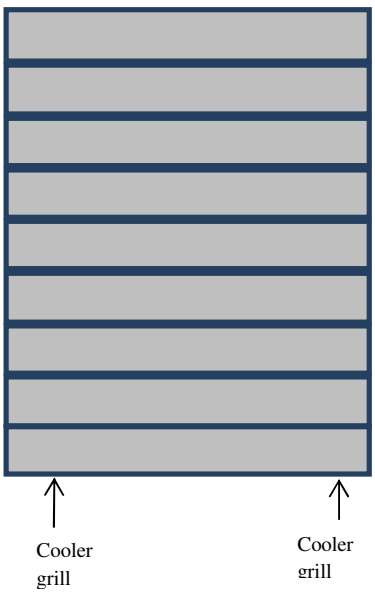

Figure 2 Arrangement of baffles on cooler grill

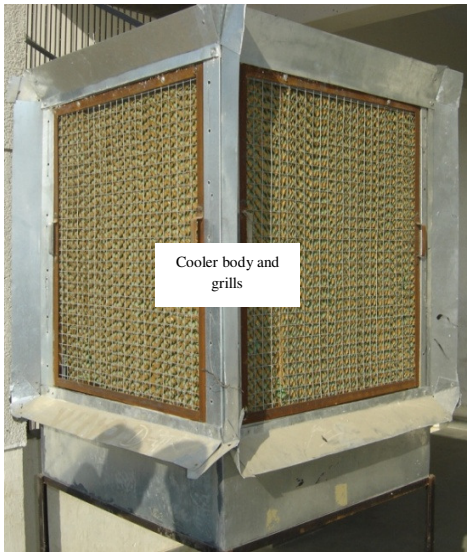

Figure 3 Cooler body and cellulose cooler pads

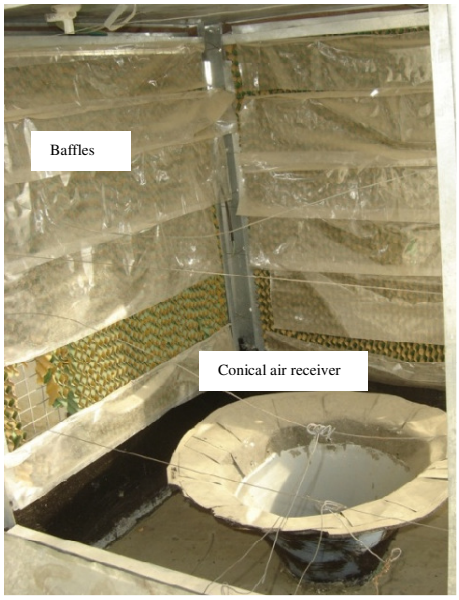

Figure 4 Arrangement of conical cool air receiver and baffles on cooler grill

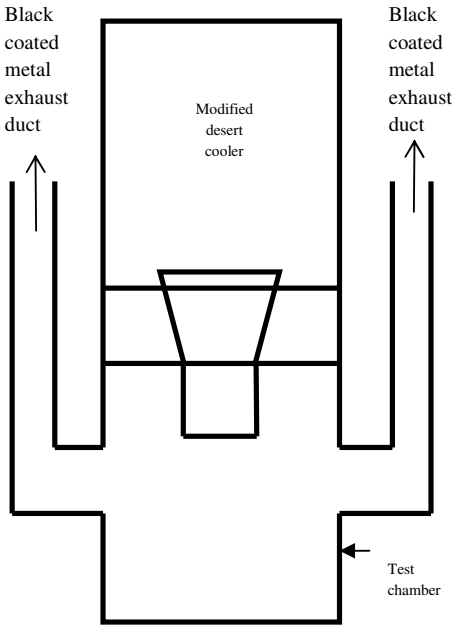

Figure 5 Arrangement of black coated metal exhaust ducts in test setup II

4. TEST AND RESULTS

Arrangements for testing of modified desert cooler are provided in figures 1 & 5. A test chamber of size 930 mm x 980 mm x 980 mm was prepared under the cooler to test the cooling effect of the cooler. This test chamber was insulated and a thermometer was inserted in it through the insulated wall to measure the temperature of the test chamber. The testing arrangements as shown in figures are different in one aspect is that exhaust of air from test chamber as in figure 1 passes through plain openings on two sides, whereas exhaust air as in figure 5 passes through exhaust ducts provided on two sides. The later provides effective exhaust of air from test chamber creating naturally induced draught after heating of exhaust ducts by sunrays. The design of exhaust duct is provided in figure 6. The test observations / results are tabulated in the tables 1 & 2 and also presented in figure 7 & 8.

5. CONCLUSIONS

On analyzing the observations in table 1 & 2 and figures 7 & 8 it is concluded that –

(a) Naturally draught cooler is effective equipment in providing cooling effect without using blower (table 1 & figure 7).
(b) The device is comparatively more effective with black color coated exhaust ducts (table 2 & figure 8) as it provides effective draught to exhaust air from the room / test chamber.

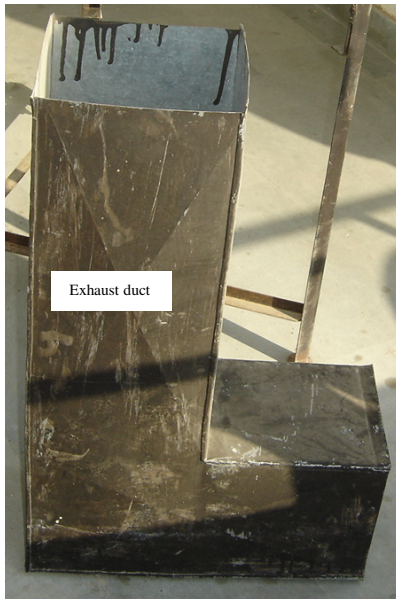

Figure 6 Black color coated metal exhaust duct

(c) Since, there is no blower in the modified desert cooler therefore, no electricity is required. Hence, the equipment is economical in operation and environment friendly.
(d) The cooler is suitable for most of the types of buildings.

Table 1 Cooling effect of modified desert cooler

S.No.	Time (min.)	Water temperature (^oC)	Test chamber temperature (^oC)
1.	0	45	38.2
2.	20	43.9	37.5
3.	40	42.8	36.9
4.	60	41.9	36.3
5.	80	40.8	35.6
6.	100	39.8	35.0
7.	120	38.7	34.4
8.	140	37.8	33.9
9.	160	36.8	33.4
10.	180	35.9	32.9
11.	200	35.0	32.4
12.	220	34.1	32.0
13.	240	33.3	31.5
14.	260	32.4	31.1
15.	280	31.5	30.7
16.	300	30.7	30.3

Table 2 Cooling effect of modified desert cooler with black color coated exhaust ducts.

S.No.	Time (min.)	Water temperature (^oC)	Test chamber temperature (^oC)
1.	0	45.5	38.4
2.	20	44.4	37.7
3.	40	43.1	36.9
4.	60	41.9	36.1
5.	80	40.7	35.3
6.	100	39.5	34.5
7.	120	38.4	33.8
8.	140	37.2	33.1
9.	160	36.0	32.4
10.	180	34.8	31.7
11.	200	33.7	31.1
12.	220	32.5	30.5
13.	240	31.5	29.9
14.	260	30.6	29.3
15.	280	29.6	28.7
16.	300	28.7	28.1

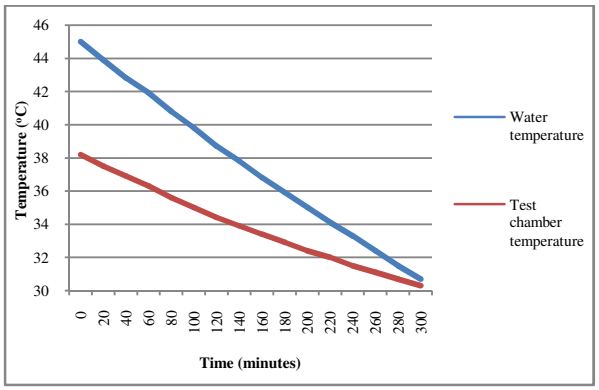

Figure 7 Cooling effect of modified desert cooler

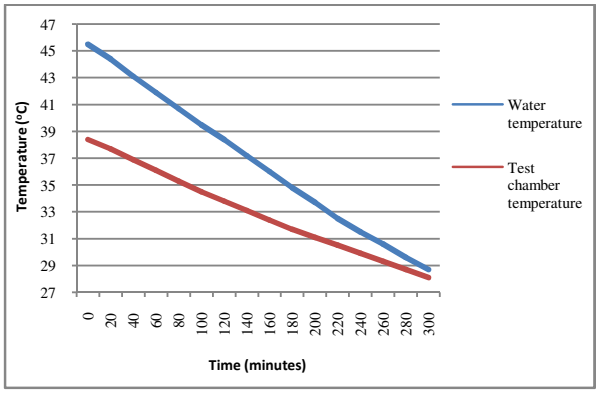

Figure 8 Cooling effect of modified desert cooler with black color coated exhaust ducts.

6. REFERENCES

[1] Al-Sulaiman, F. 2002. Evaluation of the performance of local fibers in evaporative cooling. Energy Conversion and Management. 43(16), 2267-2273.

[2] Kothare, C. B. and Borkar, N. B. 2011. Modified desert cooler (MDC). International Journal of Engineering and Technology. 3 (2), 166-172.

[3] Poonia M.P., Bhardwaj A., Upender P., Jethoo A.S. 2011. Design and development of energy efficient multi-utility desert cooler. Universal Journal of Environmental Research and Technology. 1, 39-44.

[4] Khond, V. W. 2011. Experimental investigation of desert cooler performance using four different cooling pad materials. American Journal of Scientific and Industrial Research. 418-421.

[5] Erens, P. J. and Dreyer, A. A. 1993. Modeling of indirect evaporative coolers. International Journal of Heat and Mass Transfer. 36 (1), 17-26.

[6] Guo, X. C. and Zhao, T. S. 1998. A parametric study of an indirect evaporative air cooler. Heat and Mass Transfer. 25 (2), 217-226.

[7] Ren, C. and Yang, H. 2006. An analytical model for the heat and mass transfer processes in indirect evaporative cooling with parallel / counter flow configurations. International Journal of Heat and Mass Transfer. 49, 617-627.

[8] Gilani, N. and Shariaty-Niassar, M. 2009. An investigation of indirect evaporative coolers (IEC) with respect to thermal comfort criteria. Iranian Journal of Chemical Engineering. 6(2), 14-28.

[9] Navon, R. and Arkin, H. 1994. Feasibility of direct indirect evaporative cooling for residences, based on studies with a desert cooler. Building and Environment, 29 (3), 393-399.

[10] Amr Sayed, H., Hiroshi, Y., Abdelsamei Eid, M. and Magdy, M. R. 2012. Indoor natural ventilation using evaporating cooling strategies in the Egyptian housing: A review and new approach. International Journal of Engineering and Technology. 4(3), 229-233.

International Journal of Science and Engineering Applications (IJSEA)
Volume 2 Issue 1, 2013, ISSN - 2319-7560 (online)

THE STUDY OF DATA ABOUT DATA ON SPATIAL DATA WAREHOUSES

M.Laxmaiah,
JNTUH, Tirumala
College of Engineering,
Hyderabad, India

A.Govardhan,
JNTUH, Kukatpally,
Hyderabad, India

C.Sunil Kumar
Dhanalakshmi College of Engineering,
Anna University,
Chennai, India

Abstract: In this paper, the organization of metadata of spatial data warehouse (SDW) can't leave support of the technology attached to it. The metadata of a SDW is attached to the technologies such as metadata, geographical information systems (GIS), data warehouse, geographical metadata, metadata of data warehouse and SDW. The metadata of SDW is precisely supported by technology of geographical metadata technology of data warehouse, technology of GIS and technology of SDW. The aim of geographical metadata is to extract information, and the metadata of data warehouse is its reference.

Keywords: Meta data, GIS, SDW, OLAP, OLTP, Tools

1. INTRODUCTION

The SDW can't be conventional without supporting of metadata, the metadata plays vital role in implementing the SDW. Initially it directs the SDW how to extract diverse geographical data from different sources, geographical spatial databases; secondly, it directs the application system how to obtain the standard and integration of digital geographical product, and provides user some service about geographical product. In the past, the geographical metadata is only designed for some certain geographical databases, its content and extension can't meet the needs of SDW, and its motive is why the research of metadata on SDW becomes recently a hot spot in the worldwide domain of geographical metadata. It is an important task for SDW to research metadata on SDW, because its can determine the success of the research of SDW.

2. OUTLINE OF FUNDAMENTAL TECHNOLOGY

It plays a vital role for SDW metadata to construct warehouse. It is shared forms to realize unite operation of geographic data. It is an important tool to realize selection and application of geographic data based on standardization and integration. The organization of metadata of SDW can't lose support of the technology attached to it. This paper mainly relates these relative technologies to connect with metadata of SDW as shown in the Figure 1.

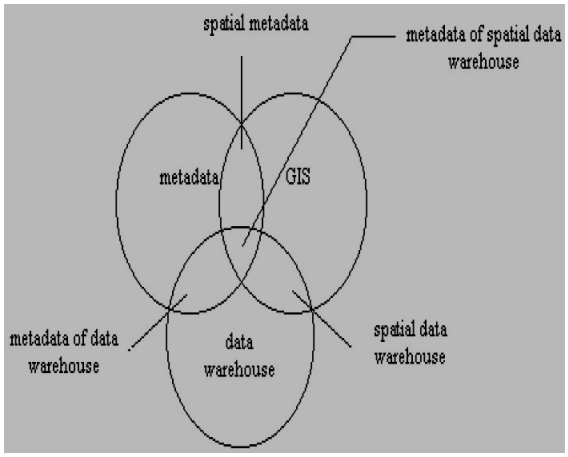

Figure1: Metadata of spatial data warehouse and relative technologies.

2.1 Geographic Information System

It is a growing technology based on computer. It is an integrated technology based on computer science, geography, survey and so on. Outstanding to the GIS research and development (R &D) and application, the GIS subject that belongs to the connection and margin comes into being. It is a technologic system to manage and study of spatial data. The support of hardware to manage and study of spatial data. The support of hardware and software of computer, GIS can function and process spatial data, manage spatial data and research spatial relation among spatial data. It can quickly obtain data to meet user by graph. GIS is a system to save and deal with sets of spatial data. GIS is divided into four (4) parts:

1. Capturing spatial data;

2. Organization of spatial data;

3. Output and display of spatial data;

4. Analysis of spatial data.

2.2 Data warehouse

Data warehouse is a data aggregation of subject-oriented, integrated, steady and managed in order to support units for decision making process. In fact, data warehouse is a managing system of network database and application system; there are lots of complex data which come from different sources in to data warehouse. There is great difference among different sources data such as data type, data formats, data accuracy and data rules etc. These different sources of data are managed by different database management systems. In general, the main task of database is to provide service for

online transaction processing (OLTP), its consistency and standard. The transaction processing is small and data capacity to be saved is small. Otherwise, database mainly manages current data set. By contraries, the historical, integrated and unaffected data set is saved in data warehouse for online analytical processing (OLAP) that is data cube. The data set in data warehouse is often modeled multi-dimension data to meet data cube.

2.3 Meta data

Metadata is data about data, there is no differentiate among other data. Many citizens consider that metadata is difficult system and needs to apply information technology (IT) and computer science. In fact, metadata is not a new concept, for e.g. book tag in library, version illumination for book publishers and disk label are metadata. It provides easy intercommunion between data producer and user that makes easy to the user to read. But when metadata is transferred into digital data, it is not easy to manage and apply metadata. The difficulties are expressed as follow: no expedient tool to select data sets from many databases; no technique message for data sets in order to no apply these data sets; no know how to understand and transform data sets when user wants to apply these data sets; no know affiliation information on data production, update and distribution; no visit to data sets by computer network.

These difficulties can be solved and overcome by metadata. It shows that it is an important tool for metadata to have user understand and apply data sets. Metadata can be used to many fields such as an enterprise of data document, data distribution and data browse and data transformation and so on. It plays vital role for metadata to encourage data management, data application and data shared. There is a firm relationship between metadata and data content to be illustrated by metadata. The content of metadata has a large differentiate for different databases.

2.4 Geographic Metadata

When geographic information emerges in digital form, some new difficulties come for management and application of geographic data. These difficulties are included as follows: it is necessary for data producer to possess a tool in order to manage and maintain nobility of geographic data, and to have the lowest effect for production and maintenance of geographic data; if data producer and user exchanges; it is necessary for data producer to have to built data document in order to save some technology information with geographic data; user need know the efficiency approach how to select geographic data, and need know the place how to find geographic data for user application; when user need to understand some digital product information with geographic data. It transforms geographic data in to different format. Under instance, it is very important to have geographic metadata for relating content, quality, status etc. The management and service of geographic metadata becomes necessary method for organization and application of information.

Geographic metadata means descriptive information of spatial data set, and is spatial\attributive\temporal exterior type and detail description to obtain, process, apply data set. It can provide characteristic information of spatial data sets for the generalization and abstraction of spatial data character. User can determine the name, source, structure, scope of data sets by the characteristic information. The difference between geographic metadata and data is that there is a lot of information with spatial location in geographic metadata.

2.5 Metadata of data warehouse

The grouping of metadata and data warehouse becomes metadata of data warehouse. The lifecycle of metadata is divided into three phases: collection, maintenance and equipment. The three phases encourage each other in order to have metadata play vital role in data warehouse.

2.5.1 Collection

The first phase of metadata lifecycle is collection. Its main job is to identify metadata and input the metadata into central database. The collection of metadata should deal automatically as possible as you can; so that there is higher reality for collection of metadata. It is groundwork for collecting proper metadata in proper time to realize successfully data warehouse. Public have no kindness that it will increase a lot of work to design and establish data warehouse. The metadata of data warehouse includes many fields in which there is own collection strategy. The collection of metadata can be deal with automatically in proper condition, but some metadata must be collect in manual.

2.5.2 Maintenance

The second phase of metadata lifecycle is maintenance. In this phase, metadata must track actual change. For e.g. if the structure of relational database table has to change, the metadata describes the table to be updated in order to manage the changes. The exclusive method to insure metadata correction and good maintenance is to have maintenance of metadata which is processed automatically. Hence, it is key difficulty to process automatically metadata. It is concluded that maintenance of metadata must be processed automatically in order to have metadata to keep in good condition in data warehouse environment. It arrive very high automatic level for physical metadata managing the structure of data source and data warehouse.

2.5.3 Equipment

The third phase of metadata lifecycle is equipment that is to provide proper metadata and its applied tool. It is the phase to yield after paying out a lot of work in the phases of collection metadata and maintenance metadata. Under environment of data warehouse, the different metadata for different users are provided. The key factor is to equip metadata to match correctly metadata and specifically demand. After metadata has been collected and maintained, metadata should be quipped to its user environment of data warehouse. It is very important task to provide proper metadata for users in data warehouse.

2.6 Spatial Data Warehouse

The combination of data warehouse and GIS becomes SDW **[1]**. The business among many subject and units is often posed when people face to modern geographic

problem. Hence, the shared operation of each other spatial information, the analysis and generalization of spatial information become very important in general research of geographic problem. In broad, GIS is subject-oriented application and is group by work flow, the data in GIS is often original state. The function of GIS is only process operation of adding, deleting, and modifying etc to data and simple spatial selection and spatial analysis.

For meeting demand of global change and stability development, a unique information view will be built so that correlative data coming from different area can be transformed into unique format and be integrated and be saved according to proper subject. SDW can satisfy these demands. SDW is more difficult than data warehouse in spatial data **[2]**. The heart problem of SDW is multi-source data combine, OLAP and data mining **[3]**.

The metadata of data warehouse is reference information of SDW. The metadata of SDW will be server for SDW. The interdependent graph among these technologic hierarchies is showed in the Figure 2.

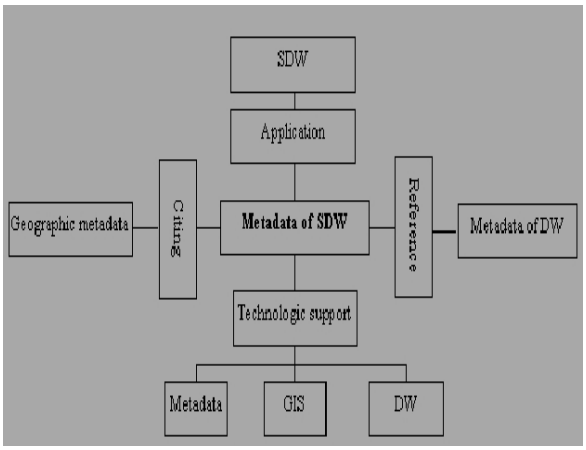

Figure 2: Interdependent graph among these technological hierarchies

The data in SDW will be selected to the user in multi-dimension in order to provide analysis tool for decision-making support, but user is not asked to be GIS professional or computer expert. So SDW should be an open system which supports various operations each other. Currently, there are many GIS systems, different program platforms and database systems are used in these GIS systems and there is no standard in these GIS systems. SDW can integrate data sets coming from different GIS and save them in order to share. The metadata plays vital role in SDW **[4]**.

3. CONCLUSION

For managing geographic data, the standardization is questioned. It is the foundation for metadata of SDW to insure effective management and operation each other of geographic data. Metadata of SDW is built on data standardization. Many countries and units have established standard of metadata content, programmed using operation tools of metadata and founded many metadata databases. These will provide a good condition for research of metadata of SDW.

4. REFERENCES

[1] Qi Li, Chaowei Yang. Data Warehouse of Spatial Information. Towards Digital Earth-Proceedings of the International Symposium on Digital Earth, Science Press, 1999

[2] Richard Annitto. The Nassau County Spatial Data Warehouse -A System Integration Challenge. URISA Annual Conference Proceedings, 1998

[3] Gonzales ML. Spatial OLAP, Conquering Geography. Db2 Magazine, Vol.4, Spring 1999

[4] Xiaofang Zhou, Jiawei Han. Efficient Polygon Amalgamation Methods for Spatial OLAP and Spatial Data Mining.Sixth SSD, 1999