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HELD ON

APRIL 6, 7, &, 8, 2005

JAFFNA, SRI LANKA

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PRESIDENTIAL ADDRESS
THEME SEMINAR
CHAIRPERSON'S ADDRESSES
REVIEW LECTURES
POPULAR LECTURE

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This volume represents a record of the proceedings of the thirteenth Annual Sessions of the Jaffna Science Association. It comprises the Presidential Address, Theme seminar (three papers), Addresses of the Chairmen of sections A and C, two Review papers and a Popular lecture presented at the thirteenth Annual Sessions of the Association held at the University of Jaffna from 6th to 8th April 2005.

I express my sincere thanks to the President Prof. A. Sanmugadas, Director, Media Resources & Training Centre, University of Jaffna, for his kind encouragement and support. I also wish to extend my special thanks to the General Secretary Dr.G.M ikunthan for his kind assistance.

Dr (Mrs).S.Sivapalan,
Chief Editor.

Unit of Siddha Medicine
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Jaffna, Sri Lanka.
April 2006

CONTENTS

ROLE OF MEDIA IN POPULARIZATION OF SCIENCE

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INTRODUCTION

People do not question traditional practices that are handed down from one generation to the next. Similarly, there is a general lack of awareness about the scientific basis of many natural phenomena. In view of the rapid strides being made in the field of science and technology, and their influence on day to day life of the people, inculcating a scientific temperament and a rational outlook in them has become all the more important. This would help them to make the right choices. It is in this context science popularization efforts assume significance. The role of media in this useful task is very much needed. Both print and electronic media all over the world are striving to popularize science. Every one must know the basics of science. Media can play a major role in this venture.

I have chosen three countries, namely India and Pakistan in South Asia and Italy in Europe, to show how various modes have been used to popularize science. The role of media in this effort is highlighted.

India

In India, an autonomous body called Vigyan Prasar under the Department of Science and Technology of the Government of India has been making a lot of efforts to popularize science. Vigyan Prasar though set up in 1989 started functioning effectively from 1994 when it undertook science popularization activities on a large scale through the media. From the time it was set up, it has published popular science books and periodicals. It has brought over 100 titles authored by experts and well known science communicators in English and other Indian languages. The topics covered in these publications are: India's scientific heritage, natural history, health, environment and biographies of scientists. It has also brought out some books in Braille for the benefit of the visually handicapped.

Vigyan Prasar has been utilising fully the print and the electronic media. It is reported that newspapers India are not reluctant to cover science and technology but the inflow of information to the print media, particularly the regional and language newspapers is scarce. Vigyan Prasar has made available ready-to-print science pages to the print media and promoted regular columns in newspapers, organized science quiz programmes and supplied articles on contemporary topics. It also issues a monthly newsletter titled Dream 2047.

Vigyan Prasar has also been utilising the services of All India Radio and Doordarshan by rendering a number of phone-in-programmes on various scientific phenomena for All India Radio to broadcast in different languages through the regional stations and video films on eclipses, comets,sc ientific institutions to Doordarshan.
Vigyan Prasar has produced video films and documentaries on Science & Technology-related topics. One such production was a three-part programme in Hindi, "Ananth Yatra", commemorating 100 years of the golden decade of 1895-1905 when major discoveries that changed the face of the world were made. Vigyan Prasar has also produced documentaries on the life and work of eminent Indian scientists, besides projecting the development of India's scientific capability through the country's historical and heritage sites.

Vigyan Prasar in order to popularize S&T uses the worldwide satellite digital radio system, "WorldSpace", and the FM radio network of the Indira Gandhi National Open University, "Gyan Vani". Schools in India have been used for producing programmes. Schools and various scientific organisations are helping Vigyan Prasar to produce a variety of software that would be of interest to students, teachers and the general public. The main objective is to introduce teachers and students to the power of digital satellite transmission.

Ham radio is another important tool that Vigyan Prasar is using to popularise science. It has been organising workshops and other programmes for those interested in radio. It has also conducted awareness programmes for the benefit of schoolchildren and the general public.

The goal of inculcating a scientific temperament and rational outlook among the people could be achieved easily if science as a subject is made interesting for the younger generation. Vigyan Prasar has been promoting

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the establishment of science clubs all over the country to make science learning joyful and meaningful. Its network (VIPNET) consists of 6,000 science clubs. If 10 persons get together they can form a science club and get it affiliated to VIPNET. It has also been involved in designing and developing activity kits and other source materials for VIPNET clubs. The activities of these clubs are highlighted through a monthly newsletter titled VIPNET News. The State S&T councils have shown a keen interest in VIPNET in order to popularise science in rural areas. VIPNET clubs through World Space Digital Radio disseminate and market S&T software in rural areas. These clubs have not only disseminated information but also mobilised the community for action. It has been reported that the VIPNET clubs in the Ratlam region had successfully mobilised the community to build water-harvesting masonry.

The home page of Vigyan Prasar Information System (VIPRIS), www.vigyanprasar.com, is one of the most comprehensive websites on S&T popularisation in India. It also runs the country's first on-line popular science magazine, titled Com-Com, and organises frequent chat sessions with experts in different fields. VIPRIS has proposed to set up easily retrievable data-bases on topics as varied as S&T in India, space, atomic energy and environment. It has also been developing websites for other scientific departments and bringing out CD-ROMs and other educational software on S&T in India. Producing quality software for S&T communication requires a good understanding of the subject matter, creativity and imagination on the part of the producer to ensure that it has the right combination of information and entertainment that will trigger an interest in science. Vigyan Prasar played a leading role in developing such software for transmission through EDUSAT, the Indian Space Research Organisation's educational satellite. Vigyan Prasar brings out a fortnightly compilation of S&T news from over 100 newspapers, titled 'VIPRIS Clip sets'. It has designed and set up information kiosks at the Department of Science and Technology and at its own office.

The activities undertaken by Vigyan Prasar have had a positive impact in India. For instance, public awareness about the scientific aspects of eclipses is found to have improved. It brings out publications on a variety of topics in all the Indian languages and had developed its monthly newsletter, Dream 2047, into a popular science magazine. It hopes to get 50,000 science clubs under VIPNET in the years to come and have them connected through satellite radio and television network. Efforts had been made to set up small FM stations that are dedicated to the creation of scientific awareness in remote areas. The number of training programmes has been increased and learning material, including kits, software, charts, posters and slides on different aspects of science have been developed.

Vigyan Prasar make use of Major scientific events to spread scientific awareness. For instance, the transit of Mercury on May 7, 2003 was a rare phenomenon, which takes place only 13 to 14 times in a century. Vigyan Prasar made use of the occasion during which Mercury comes between the Earth and the Sun, to spread awareness among the public. Arrangements were made for the public to view the celestial event through a telescope with the image of the Sun projected on to a screen. An online demonstration was organised at the Office of the Department of Science and Technology and on the Vigyan Prasar's website. During the phenomenon, which lasted five hours, the web site recorded 3,000 hits. A lecture demonstration was also organised to make the public familiar with different aspects of the transit.

On August 28, 2003, when Mars came closest to the earth, arrangements were made to enable the public to view the red planet through a telescope. Vigyan Prasar launched a nation-wide programme of science awareness in collaboration with the National Council for Science and Technology Communication when transit of Venus occurred on June 8, 2004. The National Science Day, observed every year on February 28, is another occasion to popularise science.

Science city is another landmark in popularizing science. Gradually, a notion developed in some quarters that science museums and science centres were meant primarily for the students and children, perhaps also for adults directly involved in the centres affairs in some way or the other. To dispel this misconception the science centres are constantly devising newer and novel approaches to suit the tastes of a wide cross-section of the people. A remarkable achievement in this direction has been the establishment of Science City in Calcutta on July 1 1997. In the first two months over 32 lack people have visited it.

People visit Calcutta Science City, with their families and friends for a fun-filled outing. The major attractions include the Science Park comprising large, outdoor exhibits on physical sciences which invite hands-on interactions, sprawling gardens with a myriad of flowers, birds, butterflies, cacti and bonsai as well as the musical fountains. It has also an array of aquaria with exotic fish and other aquatic animals, a well-planned 'insectarium' rearing various live insects in their recreated natural

habitat and a series of working and interactive exhibits on diverse principles of motion, transformation of energy, natural calamities and others. Visitors have the chance of flying on a simulated time machine back in the age of Pharaohs of Egypt and their pyramids. Dinosaur Alive exhibition comprising several life size animated dinosaur models attract many visitors. Science City also has the Space Theatre, the only one of its kind in the country, comprising a state-of-the-art planetarium with a multi-image projection system coupled with a large format movie projection device; the projection of the hemispherical dome aided by a dynamic sound system creates the illusion of one actually being present within the projected scene.

Pakistan

Science journalism in Pakistan is a continuation of a process that began before independence. Popularizing science is not an easy task. Pakistan has faced several barriers in this venture. One of the prevailing maxims about science Journalism in Pakistan is "If you want to commit financial suicide, launch a popular science journal." The country has seen regular launches of new science magazines, but almost all of them have faltered after a fairly short existence. The first popular science magazine in Urdu was Sa'ins (Science) launched in 1928 by Anjuman Taraq in Delhi. Publication was suspended in 1946 because of riots. In 1952, he re-launched the magazine from Karachi, but by 1954, it had ceased publication.

At around the same time, the newly founded Scientific Society of Pakistan launched Jadeed Sa'ins. Despite the society's overwhelming technical and financial support, Jadeed Sa'ins remained irregular periodical till it ceased publication in 1998. In 1964, the Pakistan Council for Scientific and Industrial Research launched Karwan e Sa'ins (Science) edited by Azmat Ali Khan. Simultaneously, the council launched two other popular science magazines, namely Science Chronicle (English) and Vigyan Prakrati (in Bangla, Published from Dhaka, in what was then East Pakistan). In January 1972, the Scientific Society of Pakistan launched the bimonthly Sa'ins Bachchon Kay Wan which was published until 1991.

In January 1985, Sayyed Qasim Mehmood brought out the monthly Talib e Ilm (The Student), renamed Magazine in 1987. In 1988, it became a weekly, but low sales soon forced a return to monthly publication. Following a long period without an editor with a scientific background, the magazine folded in 1995. In July 1988, the Association for the Promotion of Knowledge and Awareness launched Dunya e Sa'ins (The Scientific world). With a number of advertisements and colour pages, it seemed to have a jumpstart, but by the end of the first year of publication, the magazine only being published irregularly and, in 1991, it too vanished. Electro-Computer Today, a bilingual (Urdu and English) publication appeared in the early 1990s but survived for ten issues. Electronics Digest (in Urdu), launched in the mid 1990s, survived for just a few months.

In 1997, a couple of science enthusiasts decided to launch Global Sa'ins. The first issue came out in January 1998. Like its predecessors, Global Sa'ins also suffered a lot of hurdles, but has survived and prospered. In January 2002, the Urdu Science Board started the quarterly Urdu Sa'ins Magazine. So far, it is a continuous publication, but it remains an in-house journal sent only to relevant organisations. The short life expectancy of these popular science publications seems to be the result of a combination of factors. The following could be considered to be the real challenges for science journalism in Pakistan.

(1) The first problem is a lack of government support, both financial and policy-related. Despite accepting that science is vital for the country's development, the government still treats the public communication of science as 'non-developmental' activity that does not contribute to the country's social and economic development. As a result, science remains merely as something belonging to the classroom. Little support is provided to those who seek to address a wider audience, and their work is given little priority in government policy at every level. A government official has gone one step further to state that popularization of science is a waste of government funds. Only one government body, the Pakistan Science Foundation, has any responsibility for communicating science to the public. A lack of government interest in communicating science and technology to the public is reflected in comments made by the former Minister of Science and Technology and renowned scientist, Atta ur-Rahman, who said in 2001 that publishing popular science magazines is less important than enabling young people to become IT-literate. It has been pointed out that even influential policymakers seem equally reluctant to distinguish between popular science journals and primary research journals. This situation contrasts with that in India, where the government encourages popular science journals by providing grants to help ensure their financial

viability. The difference between the two policies is reflected in the abilities of students and scientists the two countries produce every year, with India considerably outperforming Pakistan, according to international measures of scientific achievement. Every industry in Pakistan owes its existence to science and technology. Despite this, the executives of private companies and state-owned organisations seem reluctant to acknowledge the importance of supporting the media's efforts to popularise science, and avoid advertising in science magazines.

(2) Another problem faced by science journalism in Pakistan is the attitude of mainstream media. Among 158 newspapers and 87 periodicals Daily Dawn is the only Pakistani newspaper with a long and sustained tradition of publishing science pages and supplements. Publishing inaccurate science features and reports is another problem. This is less often the case for science articles published in English-language newspapers, which frequently reproduce articles by international news agencies such as Reuters and Agence France Presse. Misreporting political issues can cost a journalist their job, but incorrect science reporting carries no such risk. This creates little incentive for accuracy. Writings on Pakistani academia say that though public universities, and many private institutions, offer degrees in journalism, they limit their scope to 'general newspaper journalism'. Science journalism remains an alien concept in Pakistani academia.

(3) Another problem identified is that good scientists and researchers in both the government and the private sector in Pakistan tend to be unwilling to share knowledge with the public. Neither the government nor research organisations in the private sector offer an incentive to do so.

It was against this background that the monthly magazine called Global Sa'ins was launched in January 1998. It devised a two-point strategy focusing on increasing circulation and appealing to readers. As well as working with bulk distributors in major cities, a list of hundreds of small street vendors (booksellers and hawkers) was compiled and urged them to stock Global Sa'ins. Several hundreds of readers read this magazine.

Reports point out that the political leaders, policymakers, intellectuals and scientists of Pakistan should rethink their stance on the dissemination of scientific knowledge. The media has to play a major role in popularizing science. Strengthening public understanding of science must, in principle, help education and knowledge grow and evolve and improve the economy as well. And science journalism has a vital role to play in orchestrating efforts to achieve this national goal.

Italy

In Italy, the first popular Science magazine Biblioteca fisica d'Europa was published in 1788 in Milan by doctor, chemist and naturalist Luigi Valentino Brugnatelli (1761 1818). It was created in order to "acquaint the Italian public with the most important papers of foreign scientists". The great interest in various fields of natural philosophy, characteristic of that time, along with the keenness to present progress in natural sciences led Brugnatelli to the creation of another popular science periodical called Giornale di fisica. Chimica e storia naturale (1808-1818). It was so successful that each issue sold more than 500 copies.

In southern Italy as well a young doctor and manufacturer from Teramo , Vincenzo Comi (1764 1839) founded the bi-monthly Commercio scientifico d'Europa col Regno delle Due Sicilie (1792 1793). Comi's publication was aimed at "every learned man" and featured a wide range of disciplines and stories often linked to current events written in comprehensible language. In both magazines, scientific papers and reports were summarised in less technical language. The most interesting points of the scientists' work were gathered and disseminated beyond the limits of the academic world, providing science communication to a larger sphere of learned men,a mateur scientists and entrepreneurs who were involved in industry and were interested in "progress". Commercio discontinued its publication in February 1793 because of the lack of subscribers. Even other Italian popular science magazines published in Southern Italy at the beginning of the 19th century were equally short-lived.

The period between the second half of the 19th century and the beginning of the First World War was one of the flourishing periods for Italian science popularisation. During this period, twenty-eight new magazines appeared. This unprecedented flourishing of science periodicals in the second half of the 18th century is to be understood in the light of the new scientific discoveries and theories, the technological progress in the years of slow industrial development and the rise of positivism. New magazines appeared in Italy only as late as 1924 when Scienza e tecnica pratica a popular science magazine was published and later two magazines namely, Mondo d'oggi (1934) and Sapere (1935) appeared in the early 1930s. In 1937, a fully illustrated popular science magazine, Il Giornale delle Meraviglie, was published

and three more magazines appeared between 1940 and 1944.

In 1979 new popular science magazines appeared following the publication of Scienza e vita nuova and Test (later Scienza 2000) which inaugurated the golden period of popularised science journalism in Italy. Between 1979 and 1988 thirteen magazines appeared. The publishing sector allocated funds to periodical publications. In those years of economic prosperity, science journalism was supported financially by companies operating in the field of science and technology.

Chemistry and medicine were among the disciplines which most frequently appeared in the first popular science magazines, followed closely by industry-related news. According to the analysis of Biblioteca fisica d'Europa and of Commercio scientifico d'Europa con il Regno delle Due Sicilie, what we now call physics and natural philosophy didn't appear regularly but their presence was nonetheless significant. This is accounted for by the fact that the founders of the first popular science magazines were chemists and doctors like Brugnatelli, Comi and Todde, a pharmacist from Sardinia, whose Compilatore delle cognizioni utili expressed the hope that Italy, too, could become an industrially developed country. In the medical field, the most frequent items were information on surgery techniques, principles of hygiene and news related to public health. News reports where scientific innovations played a significant role often appeared.

A Science Journalist studied closely forty-two magazines published between 1864 and 2002 in order to examine their contents has given his findings. In the second half of the 19th century articles and news on electricity were extremely widespread. Towards the end of the 19th century, photography and cinematography appeared and in the middle of the 20th century, technological applications in home and leisure activities had particular appeal to readers. Since popular science magazines devoted a great deal of space to current issues, the latter were all gathered together in a special category which includes current events and articles on aspects of social, political and economic life.

From his analysis we find that industry, medicine and physics receive constant attention. Astronomy remains for practically more than a century among the most frequently covered disciplines due to its permanent appeal to the public. Zoology and nature in general have received growing attention over the years whereas other topics fluctuated considerably over time. For example, electricity was among the most extensively covered topics during the entire second half of the 19th century. However, attention to this topic wavered considerably in the period between the two world wars. Other topics, such as agriculture and meteorology equally lost their interest while new topics, such as computer science, space and the environment, gained appeal in popular science magazines in the second half of the 20th century.

Science news reporting was adopted by the very first popular science magazines in Italy. Along with scientific papers on the latest theories and discoveries, brief news items were published. In 50 years' time news items became the pillar of a large number of popular science magazines. They were often presented in the form of very short articles written in everyday language. Rather than popularise science, the aim of those magazines was to inform readers and bring them up to date with the latest news from the world of science and industry.

The popularisation aspect was emphasised in the years that followed the unification of Italy when a large number of popular science magazines were published. Those publications were full of news and information, including information of commercial interest, on new products, inventions, technological procedures useful to industry and objects of various natures which closely concerned everyday life. If one browses through the popular science magazines circulating in the second half of the 19th century, the importance of reporting as many news items as possible becomes evident.

From the second half of the 19th century on, some popular science magazines opted for another form of introducing readers to scientific topics: they published short stories, whose style was very similar to that of novels, describing scientists'l ives and discoverers. They were based on the lines of popular books written by famous British and French writers who popularised science such as Emile Rengade's La vita normale e la salute or Camile Flammarion's La terra e il cielo (Dans le ciel et sur la teree). Their works appeared in the form of serial novels in La Scienza per tutti, a popular science magazine which also ran a serial feature on the "Martyrs of science".

Some popular science magazines such as La Scienza e la fede adopted dialogue between teacher and student as an approach used mainly in order to analyse theoretical topics such as the relation between science and faith of the nature of scientific knowledge.

Dialogue was one of the least used communication modes in popular science magazines although it never ceased to exist completely. Almost 100 years after the appearance of La Scienza e la fede, other popular science magazines

still used dialogue in order to introduce and explain new terms and, above all, new concepts, just as Scienza e lavoro did in the 1940s and 1950s.

After the Second World War part of the popular science press continued cultivating the image of a science which provides certainties, truths and social well-being. That tendency is confirmed by the way in which fear that scientific research was being used to construct lethal weapons such as the atomic bomb was dealt with positive images of a future when technology would be the pillar of an advanced society were often presented. "In 2000 we will be young at 100 years of age" claimed La Scienza Illustrata in 1955. It was one of the many dreams of that time with reference to the mythical 2000 when it was imagined there would be nuclear railway engines and cars that could travel at sea or in the air (Scienza e vita, 1965). In addition, the dividing line between scientifically grounded forecasts and pure imagination was very subtle. In fact, particularly in the 1950s, it was possible to read on the front cover of a popular science magazine: "Flying saucers exist for real" and find an illustrated report on the inside with the title "Flying saucer mystery revealed".

Sri Lanka

In the Internet we find that The National Science Foundation of Sri Lanka is responsible for popularization of Science. In its own way it has contributed to the Science Education in Sri Lanka. It has brought out more than 147 titles of Journals, books and monographs. It has the following publications:

1. Journal of The National Science Foundation of Sri Lanka
2. Sri Lanka Journal of Social Sciences
3. Vidurava (Science Bulletin) ceased from 2003.
4. Social Science News
5. NSF Monographs
6. MAB Publications
7. NSF Newsletter (Vidya)
8. Science Education Series
9. Posters.

The NSF has not collaborated with any type of media to popularize science in this country.

In the print-media articles on scientific topics use to appear. But we see no conscious attempt has been made to use the media to educate the public at least in basic scientific topics.

In Sri Lanka, the setting up of a Planetarium was the first attempt to popularize science. Similar attempts have not been made. But there are Associations and Clubs that pay an attention to this useful task. For example Jaffna Science Association from its inception has been making effort to popularize science by its annual exhibitions. Some of the members of the Association have been making use of the regional print media to publish articles that enlighten the public on certain scientific matters.

Let us take a closer look at the situation prevailing in the media industry with reference to popularization of Science in Tamil. Comparing with English and Sinhala media, the Tamil media has made only a little effort. But we cannot forget the effort made by the print media to educate the farmers especially youngsters in identifying the new types of paddy and the use of various types of fertilizers and insecticides. Regional papers devote some space for science education. Tsunami disaster has forced some of the scientists to write on the technical aspects of Tsunami, earth quake, etc. These writers were genuinely indulging in educating the public on the scientific aspects of the natural disasters. Like Vigyan Prasar, a centralized media body has to be set up to popularize science. Independently some creative literary writers have written stories, novels and poetry to give simple explanations to scientific concepts.

In conclusion, let me reiterate that media has an important responsibility. It has to educate the people. Today science education is the primary one. Every man and woman has to know and understand simple scientific truths. This argumentation consists of three steps:

1. The well being of the society in any respect- is depending on science. Scientific knowledge is superior to other forms of knowledge, especially to those of the lay public. But unfortunately not all see the cases like that. So precautionary, a crisis of science has to be proclaimed.

2. To solve this pretended crisis the lay public has to be educated about the scientific progress in order to "understand", that means to accept it and support it. Terms like "science literacy" and "public understanding of science" are used to measure how far the public is already enlightened.

3. The media is declared to be responsible for the popularization of science. In other words: The communication problem of science becomes now a communication problem of the media.

ECONOMIC WELFARE *

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Respected Chairman of the session, Prof.C.Sivagnanasundaram, The Distinguished Chief Guest , Prof. Eric H. Karunanayake, The President and other members of Jaffna Science Association, friends and Colleagues,

It is really a grateful opportunity of being invited to talk on the most crucial topics on Social welfare in an environment where the Tsunami has wiped out completely the rest of the things that were left by the ongoing war in our society.

My part is here to focus economic aspects of social welfare which is the base for any development and I feel it is better to think in a way by answering many questions for the achievement of social welfare through economic ladder. I can start from pointing out the major social problems faced by humanity, and defining the term "what is social welfare?" in general.

Social Problems

The answers for the question what are the major social problems faced by humanity may be varied. To some, the high rates of crime may be the major problem.. To some, the state of the economy. To some use of the children for sexual enjoyment. A student's responses tend to mirror everything highlighted by the mass media particularly AIDS, Child abuse, poverty, war, famine, racism, sexism, crime, riots, the environment, abortion, etc. Some of the above issues are environment related. Some are interlinked with culture and some are interrelated with economics. Encyclopedia Britannica denotes that the basic concerns of social welfare are poverty, disability and disease, the dependent young and elderly and these are as old as society itself. The most common welfare programs are elder, disabled, mothers, unemployed. The objective of social work is to help individuals, family, community and group of persons who are socially disadvantaged and to contribute to the creation of conditions that will enhance social functioning and prevent break down.

What is social welfare

When we talk about the definition of social welfare it can be briefly defined as the total well being of a community. When we refer to someone's well being we are referring to whether they are healthy, happy, etc. so that life is enjoyable and worth living. It is believed that every technological advance contributes to the well being of mankind.

In British context, the term social welfare is used in the sense of social security means government payments to people who are unemployed, ill, disabled etc. In most countries social welfare services or personal social services are often attached to other major social services such as social security, health care, education and housing.

From the above definition we could understand there are two types of population in any society i.e. Independent and dependent. Though youth and the adult are considered as independent population the ongoing war and country's economic policies have inevitably made majority of independent population as dependent. To explain the both types of population it is prerequisite to ask the next question what is the present condition of our society in terms of independent and dependent population.

Present condition of the society

The world is now surrounded by poor productivity due to deteriorating environmental conditions, natural and man made disasters, poor security conditions, inaccessibility to resources, denial of basic rights etc. Despite the positive steps taken after the peace process major economic problems such as poverty, unemployment, inflation, macro economic imbalances, and vulnerability of external shocks and ,at present, major sociological and economic set backs of Tsunami continue to threaten the country's ability to move along a long term sustainable growth path. Every one agrees that peace is essential for economic development and the war creates a huge economic burden. The cost of the war has been very clear during the last two decades resulting low per capita income, lower employment opportunities high inflation, low productivity, destruction of infra structure facilities weakening of market confidence, discouraging investment from inside as well from outside.

* Theme Seminar

Stumbling blocks of social welfare

Internal Displacement

Depending upon state government officials and other authorities for protection and assistance Internally Displaced People (IDPs) have been described as the single largest at risk population in the world. They are the people in desperate straits enjoying a little international sympathy or protection. Often destitute and marginalized, IDPs are likely to have their fundamental rights and freedom compromised, their economic and political opportunities denied.

There are almost certainly more internally displaced persons in the world than refugees. The most reliable estimates indicate that in addition to 12 Mn refugees, approximately 25Mn people are internally displaced within their own country. Sri Lanka has one of the largest IDP populations in the world. The estimate in mid 2001 shows that 1 of every 25 citizen in Sri Lanka are displaced and 1of 3 persons is an IDP in Northern Province.

However, we cannot ignore the fact that they are the people who have been left out to be remembered on humanitarian ground. These are the people in an extreme state of distress getting no assistance in their long displaced life. It has been estimated that even though 49,000 families have returned back to Jaffna peninsula nearly 18,000 families are still living in welfare centers and out side the welfare centers. In addition to this another 20,000 families are expected to come back from other districts if the situation permits. Most of the IDPs in coastal areas do not even have proper water and sanitation facilities.

Poverty

The problem of poverty expresses itself in many ways. Uneconomic holdings, large family to support, poor housing facilities, lack of amenities like education sanitary etc., malnutrition, poor health, illiteracy..... All these make people economically poor, socially weak and politically vulnerable and open for exploitation. Hunger leaves scars on which some are visible and some are not visible. Invisible scars are the long term effects of hunger that run in families through succeeding generations. The most obvious birthmark of hunger is the size and weight of a new born. Food deprived children carry a great risk of neurological deficiencies that result in poor vision, impaired educational attainment, cerebral problems.

Personal distress

Personal distress may be the first enemy for the happiness of mankind. Human development report records that among the countries categorized under medium human development, Sri Lanka records 44 people in every 1 lack of population committed suicide whereas India, the another medium development country has only 11.4 committed suicide.

Incompetent education

Insufficient opportunities for higher education create serious economic social and political problems and lead to social unrest among youth. Though our country marks extraordinarily high rates of literacy and place herself among other developed countries this high rates of literacy has not been translated to satisfactory learning achievements gearing towards sustainable economic development. Regional disparities in service delivery, legislative constraints preventing private sector participation, inadequate teacher deployment, excessively centralized education management, acute shortage of quality inputs in class rooms, insufficient attention to the role of education in promoting social harmony have been identified as quality constraint in education. Serious inadequacy in tertiary education opportunities as well as skill and competency gaps among university graduates has also been a serious problem. Above all every youth has been brought up in a way to think about government oriented employment is his ultimate aim and not be proud of being a self employed person unemployment rate of educated youth are ever increasing.

Unemployment

The following issues could be taken into consideration with regard to unemployment.

1. The first one is to overcome the nagging problem of educated youth unemployment. According to 2002 statistics 31.6 % who have completed their O/L and above are unemployed. Though there are initiatives by the country for integrated package of employment oriented training which includes Leadership, English, Computer and Information Technology, productivity and career guidance, Vocational training and others until we are prepared to freed ourselves from the conservative concept of seeking government oriented jobs and being proud of government servant the total contribution of youth in the well being of the society is not reach out.
2. Unemployed graduates are another major issue and Higher education institutions have failed to train their educated citizens to get down to self

employment activities. Nearly 25 thousands unemployed graduates are waiting and the state is in a position to minimize the mismatch between the human resource needs of the private sector and the qualifications of these graduates produced by state run universities by providing computer training and English language training.

Under employment and Women welfare

Down below the economic ladder, at the bottom most rung, is a whole group of working women in the informal sector, who are mere coolies, left uncared for, with no support or social security at the work front. This neglected lot works hard and without respite, at home and out of it, only to earn a pittance and live a life of drudgery. Lack of education, apathetic government policies, a faulty social system and erroneous beliefs and dogma are the culprits. "uplifting the woman at the grass root level would alone help society flourish"

There is a need of educated social workers who will be able to go to the slums and speaks of hygiene, small family norms, mother and child care, literacy or social evils. People from among the poor should be selected and trained for this purpose. Otherwise having been blessed with everything in life have-nots will never respond the advises of haves. In the year 2002 there are 619,704 widows and orphans in the Northeast.

Small loans at nominal interest rates would help them to develop their own small business, be it vegetable vending or weaving. "Even if a woman has no experiences about any business she can be trained through vocational training centers to take up a small business of her choice and loan can be provided.

According to the statistics in 2000 there are nearly 110 small industries training centers in Northeast. These includes coir center, handloom textiles, pottery making, cane product, brass center, dye centers sales center and others. Jaffna representing highest number in handloom textile in which there are 92 centers in Jaffna.

Collective welfare for dependent population

Social life particularly in the complex forms of civilized societies creates many dependencies among members of a community. The welfare of each member depends upon the exercise of restraint and precaution by others in the pursuit of their legitimate activities as well as upon cooperation towards certain common objectives. These matters of collective welfare involve many kinds of interests that may be said to be processed by the community. The last half century has witnessed an expansion in the role of every state as a guarantor of public well-being and every country is now expected to play the leading role in the planning and provision of human services.

The assumption of greater public responsibility for human needs may have proceeded to the point where we have lost sight of the substantial role that informal care giving and mutual aid still play in the daily lives of clients and those who manage not to become clients. We may forget that family members,f riends,n eighbors,c lergy and others who might be labeled as "just plain citizens" often comprise an informal circle of helpers for a person experiencing problems and that formal help from agencies and trained professionals is sought only as a last resort. Considering the two sides of arguments regarding the responsibility for care one side emphasizes the need for family and community responsibility and other side calls for state intervention and public responsibility. However, it seems clear that due to the scarcity of resources, no one source of care- public, private, or voluntary- can by itself adequately meets the needs of dependent population.

Like other developing countries, formal services in Sri Lanka are generally under resourced and the traditional networks of informal care are the main source of assistance. High rates of migration and unplanned urban growth, however, have weakened this network in impoverished rural areas and overwhelmed the limited public services in cities. Indigenous overcrowding and poor housing, unemployment and over wages, inadequate sanitation is not responsive to western methods of personal social service intervention. In the poorest rural areas where the majority of people live at or well below subsistence level, disaster relief is heavily supplemented by international aid agencies such as UN and charities such as save the children fund.

Present social realities in terms of the exploitation, abuses, addiction and child prostitution that we see in our midst. It exposes the problems of the elderly, the struggles of the refugees, and the needs of the slum dwellers. It calls on social workers to reflect on the role of the profession towards such issues.

Family welfare

Throughout history the family has been the most effective and primary transmitter of values beliefs and behaviors for good or ill. Social welfare and case workers generally regard family life as the real context for the promotion of social welfare. Family welfare programs seek to preserve and strengthen the family unit through both economic

assistance where available and personal assistance with a variety of services.

National and International help

In Sri Lanka Janasaviya, Samurthi, the food stamp and mid day meal schemes are existing govt. sponsored poverty alleviation programs. The major scheme Samurdhi, which commenced in June 1995, was the major strategy of state intervention in alleviating poverty at the national level starting with the family unit and uplifting the economic status of the marginalized poverty groups. The main objectives of the Samurdhi program is to improve the living standards of the poor with direct assistance to vulnerable groups and to assist in various other programs such as small scale infrastructure development training and financial and social security to raise the income level of poor. The implementation strategy of the Samurdhi is basically two fold.: the income supplement program, and the social and economic infrastructure development program increasing employment opportunities. nearly 50% of the population or total 2.1 Mn family units were covered under this program. Samurdhi relief ranges from 250/= to 1000/=. Amparai, batticaloa Trinco and Vavuniya have quite number of beneficiaries under social services assistance.

Working for the upliftment of the marginalized and releasing them from the clutches of poverty and exploitation are the main focus of international and national humanitarian agencies.

Housing construction is an important economic activity. The national housing development authority implemented seven major housing programs namely Janaudana, rural, urban, estate, direct construction, disaster housing and fisheries housing.A mong these disaster housing has been designed especially to provide houses to displaced families in the northeast provinces. Under this program 2351 houses were completed at a total cost of 25mn.
we have to mention the UNHCR's Quick impact projects in Jaffna for vanni returnees. Under these projects 2205 IDPs were relocated and resettled through out Jaffna district, and 41,141 families are awaiting resettlement. Providing shelter is the major concern of the QIP since it is the heart of life . Nearly 65% of the allocation was devoted to shelter program. Under this program 1080 families were relocated with other communities through out Jaffna district with an intention to strengthen the community through social integration of the returnees with the local population.. Ilavalai and Kudathanai are the best examples for the successful implementation of emergency shelter with effective community participation. No one can deny the fact that though they are still landless, lost their own land in army occupied areas, and are under the poverty line working hard for their daily bread, certainly the collaborative efforts of each and every family, their day and night hard work and the will to live made these simple temporary emergency shelters as lovely camp like their own dwellings. When analyzing the nature of these families it became apparent that every individual of these families have "we" feelings which marks them off as coherent communities living together in a same place.

Child welfare.

A paramount concern in all family welfare programs is the welfare of children. Usually children services are rendered within the setting of home life. Income assistance to parents may help to ensure that the basic security of the family structure. maternal, prenatal and child health care programs are important in all societies but especially so in those affected by widespread disease and malnutrition; infant and maternal mortality rates are, in fact, the most basic indexes of child welfare. The increasing number of working mothers worldwide has given rise to day care services from simple custodial supervision to educational and health care programs. Totally 50 day care centers are in northeast and number of beneficiaries are 2214 for the year 2001. Amparai has recorded highest percentage on which 29 day care centers are functioning.

According to the statistics of Dept of Social welfare there are 31 children homes comprising 1695 children in Northeast in 2001 Ramakrishna mission, Boys home in batticaloa, Ghandhi nilayam, Kurukulam, Punith pumi, Barathi illam, centhalir in Vanni thayakam, karuna nilayam in Jaffna are important to mention.

Welfare of the elderly

The elderly now constitute the largest single client group using personal social services worldwide. In all advanced industrial societies the proportion of infirm elderly is on the increase. And although they constitute only a small minority of the retired population the claim on social services is disproportionately heavy. Because social care for the elderly is often labour intensive. In Tamil society elders are still considerate as important custodians of homes there are homes for elderly in North east. According to the statistics though 409 elders are cared in home for elders

Welfare of the sick and disabled

The new term for the disabled differently able falls into two major groups; those who are too handicapped ever to

have earned a livelihood such as children, the mentally disturbed and defective, the blind and those who although disabled have had a record of earned income.

Serious illness and disability account for many of the problems addressed by social services. In addition to the need for adequate primary care, the ill and disabled also frequently face disruption or loss income, inability to meet family responsibilities, the long term process of recovery or adjustment to handicaps, and ongoing care in the form of medication, therapy, and the observance of dietary or other precaution. In Sri Lanka aid to the disabled is accomplished imperfectly through a combination of state and local aid.

According to the statistics of Dept. of Social welfare there are 308 disables in northeast in 2001. Nuffield and Valvakam in Jaffna, Victory home, Iniya valvu illam in Vanni, Dharisanam, Osanam and Eastern Islamic disabled welfare in Batticaloa, School for Hearing impaired in Trinco are some of the important homes to be mentioned here. The equipments like Tricycle, wheel chair spectacles, earphones crutches, white cane Artificial leg are issued for the handicapped. Most of these homes are aided by national and international NGOs and individuals from abroad also considerably help in this regard.

Total well-being of a society

As a concluding remark I wish to point out that the total well being of the society is possible when the independent population of a community must be in a position to help the dependent population.. Unless the welfare of each person in a community is achieved, the welfare of a community as a whole is impossible. If we argue the money and the materials are the most important factors for the well-being, we should not forget the present realities in front of us in which foreign income has to some extent considerably changed the rural areas.

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CULTURAL WELFARE *

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What is culture? You can get a large number of definition for it.

An early definition is that, 'a particular society at a particular time and place'.

It was also said that "The taste in art and manners that are favoured by a social group or all the knowledge and values shared by a society'.

In biology culture means 'the raising of micro organisms, plants and animals'. If we say 'the culture of oysters' for example, you know all of them are alike in many features.

Here it self a question arises? Are we Sri Lankan Tamils alike in many features where ever we live in this earth?

We may try to define culture as follows, ' culture is the accumulated habits, attitudes, beliefs, customs, tradition, values, way of dealing with their problems, goals, art, literature, religion, philosophy, food, clothing, buildings, tools, machines, roads and canals and everything of a group of people that define for them the general behaviour and way of life that is the total set of learnt and shared activities of a group of people and transmitted from one generation to the other. Some scientists view culture very broadly as the beliefs and values, tastes and interests, knowledge, behaviour and even the very ways the individual conceive of their selves. Culture in short has come to be seen as the fabric out of which the social is made.

In another way you could also say that culture is the equivalent and complementary meaning approximately shared by members of a society. Feelings and behaviour related to sexuality are also a part of a larger system of culture.

So, culture is the sum total of the ways of life of people includes norms learned behaviour, patterns and artifacts how people feel and interact the means by which they order and interpret the world ways of perceiving, relating and interpreting events based on established social norms a system of standards for preceiving, believing, evaluating and acting.

People learn culture and that is cultures essential feature. Many qualities of human life are transmitted genetically. An infants desire for food is triggered by physiological characteristics determined within the human genetic code. An adults specific desire for milk and 'Thosai' in the morning on the other hand can not be explained genetically rather it is a learned response to morning hunger.

Culture as a body of learned behaviours common to a given human society, acts rather like a template. That means it has predictable form and content, shaping behaviour and consciousness with in a human society from generation to generation. So culture resides in all learned behaviours and in some shaping template or consciousness prior to behaviour as well. That is a culture template can be in place to the birth of an individual person.

The primary concept of a shaping template might be further broken down.

i. Systems of meaning of which language is primary
ii. Ways of organising society from kinship groups to states and multinational co-operations.
iii. The distinctive techniques of a group and their characteristic products.

Because the relationship between what is taught and what is learned is not absolute, some of what is taught is lost while new discoveries are constantly being made culture exists in a constant change.

Meaning systems consists of negotiated agreements members of a human society must agree to relationships between a word, behaviour or other symbol and its corresponding significance or meaning. To the extent that culture consists of systems of meaning it also consists of negotiated agreements and process of negotiations.

So we have the sense that there is much disagreement about the word and concept of culture and we realize that any definition is part of an on going conversation about what we should take culture to mean.

* Theme Seminar

Mathew Arnold a pre eminent poet of the Victorian era saw culture 'contact with the best which has been thought and said in the world'. His view of culture as involving such characteristic as 'beauty'. 'intelligence' and 'perfection' is a 'Neoplatonic' one. These values exist in the abstract and are the same for all human societies. But the common idea is that values, behaviours and ideologies are different from people to people.

This is a view in which all the love of our neighbour, the impulse towards action, help and beneficience, the desire for removing human error, clearing human confusion, and diminishing human misery, the noble aspiration to leave the world better and happier than we found it, come in as part of the grounds of culture and the main and pre eminent part. Culture is then properly described not as having its origin in curiosity but as having its origin in the love of perfection. It is a study of perfection.

The Greek idea of a finely tempered nature gives exactly the notion of perfection as culture brings us to conceive it a harmonious perfection a perfection in which the characters of beauty and intelligence are both present.

At the same time, culture is ordinary. Every human society has its own shape,i ts own purpose and its meanings.

So a culture has two aspects.

i. The known meanings and direction which its members are trained to
ii. The new observation and meanings which are offered to tested.

So, culture is always both traditional and creative
The Greek culture and the ancient Roman culture are famous in the world. If we come to the Tamil culture, the external manifestation of Tamil culture may be found in our folk songs, and dances, un the food and dress forms. But as always, the external go with the internal.

In 1996, a series of articles written by C. Kumarabarathy of Wellington, New Zealand looked at Tamil culture from the stand point of an expatriate Tamil in an emerging post modern world. His reflection provided food for our thought.

If culture is the distilled essence of the way of life of people, them in the case of Tamil people, the distillation process has covered a time span of more than 2000 years. And to-day the Tamil people living in many lands across distinct seas acquire strength from the richness of their own cultural heritage not only because that culture has something to do with their our roots and their way of life, but also because they believe that culture has a significant contribution to make the world.

As the Czech Prof. Dr. K. V. Zvelebil said, 'There is no doubt that the culture of the Tamils belongs to the great and immortal treasures of the world civilisation'.

So, now it is the main task of the academics of Tamil culture to acquaint the worlds' cultural public with the most important contributions of Tamil culture to the worlds civilisation because most of the population are not aware of it.

As far as literary works are concerned, it is necessary before all to make them accessible to a wide public of readers by means of artistic translations in to the world great languages.

With regards to the works of art and architecture it is necessary to make them a common treasure of the world with the help of publication giving detailed and perfect reproduction. This may be achieved through the UNESCO as well as through the work of individual scholars and local institutions.

The following works should be made familiar to the whole world.

i. The ancient Tamil lyrical poetry.
ii. The Thirukkural
iii. The epical poem 'Silappathikaram'.
iv. The school of Bakthi, both Vaishnave and Saiva, specially the works of Manivasagar, Sampanthar, Nammalvar and Andal.
v. The philosophic system of Saiva Sidhdantha.
vi. The Dravidian temple Architecture of which the chief representatives are from the temples of Thanjavoor, Chithamparam and Madurai.

With all the classical dances of the Ancient Tamils, both Sri Lankan and Indian, the poetic works of Barathy should be taken care of.

And today the internets and the world wide webs have rendered that task hopefully less difficult.

So far we have thought about some things that we have to preserve. Are there anything that we have to change? Yes a lot.

As I said in the very beginning, we the Sri Lankan Tamils or the Tamils in common should try to maintain many features alike. Where ever we live in this world. Otherwise culture may loose its meaning in our future generations.

And as we said earlier, culture is a system of meaning of

which language is primary. We all know the fact that the language skills of our society is falling fast even in our country. In the other countries, we are in doubt whether the next generation would know to read and write the language. So we have to put a 'stop loss' order at some point.

Another important thing to observe is that we are gradually changing to an aggressive culture. There is a common opinion in the world that Sri Lankan tamils are very aggressive and without manners. We have to observe closely this criticism and develop ourselves. The way of dealing with problems is a part of culture. We have to study a bit about it from other cultures.

We still belief in Ghosts and offering animal blood to God. We have a custom of dowry. We have a tradition of listening to the voice of lizard. We believe in caste system even now at least in marriages. We perceive things more negatively when empared to the other cultures. We don't trust people and we don't behave in a way so that others would trust us also. We belief money and power are the only important factors to live happily in this world. So, these sre some of the many things where we need changes.

We should not allow other cultures to mix in our rituals. For example our way of during a funeral is very healthy. Phychologists are of opinion that we give a lot of chances to grief and mourn. The chances are less to became depressed after a loss if we go through our cultural process. We have to keep them up.

We said that culture exists in a constant state of change. So the changes in food, clothing, buildings, tools, machines, roads and canals I hope that we may have to accept the changes because there is no harm in accepting the changes in these parts. We have to try and add some good aspects of other cultures to ours. For example the sitting method on the floor while doing some work at home in Japan is something we could take in with our culture. In European culture people get together for dinners in the week ends. We may follow it.

I wish to finish this article by saying, 'culture consists in the way that help certain thoughts are used to others think'. So thank you very much for this opportunity for giving some of my thoughts to arouse your thoughts.

HEALTH & SOCIAL WELFARE *

Aiming towards future

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President of JSA, the Chairperson, distinguish guests and friends! First of all I thank the JSA for inviting me to participate in the theme seminar.

Health and Welfare are the two terms often go hand in hand. Health comes as a priority issue whenever we discuss about welfare. Health of an individual is defined by world health organization as physical, mental, social (& spiritual) well being and not merely the absence of disease. Welfare of an individual is defined as physical, social, and financial well being: the physical, social and financial conditions under which somebody may live satisfactorily. Health and welfare of a society is much broader than what is defined for an individual. Welfare of a society is a multidisciplinary thing. There are many partners involved and responsible for social welfare. There is no absolute or perfect health whether individual or society can achieve. Gold standard healthy society is an imaginary thing. When we talk about health and welfare we talk about improvements from the current situation. Even the well developed countries are trying to improve the health and welfare of their citizens.

My discussion will be based on some of the future demand on welfare services on health aspects in Sri Lanka. Currently, Sri Lanka is in demographic transition (change in age structure of the population) and epidemiological transition (change in disease pattern).

Demographic transition

Improvement in diagnosis and treatment facilities, improvements in living conditions have contributed to reduction in death rates in all ages and increased life expectancy at any given age. Increase female education, acceptance of family planning, increase age of marriage and many other factors have lead to reduction in the birth rates.

Figure 1: Age structure of the population in 1981

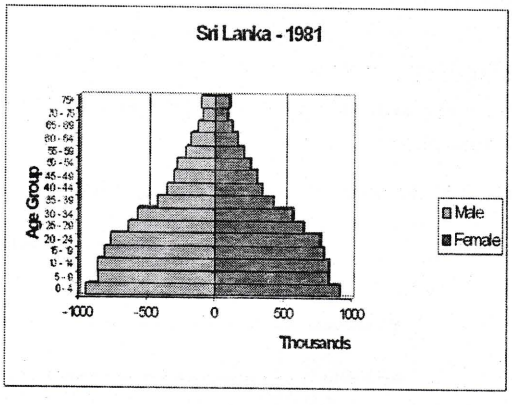


Figure 2: Projected age structure in 2010

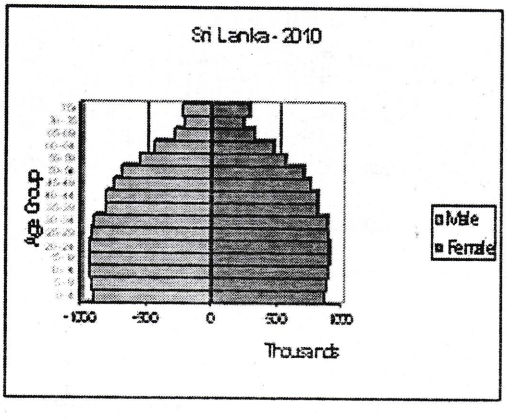
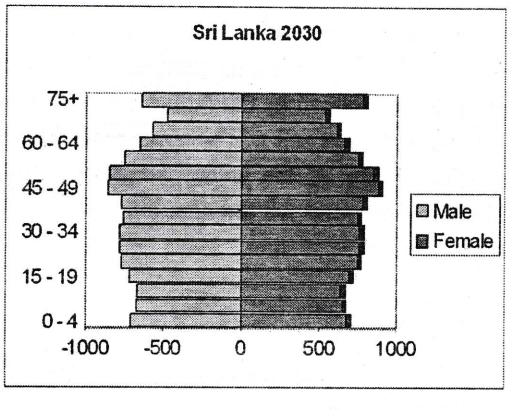


Figure 3: Projected age structure in 2030



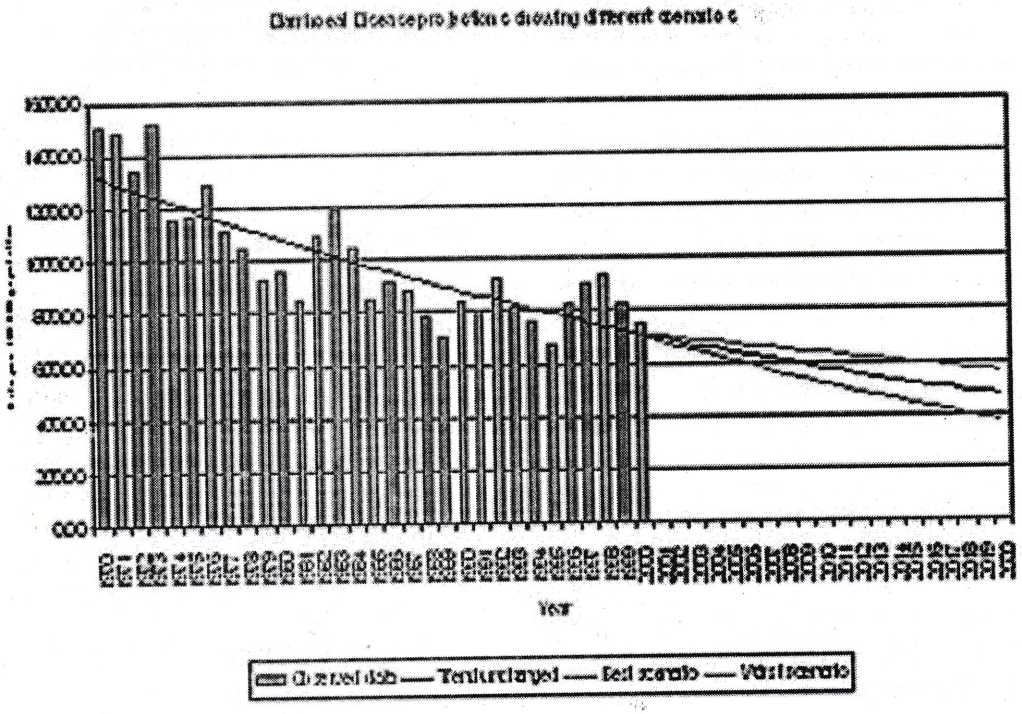
As a result of reduced birth rates and death rates the population is fast ageing. Projected age structure of the population at the end of first quarter of 21st century is described in figure 3. We will be having more elderly population than before. Among the elders females will be slightly higher in number than males. Now there are about one in ten people are above the age of sixty years. This figure will increase in two folds in 2030 where one out of five people will be above the age of sixty. Aged dependency ratio (ratio between the +60 age group and 15-49 age group) will increase from 15.4% in 2001 to 36% in 2031. Middle age people (15-49 years) will have to look after more elders than youngsters. One working person will have to look after six elders in future where as now one working person is looking after only three elders.

still morbidity (disease burden) due to communicable disease is a public health problem.

As our population is fast ageing and our life styles have changed non communicable disease like hypertension (high blood pressure), diabetes mellitus, heart diseases, cancers,e tc in our population are on the increase.

Apart from this communicable diseases and non communicable diseases, accidents are on the increase. Road traffic accidents kill nearly 2000 people on the road every year in Sri Lanka. There are no reliable data on home accidents and industrial accidents. This situation is described as triple burden of diseases ie: communicable diseases, non communicable diseases and road traffic accidents.

Figure 4 Disease projections for diarrhoeal diseases



Nearly 25% of the present population is comprised of adolescents and young adults. In actual number there are more than five million young people. This cohort of people will become will be the future working group for the next three decades and will become elders in 50 years time. Taking care of this young people will result in healthy working group for the next 30 years and active ageing group in 50 years time.

Epidemiological transition

Improvements in the preventive health care and advancement in treatment options have lead to reduction in mortality (deaths) due to communicable disease, but

Therefore our welfare services need to focus on preventing communicable diseases like improvement in living conditions and sanitation; addressing the issues of non communicable diseases like lifestyle changes; and programmes to prevent accidents mainly on the road.

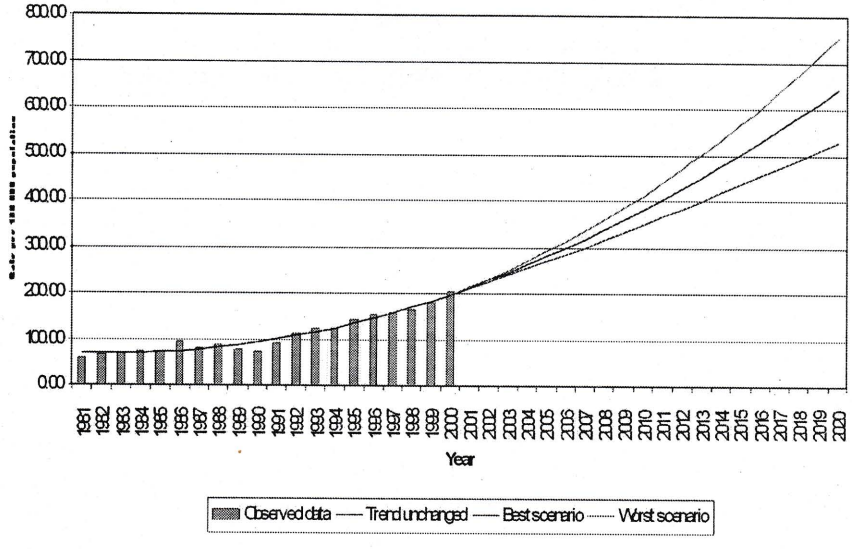
As we will be facing more number of elders in the population our welfare services also need to address the needs of the elders. As our family types have changed from extended family to nuclear family taking care of the elders will be a problem. This will be further aggravated by the fact more and more younger generation willing to migrate to other countries. This will result in greater

demand for elder's homes. Doctors need to be specialized in geriatric care because they will be seeing more elders than youngsters. Elders need specialized clinics. Health insurance schemes have to be developed to cater the health demands of the elders. Day care centers can play an important role in welfare of the elders. Day care centre is a place where the elders can come during the day time, chat, read news papers, do exercise, have lunch and relax. This type of day care centers are plenty in the western world, but we need to think of developing one to suit our own culture.

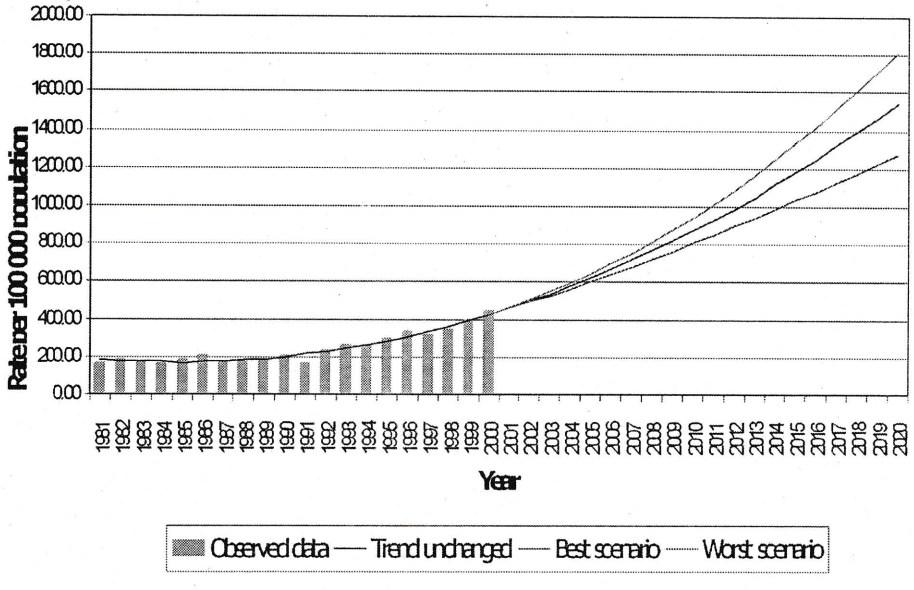
We have a group of adolescents and young adults in our population (nearly five million in Sri Lanka). This young people will be middle age working group in 2030 and will represent the elderly population in 2050. This cohort of adolescents have to be looked after well so that we will have a quality working age group in the future. If the lifestyle changes and risk factor modifications are made at early stage future elders will be more healthier than we expect.

In conclusion our population is fast ageing and the disease pattern also have changed a lot. Therefore our services future nation.

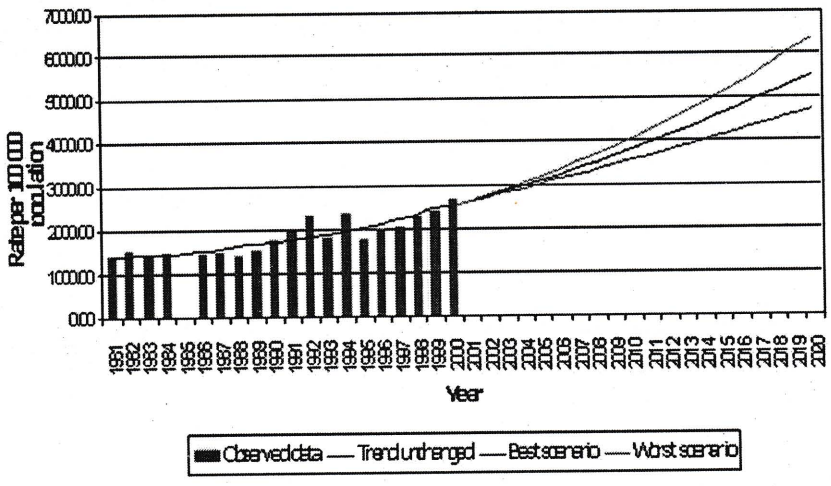
Diabetes Mellitus projections showing different scenarios



Hypertension projections showing different scenarios



Traumatic Injuries projections showing different scenarios



UNDERSTANDING CHAOS

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1 Introduction

You are watching a cricket match either in a play ground or in a television. The batsman hits the ball, the crowd roars as the ball heads towards the boundary. As soon as the ball leaves the bat, one of the fielders starts running in a predetermined direction and speed. Player and ball converge on the same spot and the player either stops or catches the ball or even misses it out. This is a very usual phenomenon in which the cricket ball follows Newton's laws of motion and its flight is predictable.

Now, if you are at a wedding or birthday party, you observe a different but very usual phenomenon. A child pick up a balloon, blows it up, hold it out and releases it. The child laughs delightedly as the balloon sputters and darts around the hall. Again and again the child fetches the balloon, blows it up, and releases it. Each time, the balloon races around the room in a different crazy path. Here too the balloon follows the Newton's laws of motion but its flight is erratic and unpredictable.

How can the same laws produce such different results? The motion of the cricket ball through air is said to be stable system whereas the motion of the balloon buzzing wildly around the hall is an unpredictable system. The motion of the balloon is one of the simple examples of chaotic systems. The world chaos usually means a place of total disorder and confusion. However, if the term chaos really implied total disorder or randomness, there would probably be no point in studying the phenomenon. Technically, the term chaos means something that appears to be random and disordered but is actually deterministic in nature. It means that the system is precisely controlled by natural laws. The apparent disorder arises from an extreme sensitivity to initial conditions, much like the path of the balloon described above.

In 1970s, a few scientist in the US and Europe began to find a way through disorder. Physiologist found a surprising order in the chaos that develops in the human heart and causes sudden death. Ecologist explored the rise and fall of gypsy moth populations. Economist dug out old stock price data and tried a new kind of analysis. The insights that emerged led directly into the natural world the shapes of cloud, the paths of lightning, the microscopic intertwining of vessel, the galactic clustering of stars. A decade later chaos has become a new science. The new science has spawned its own branches: fractals and bifurcations, intermittencies and periodicities, folded- towel diffeomorphisms and smooth noodle maps etc.

Now chaos seems to be everywhere. A rising column of cigarette smoke, a flag snapping back and forth in the wind, behaviour of weather, behaviour of an airplane in flight, behaviour of cars clustering on a highway, the behaviour of oil flowing in underground pipes etc. are all examples of chaos. No matter what the action is, the behaviour obeys the same newly discovered laws. Therefore, we can say that the chaos is a science of global nature of systems. Chaos poses problems that defy accepted ways of working of science. It makes strong claims about the universal behaviour of complexity. Chaos, as some scientist say, has become the last century's third great revolution in the physical sciences next to relativity and quantum mechanics. As one physicist put it, "Relativity eliminated the Newtonian illusion of absolute space and time; quantum theory eliminated the Newtonian dream of a controllable measurement process; and chaos eliminates the Laplacian fantasy of deterministic probability". In fact, the chaos applies to the objects at human scale, that is, to the universe we see and touch.

Understanding chaos would definitely be of great benefit to mankind or in another way, we can say that it may be critically important to understand chaos in order to sustain our own existence. Modern discussions of chaos are almost always based on the work of Edward N. Lorenz [1]. He defines a deterministic sequence as one in which only one thing can happen next and randomness as being identical to the absence of determinism.T he deterministic chaos is then something looks random, but is really deterministic.

This can happen because we could only know the initial situation approximately. Although in principle we can predict how a system will behave to an arbitrary level of

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precision, in practice, we can't find the initial starting point of the system accurately enough to be able to persist in detail what will happen beyond a short period of time. Small mismeasurements eventually add to a big discrepancy between calculated and observed behaviour.

2 History of Chaos

The roots of chaos theory goes back to Henri Poincare (1854 - 1912) who discovered 'strange' properties when trying to solve the two Suns and a single Earth system (Three body problem) at the end of the 19th century. This problem is a two step problem. First using the Newton's law (in fact Newton failed to find the solution to this three body problem) calculate the acceleration of the earth from its position and velocity. Secondly, find the new position and velocity and determine the new acceleration. It was shown that the trajectory of the earth will never repeat itself, even if we let the time go to infinity. Figures 1, 2 and 3 shows the trajectory of the Earth in the presence of two Suns at different times. We can note that the trajectory after an infinite time is an infinitely long line in a finite volume. This simple gravitational system is the first example of a chaotic system.

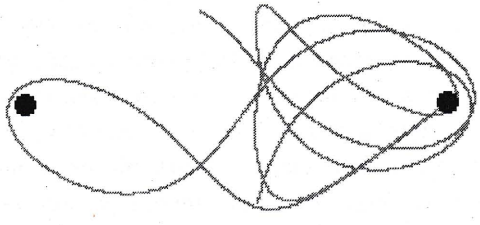

Figure 1: Path of the Earth in the presence of two Suns after certain time elapse.

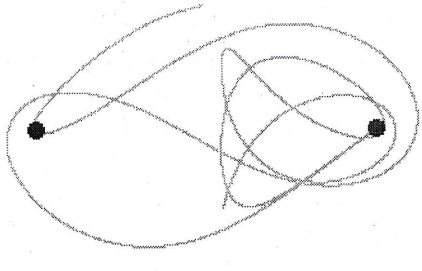

Figure 2: Path of the Earth in the presence of two Suns at a different time elapse.

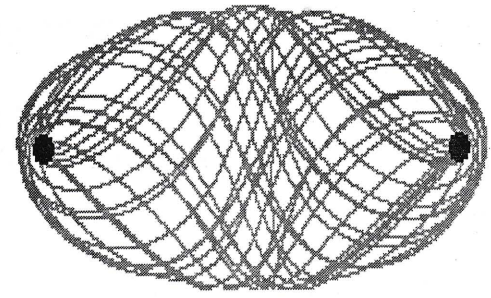

Figure 3: Path of the Earth in the presence of two Suns after very long time.

Although, the chaos theory was first discovered more than 100 years ago, it got momentum only during 1070s due to Edward Lorenz (1917-). He found that extremely small changes in initial conditions had a significant effect on the weather. Lorenz plotted phase space (velocity versus position plot) and observed that it look like the wings of a butterfly (Figure 4). This was called Lorenz butterfly. An appropriate example of small perturbation affecting the weather is that 'butterflies flapping their wings in Sumatra may result in a Tsunami in Sri Lanka'.

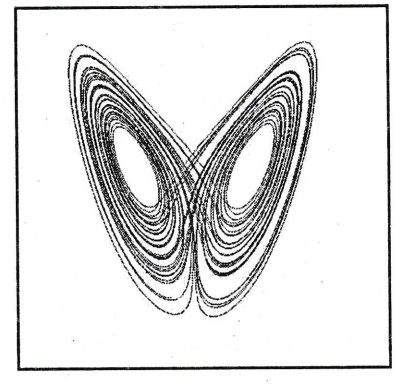

Figure 4: Lorenz attractor (looking like the wings of a butterfly).

Later it was found that these strange attractors are integral part of chaos. These attractors are not new to anyone and all are quite familiar with many usual phenomenons which contain different type of attractors. As a simple example, release a ball from the brim of an inverted corn. No matter what the initial velocity is, the ball will draw different path and finally will settle down at the vertex of the cone. Here the vertex of the corn is an attractor. As a different type of example consider the heart beat. One must have noticed that the heart beats very fast while doing exercises or running. But when stopping the exercise one can notice the heart beats start to settle down

on to a regular beat.H ere the regular beat is another kind of attractor.N o matter how fast the heart beat it always settles down to a regular beat. Remember the attractors mentioned here as examples do not give rise to chaos.

Michael Henon (1931 -) discovered [2] another kind of strange attractors in 1962. He discovered a 'banana shaped' attractor while working on star clusters (Figure 5). In 1960s Stephen Smale (1930 -) discovered that the phenomenon of strange attractors can be explained by a topological transformation in phase space. Robert May (1936 -), in 1970s, using logistic equations, showed that the biological population could become chaotic. While doing his analysis, Robert May discovered the 'Logistic Attractor'. This Logistic Attractor is produced through a process known as Bifurcation process. This simple and interesting process is discussed in detail in the Section: 3.1.

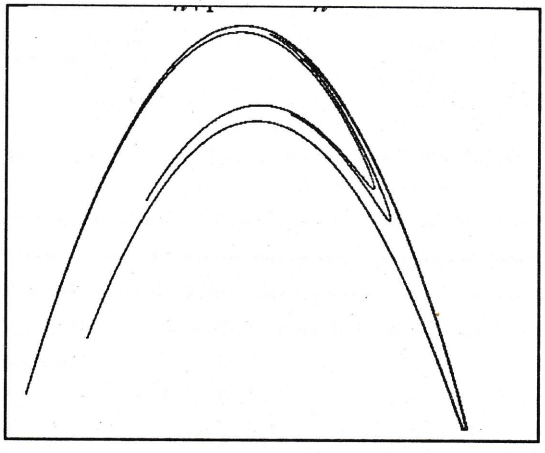

Figure 5: Banana shaped Henon attractor.

Although Robert May observed chaotic behaviour in his system, Mitchell Feigenbuam (1944 -) discovered an order in the chaotic system observed by May. Feigenbuam further investigated the system and found that the route to chaos was universal and there is a universal constant (~ 4.66920160) involved in the Bifurcation process. Investigation on chaotic system continued and a few years later, the relationship between chaotic theory and Fractal theory was forged and incidentally it was found that all strange attractors are fractals [3].

Investigating solar systems in the late 1970s, Jack Wisdom showed that the gaps in the asteroid belt of our solar system are due to chaos. With this discovery, more and more astronomical phenomenons were explained using the chaos theory. As an example, Saturn ring, galaxy clusters, super clusters (clusters of clusters of galaxies), black holes are found to be related to chaos theory [4].

Some of the very interesting phenomenon occurring in nature also has been explained using chaos theory. As an interesting example, one must have noticed that birds fly in a 'V' shaped pattern without colliding with each other. How does a flock of birds fly in that fashion without colliding with each other? To explain this phenomenon, Frank. H. Heppner, in 1997, used chaos theory. Assuming following initial conditions he was able to formulate a triangle of birds. The initial assumptions he made were:

a. The birds are attracted towards a focal point.
b. They are attracted to each other.
c. They want to maintain a fixed speed.
d. Flight paths are altered by random occurrences, such as gusts of wind.

When he modelled a triangle of birds in his computer and varied the intensities of the above initial assumptions, his triangles indeed flock in a bird like fashion. Many other similar models were used to explain many other similar phenomenons such as the movement of vehicles in a high way, movement of people in a crowed place (e.g. movement of devotees in a temple car festival.

Presently, chaos has become a booming area of scientific interest and in future we certainly can see more and more physical phenomenon get explained by chaos theory.

3 Properties of Chaotic Systems

In order to understand chaos, it is important to first understand the properties that all chaotic systems exhibit. Therefore, in this section, we take a few examples of chaotic systems and try to build up the properties common to all chaotic systems.

First of all let us consider a very simple technical example. Consider a simple experimental system as shown in Figure 6. It consists of two fixed magnets along the x- axis and another magnet, fixed at the bottom of a pendulum, is hung directly above at the centre of the two magnets and is free to swing. Hence we have a system with two possible equilibrium positions. If the pendulum is pulled aside along the y- axis and released; it quickly begins to execute an extremely complicated motion. Since the magnetic force is a strong function of the relative distances between the magnets and therefore the magnetic force can provide acceleration, deceleration and damping and the damping is also possible due to friction of the pendulum support on the supporting rod and also due to induced currents. Due to the damping the pendulum is eventually forced to move towards one of the magnets (equilibrium position). But to which magnet it will go depend on the initial conditions.

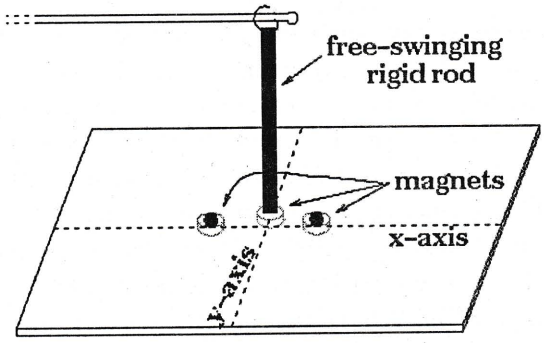

Figure 6: Experimental arrangement of two fixed magnets and a pendulum with a magnet at the bottom.

Figure 7 explains the complex path of the two possibilities of reaching any of the magnets. But due to the complexity in the initial conditions and there are infinite number of ways in which the pendulum can be released, it is nearly impossible to determine which equilibrium position the pendulum will choose. Although the motion of the pendulum is completely governed by the Newton's laws of motion, but the motion is complex and cannot be determined. Therefore, this experimental set up is a perfect example of chaotic motion.

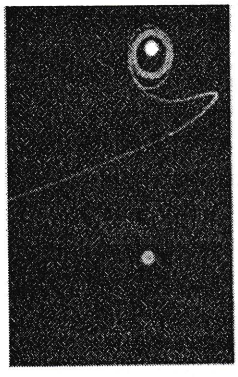

Figure 7(a): Path of the magnet fixed with the pendulum orbiting near one of the equilibrium positions.

Figure 7(b): Path of the magnet fixed with the pendulum orbiting near other of the equilibrium positions.

The Figure 8 displays which equilibrium position the magnet winds up on according to its initial positions as projected on the plane containing fixed magnets and horizontal. The dark and white regions show initial positions which correspond to the magnet coming to equilibrium around either the dark or white magnet. When the region around the boundaries between dark and white areas was explored, it was found that the boundaries are not infinitely sharp but contain a complex structure termed as a fractal. Fractals are shapes in which every piece looks like every other piece and have fractional dimensions and the unique property of self-similarity to all levels of magnification. Fractals will be elaborately discussed in the Section: 3.3.

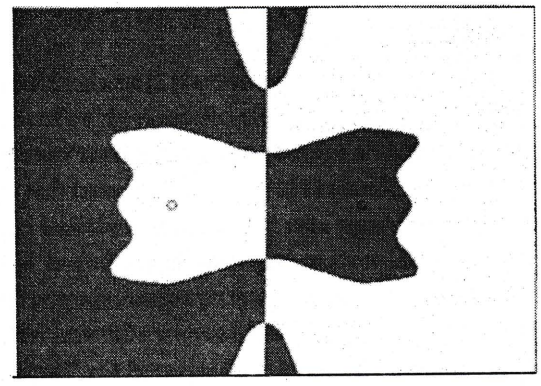

Figure 8: Regions showing the initial positions corresponding to equilibrium around either dark or white magnets

Now from the above example of a perfect chaotic system, we can formulate two of the properties of chaotic systems.

1. All chaotic systems exhibit Sensitive Dependence on Initial Conditions (SDIC).

2. For all chaotic systems, the trajectory never repeats.

Now we imagine another experimental set up to formulate one more property of chaotic systems. Take a big hopper of sands and allow grain of sand to drop one by one on the floor at a time. You will observe a sand pile beginning to form and the height of it goes up as the number of grains of sand that are dropped onto it increases. One can work out an exact relationship between the height and the number of grains if some of the conditions like how the grains pack together in the sand pile etc. are known. Then we call such a situation as linear even if the height does not vary as the number of grains. It may increase as the square or square root of the number of grains. But the important point is that the height increases slowly as the number of grains increases. At some critical point we will observe that even a single grain is dropped onto it, an avalanche occurs and height of the sand pile collapses and is reduced. One must have observed a similar behaviour while downloading sand or stones from the trailer of a tractor. As the angle of the trailer increases, at a critical angle, all the sand or stones fall down rapidly. At this point we should note two things.

(a). A small change in the input, i.e., dropping one more grain of sand, has caused a huge change in the output, i.e., height of the sand pile reduced. In this situation, the system is said to exhibit Sensitive Dependence on Initial Conditions as explained above.

(b). At this juncture, the system is nonlinear, i.e., the output and input are not proportional to each other.

The second point we observed here too is shared by all chaotic systems. Therefore now we have another entry in to our list of properties of chaotic systems.

3. All chaotic systems are nonlinear.

3.1 Logistic Map

Now we look for another property of chaotic system and for that reason we should first learn the idea of Logistic map. Let us imagine that we are trying to formulate a model for the population of, say, rabbits in a forest. Let us also assume a condition that the increase in the number of rabbits is related to the number of rabbits we have. So we can write down an equation something like:

Number (next generation) = L × Number (this generation)
Here, L is a constant representing the fecundity of the rabbits.

Also we know that when there are too many rabbits in the forest then the lack of food, overcrowding etc. will suppress the number of rabbits in the next generation. Suppose that if at a population of, say, 100,000 all the rabbits die,t hen we need a term like:

Number (next generation) = 100,000 Number (this generation).

Putting these two equations together we get:

No. (next generation) = L × No. (this generation) × [(100,000 No.(this generation)]

This equation is called the Logistic equation. Here it is so over-simplified for easy explanation and in fact, it has nothing to do with the actual dynamics of how a population of rabbits (or much of anything else) changes. But it teaches us an important lesson about chaotic systems. As an example, let us start with two thousand rabbits present at the moment, and that the value of the constant L is 0.000028.

Then it is simple to calculate that the next generation will have 0.000028 ×2,000 × (100,000 2,000) = 5,488 rabbits. The next generation after that will have 0.000028 ×5,488 × (100,000 5,488) = 14,523 rabbits, and so on. We can make a graph of the total number of rabbits in the population as shown in the Figure 9.

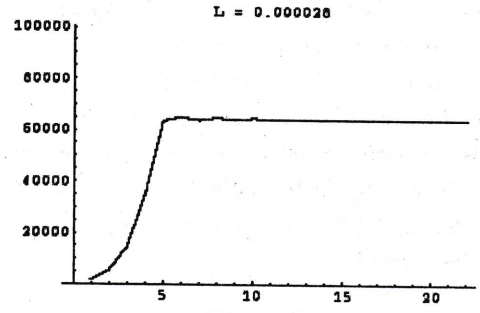

Figure 9: Population fluctuation of rabbits with L = 0.000028

Note that there are some initial small oscillations, but eventually the population settles down to a constant value of 64,285

Now again assume that we start with two thousand rabbits, and that the constant L is 0.000029. As shown in the Figure 10, we see that there are some initial somewhat larger oscillations, but eventually the population settles down to a constant value of 65,517. So increasing L increases the steady state number of rabbits in the population.

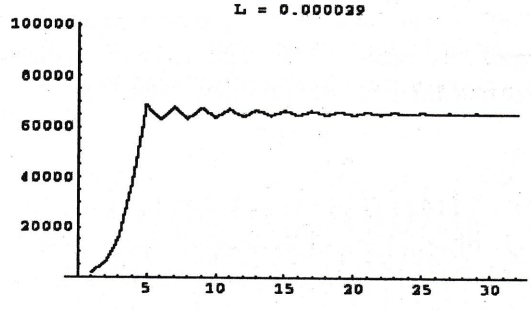

Figure 10: Population fluctuation of rabbits with L = 0.000029

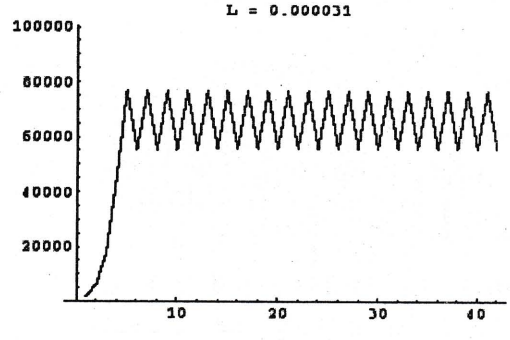

Figure 11: Population fluctuation of rabbits with L = 0.000031

Again if we increase the fecundity of the rabbits by setting L to 0.000031, something very interesting thing happens. The population bifurcates and, in the "steady state", the oscillation occurs between two different values as can be seen in the Figure 11. Some ecologists now believe that such a "boom-bust" ecological system is better than a stable one. Increasing the fecundity factor, L, to 0.000032 increases the size of the swings in the population and is shown in the Figure 12.

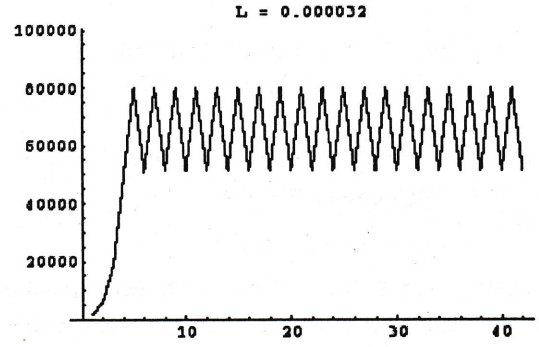

Figure 12: Population fluctuation of rabbits with L = 0.000032

Now, when we further increase the fecundity factor, strange thing begin to happen. For example, say at L equal to 0.000035 the bifurcated population values have bifurcated once again, and the number is now oscillating between four different values as shown in the Figure 13.

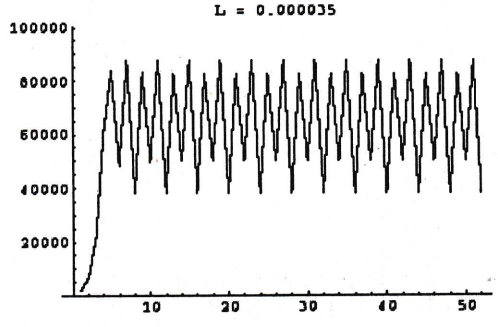

Figure 13: Population fluctuation of rabbits with L = 0.000035

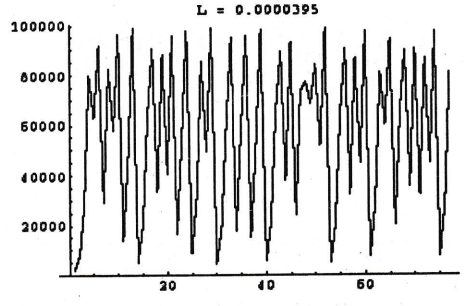

Figure 14: Population fluctuation of rabbits with L = 0.0000395

Further increase in the value of L, say, equal to 0.0000395, the population values are weird and, in fact, the system has now become chaotic as shown in the Figure 14. This means that it exhibits all the properties of chaotic systems.

One can notice that a miniscule change in the initial number of rabbits leads to radical changes in the number of rabbits in each succeeding generation. It also means that the trajectory shown above never repeats no matter how many generations we calculate in the graph.

Now we calculate the "steady state" values of the population as a function of the fecundity factor L, and plot them in a graph. This type of graph is called the Logistic Map and a result of such a calculation is shown in the Figure 15.

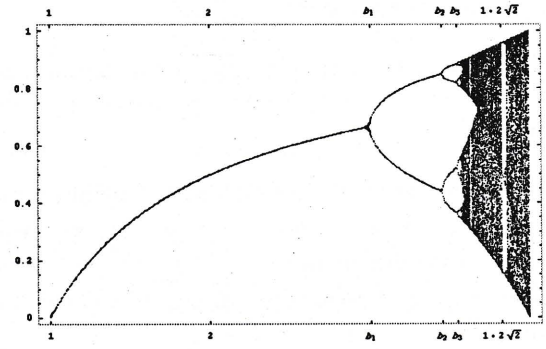

Figure 15: Logistic map drawn by calculating steady state population as a function of fecundity factor.

One can notice from the logistic map (Figure 15) that, as the value of L increases, the value of the population also increases. Then the first bifurcation of the population occurs, followed by the second, and finally the transition to chaos (dark region). There are islands of stability for some higher values of L. If we zoomed in on the region just before the first transition to chaos, we would see further levels of bifurcation occurring. It was found that this bifurcation occurs to an infinite level of magnification.

It is important to analyse about the Logistic Map in somewhat detail and we can show that it can be defined by the following equation:

$$x_{n+1} = 1 - \alpha x_n^2$$

This is a deceptively simple equation. Successive points can be found through iteration. Plotting 200 successive values of x for every value of α we notice that as the nonlinearity increases we sometimes encounter chaos

(Figure 16). The bifurcation diagram displays unexpected properties. If we enlarge the small portion shown within the box in Figure: 16, we will obtain an almost identical diagram as in the Figure 17. If we continue to do so for infinite time, we will observe that the logistic map repeats itself over and over at smaller scales and, this behaviour was found to be universal!

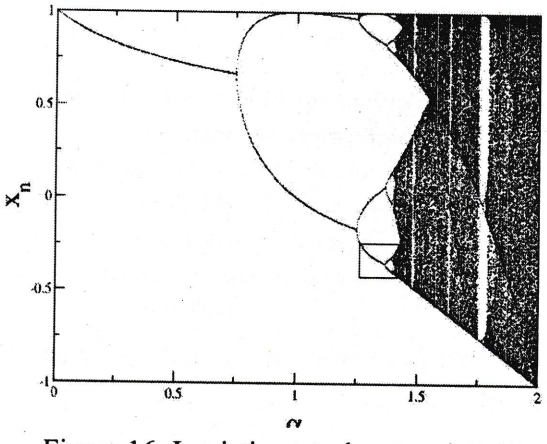

Figure 16: Logistic map drawn using the equation $x_{n+1} = 1 - \alpha x_n^2$. The rectangular box inside the map shows the area to be enlarged.

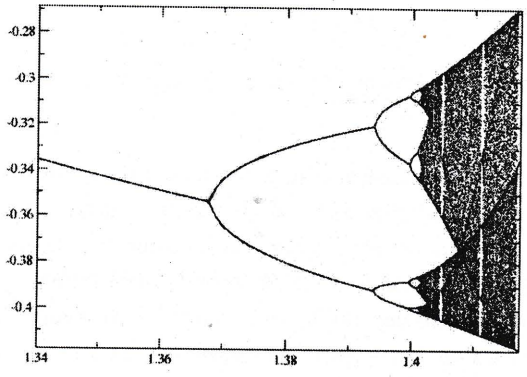

Figure 17: Logistic map showing the area enlarged.

It was found that a very large number of systems behave in the same way as the logistic map. Therefore studying the 'paradigm' of the logistic map will provide insight into the dynamics of large class of possibly much more complicated systems. In fact, it can be shown that these bifurcations occur to an infinite level and this leads us to our next indicator of chaotic systems:

4. For all chaotic systems, the transition to chaos is preceded by infinite levels of bifurcation.

Much of the early work on the logistic equations was done by physicist Mitchell Feigenbaum in the mid-1970s. He tried to guess the value of L for which the next bifurcation would occur. This led him to discover that the rate at which the bifurcations were occurring was governed by a constant number. Suppose that if, L(n) is the value of L for which the nth bifurcation occurs, and L(n + 1) is the value where the next bifurcation occurs, then at all levels L(n + 1) divided by L(n) gives always a same value. It turns out that this number, now is called as the Feigenbaum number, and is irrational and approximately 4.6692016090... It also turns out that the Feigenbaum number is associated with all chaotic systems. Therefore we can state another property of chaotic system.

5. For all chaotic systems, the infinite bifurcations preceding the transition to chaos are characterised by the Feigenbaum number

3.2 The Lorenz Attractor

We have seen that this "attractor" has two points that attract the trajectory (Figure 4). In the early days of studying this Lorenz attractor everything about it seemed strange and therefore, it is sometimes called the strange attractor. Although it is very strange, many chaotic systems that have been discovered so far are similarly strange. We note that the trajectory around each attractor is approximately in a plane. The two planes about the two attractors are almost but not quite in the same plane. In fact, we describe the dimensionality of the Lorenz attractor as being just a bit larger than two. This non integer or fractional dimensionality turns out to be another characteristic of all chaotic systems. Sometimes such objects are called fractals. Therefore, we have our next property shown by all chaotic system.

6. All chaotic systems exhibit fractional dimensionality.

3.3 Fractals

At this juncture we shall briefly see about the Fractals. Roughly speaking a fractal is a self-similar geometrical object with a fractal dimension. Here, the word 'self-similar we mean that if we put it under the microscope and enlarge it as much as we can, it will always look exactly the same and the word 'fractal dimension' means that the dimension of the object is not an integer like 1 or 2, but something like 0.63, a fraction. There are two famous examples of fractals: The Cantor set and the Mandelbrot set.

(a) The Cantor Set

Take a line and divide into three parts and remove the

middle part as shown in the Figure 18 and repeat this procedure endlessly for the resulting lines. Cantor set, named after the nineteenth century mathematician George Cantor, is the dust of points that remain in this process. They are infinitely many,b ut their total length is zero. This set was used by Mandelbrot, as a model for the occurrence of errors in an electronic transmission line.

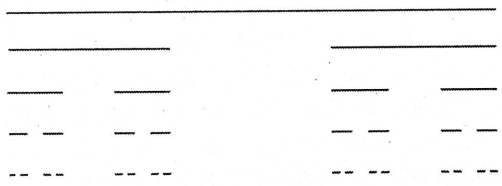

Figure 18: The Cantor set obtained by removing middle third portion of each line.

We shall try to calculate the dimension of this cantor set and see whether it is a fractal dimension. For that reason first we shall learn how to calculate the fractal dimensions.

Fractal Dimension

For easy understanding, let us first look at a regular line and a regular square and see what happens when we copy the these and then paste them at 1/3 of their original size [Figure 19(a) and 19(b)].

Figure 19(a): A line and the line obtained by pasting it at 1/3 of its original size.

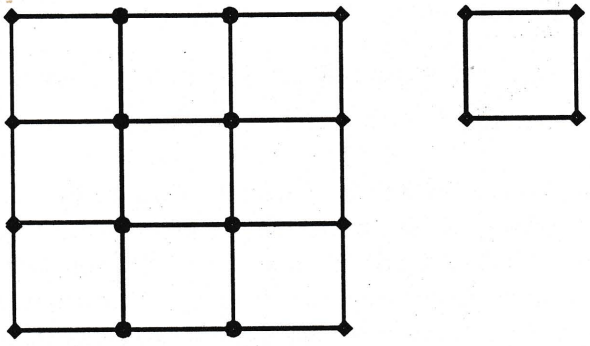

Figure 19(b): A square and the square obtained by pasting it at 1/3 of its original size.

We see that our original object contains 3 of the reduced pieces as explained in Figure 19(a) and in Figure 19(b) we see that our original object contains 9 of the reduced pieces.

We can write an equation for the above process in the following form:

$$a = \frac{1}{s^D}$$

where a is the number of pieces, S is the reduction factor and D is the dimension.

Therefore we have for the Figure 19(a)

$$3 = \frac{1}{\left(\frac{1}{3}\right)^D}$$

$$\left(\frac{1}{3}\right)^D = \frac{1}{3}$$

$$D\log\left(\frac{1}{3}\right) = \log\left(\frac{1}{3}\right)$$

$$D = 1$$

Therefore the line shown in the Figure 19(a) has one dimension.

Similarly for the Figure 19(b)

$$9 = \frac{1}{\left(\frac{1}{3}\right)^D}$$

$$D = 2$$

Hence, the square shown in Figure 19(b) has two dimensions.

Our common sense also agrees to these calculations as we are well aware that a line has one dimension and a square has two dimensions. By this example one can clearly see that our equation is perfectly correct in determining the dimensions of the well known structures. Now let us look at the Cantor set (Figure 18) and apply the same equation. We obtain:

$$2 = \frac{1}{(1/3)^D}$$

$$D = \log 2 / \log 3 = 0.6309$$

This is a fractal dimension, i.e., it is not a whole number as we encountered in the above examples.

(b) The Mandelbrot Set

This set is defined as the collection of points c in the complex plane that does not escape to infinity for the equation:

$$z_{n+1} = z_n^2 + c$$

Note that the actual Mandelbrot set (Figure 20) are just the black points in the middle of the figure. All the white coloured points escape (but after different numbers of iterations). The Mandelbrot set is strictly speaking not self-similar in the same way as the Cantor set. It is quasi-self-similar (the copies of the whole are not exactly the same). What I'd like to illustrate here is not so much that fractals can be used to generate beautiful pictures, but that a simple non-linear equation can be surprisingly complex. The Figure 21 explains what happens when we keep on exploring the Mandelbrot set to an infinite level. One can notice that after many fold magnification; we encounter a similar object as the original one.

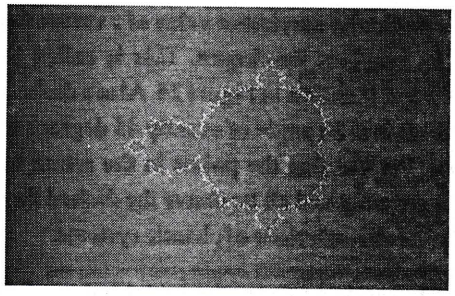

Figure 20: The Mandelbrot set.

3.4 Lyapunov Plot

Now we again go back to Lorenz attractor. To obtain Lorenz attractor, he used the following three set of equations:

$$\frac{dx}{dt} = ax + ay$$

$$\frac{dy}{dt} = -xz + rx - y$$

$$\frac{dz}{dt} = xy - bz$$

Here x, y, z are all variables, t is the time and a, r, b are all constants. These equation are not simple to solve and can be solved with the help of a computer. The result of such a calculation gives the trajectory {x,y,z}as the time evolve is called the Lorenz attractor and is shown in Figure 4. To obtain this attractor, the Lorenz equations had initial positions of x = 0, y = 1 and z = 0. The constants were r = 28, a = 10, and b = 8/3. The time t goes from 0 to 2048 seconds. Note that, not all solutions of the Lorenz equations are chaotic; the crucial factor is the value of the constant r.

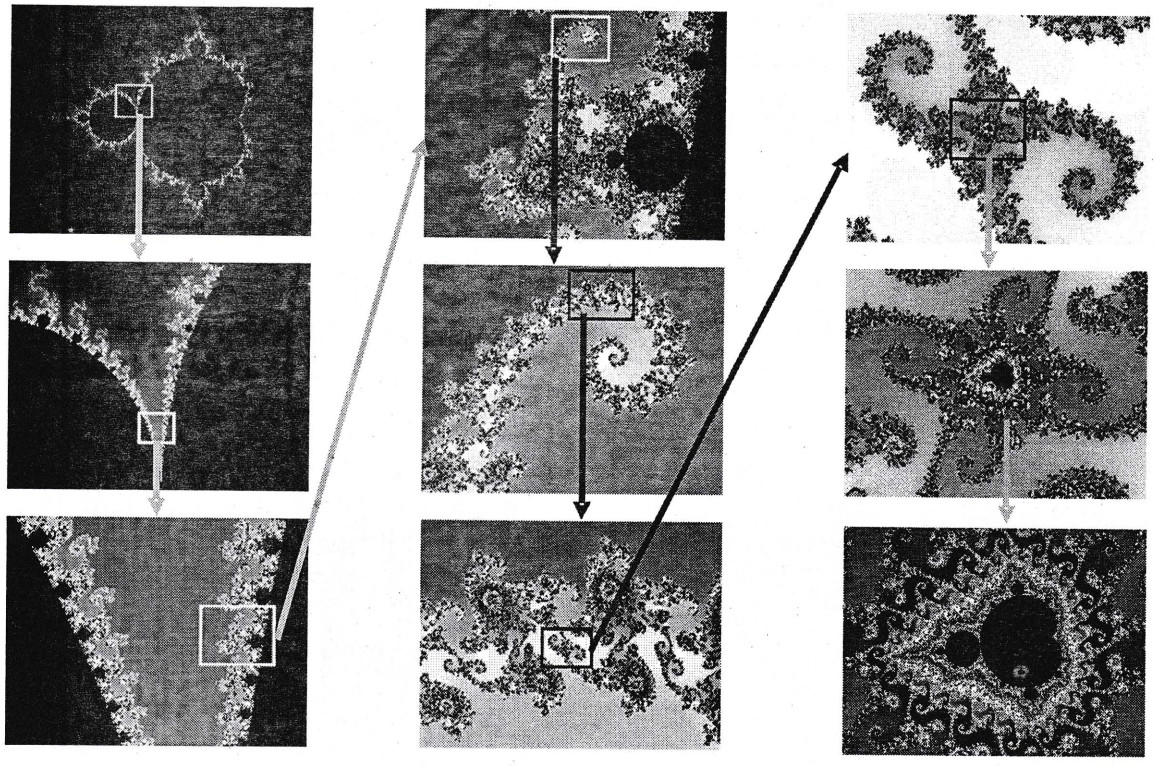

Figure 21: Enlarging Mandelbrot set at different positions and obtaining an identical set.

As stated here, the above solution was generated with the initial value of y equal to exactly one. Now we calculate a second solution with the initial value of y = 1.000000001and make a plot of the distance between these two trajectories as a function of time. This plot is shown in the Figure 22. We see that initially the distance between the two trajectories is fairly small. Then, at some point they diverge rapidly. This graph is called a Lyapunov plot and it is a log-log plot. You can see that when the two trajectories begin to diverge, the distance between them as a function of time is almost exactly a straight line. This, too, is a property of all chaotic systems. Therefore, one more property of chaotic system has been identified.

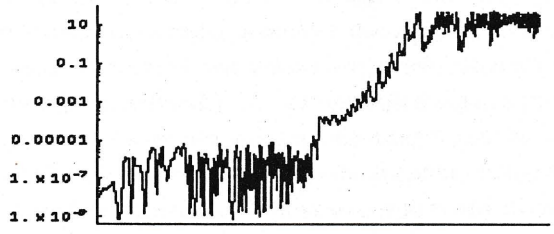

Figure 22: Lyapunov plot obtained from Lorenz plot.

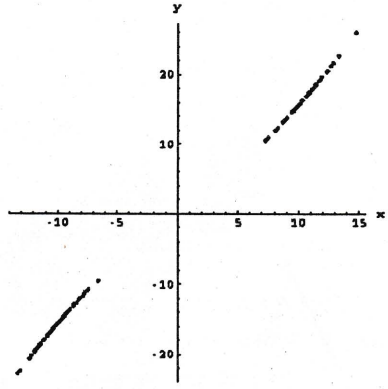

Figure 23: Poincare section of Lorenz plot.

7. For all chaotic systems, a Lyapunov plot of the distance between trajectories versus time will exhibit a straight line.

Now we take one of the solutions to the Lorenz equations, and plot where the trajectory crosses the x-y plane, when the value of z is 20 and increasing. This is called a Poincaré section, and is shown in the Figure 23. The section is a way of analysing complex motion by reducing the amount of information we need to deal with all at once.

3.5 First Return Map

For the Lorenz attractor, all the variables, such as z, go through maximum and minimum values as the trajectory cycles around the attractors. We can make a plot of the value of a particular maximum value of z versus the value of z for its previous maximum. This is called the first return map and is shown in Figure 24. Also a dashed line is shown which is at an angle of exactly 45 degrees with the horizontal. We see that the points in the return map are initially increasing and all lie above the dashed line. This is yet another characteristic of chaotic systems.

8. For all chaotic systems, the initial points of the first r of 45 d

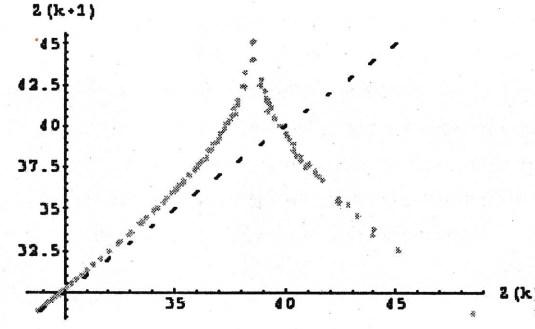

Figure 24: First return map (straight line is drawn at an angle of 45 degree.

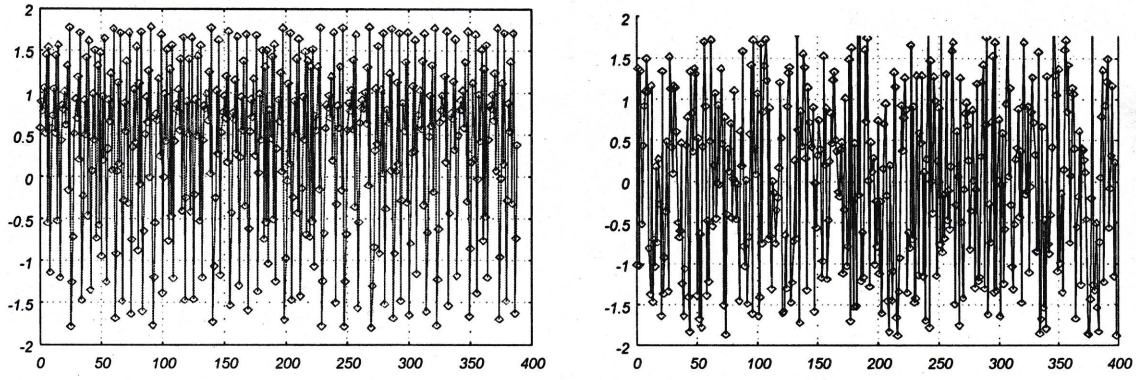

Figure 25: Two different time series.

4 Chaos and Randomness

Because of the similarity between the words chaos and randomness and also due to the fact that the figures looking similar, one may wonder whether there is any difference between them to distinguish. In fact, the chaos is NOT randomness though it can look pretty random. As an example let us consider two time series as shown in the Figure 25

Now look at these figures carefully and see whether you can distinguish them? Suppose we use some of the known techniques. For example, try to analyse these time series by using, say, Power spectra or Histograms or even Autocorrelation functions. You will not be able to find any qualitative differences between these two time series. But, now, try to plot Return map (plot x_{n+1} versus x_n) and see what happens. Here the return map obtained by Henon, and known as Henon Map ($x_{n+1} = 1.4 - x^2_n + 0.3\ yn$, $y_{n+1} = x_n$) is presented in the Figure 26.

In studying the behavior of a gaseous system, Edward Lorenz simplified the Navior-Stokes equations and produced a set of three ordinary looking nonlinear differential equations as described in Section: 3.4.

Choosing a suitable initial value and solving with a numerical procedure leads to the well known butterfly. Figure 27(a), 27(b) and 27(c) shows the X-Z, Y-Z, and X-Y View of Lorenz attractor respectively.

We can see how the trajectory weaves back and forth between the two lobes of the butterfly, never repeating the same path twice. Also, the behavior in one time segment doesn't really give a clue as to how it will behave in the next time segment. Sometimes it spends the majority of its time whirling around on just one side, while at other times it weaves back and forth, sharing time on each side. Yet at other times, it seems to find a nearly stable orbit and stays so close for a while that it looks periodic and stable-but not quite.

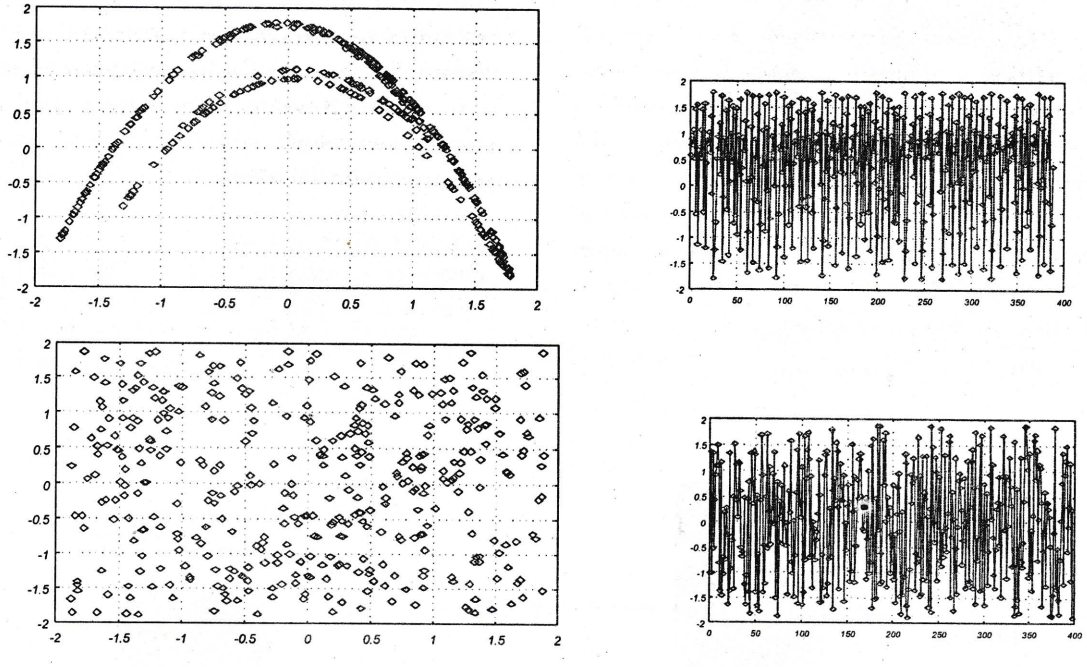

Figure 26: Return map of the time series.

In this return map, one can easily see the difference between the chaos system and random system. The figure on the top shows a deterministic behaviour indicating a chaotic behaviour and figure at the bottom shows non deterministic behaviour indicating random behaviour.

5 Application of Chaos

5.1 Chaos in the atmosphere

Lorenz attractor demonstrates how difficult even a simplified gaseous system in a box can be. Imagine now that we try to simulate the weather by breaking the atmosphere into many millions of interactive little boxes and attempt to predict conditions several weeks into the future, keeping in mind that we don't know the initial conditions at time t=0 very accurately. Now you will understand why your local weather reporter isn't using chaos theory on the evening weather report at the end of

the news bulletin. However, progress is being made in this area, and some day large scale simulations will be possible.

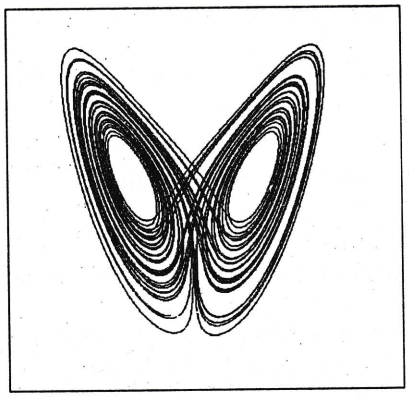

Figure 27(a): X-Z view of the Lorenz attractor.

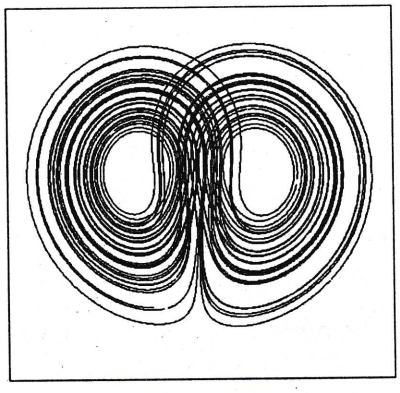

Figure 27(b): Y-Z view of the Lorenz attractor.

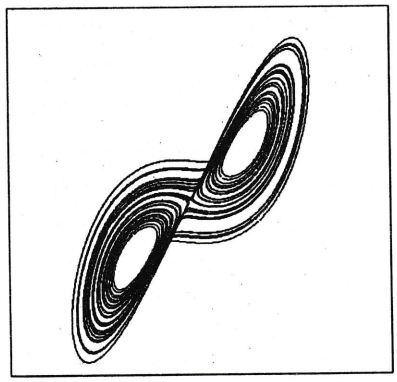

Figure 27(c): X-Y view of the Lorenz attractor.

5.2 Chaos in Industry

Since chaotic systems are systems that only appear to be random, but are really deterministic in nature, they possess an underlying order. This underlying order leads to the possibility of controlling chaotic systems. William Ditto and Louis Pecora have been pioneering methods of controlling chaotic mechanical, electrical and biological systems. For example, Pecora and Thomas Carroll of the U.S. Naval Research Laboratory realized that synchronized chaos might be used for encoding private electronic communications.

Chaotic systems are described as having an infinite number of unstable periodic motions. This instability means that no two chaotic systems can be built that provide the same output.

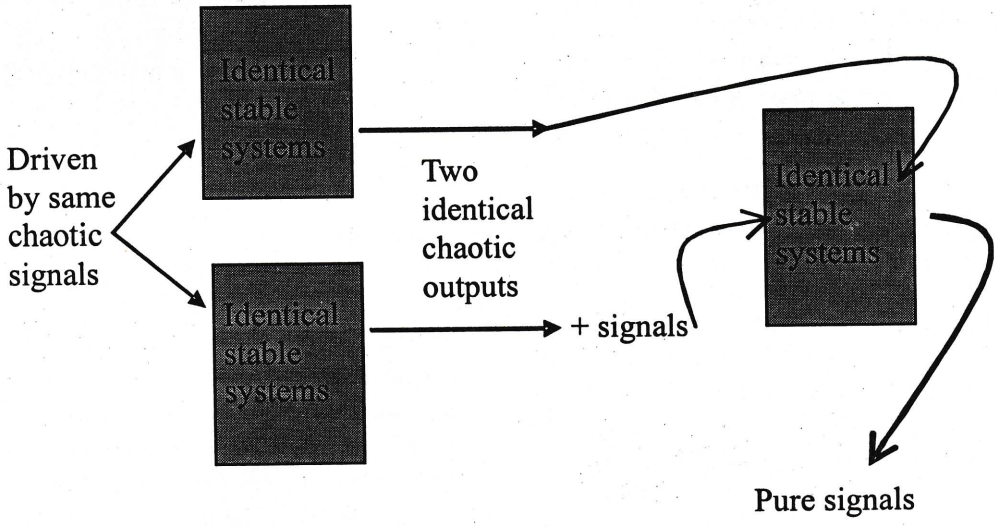

Figure 28: Block diagram showing the method of sending a secret signal.

However, it has been shown that if two identical stable systems are driven by the same chaotic signal, they will generate a chaotic output, but their inherent stability causes them to suppress differences between them. The result is two identical chaotic outputs. At the sending location, generate a chaotic signal and use it as the input to a stable system to generate another chaotic output signal. Mix the chaotic output signal with a message; the result is another signal that looks chaotic but has a message embedded in it. Now transmit two signals to the receiving location: the original chaotic signal and the message-carrying chaotic output. At the receiving location, feed the original chaotic signal into a stable system identical to that at the sending location; the result is the same chaotic signal that was mixed with the message at the sending station. Subtract this from the message-encoded chaotic signal and you have the original message. This is explained in the block diagram given in the Figure 28.

While the technique discussed above is a method of using chaos, others are working on methods of controlling chaos. Since a chaotic system is composed of an infinite number of unstable periodic orbits, the key to controlling the system is to wait until the system comes near the desired periodic orbit and then perturb the input parameters just enough to encourage the system to stay on that orbit. This method-referred to as OGY after Edward Ott, Celso Grebogi and James A. Yorke who developed the system that has been used successfully in stabilizing lasers and other industrial systems. But the techniques employed in the OGY method are not limited to industry; they show promise in controlling chaotic behavior in the human body as well.

5.3 Chaos in the Human Body

It has been argued that some cardiac arrhythmias are instances of chaos. This opens the doors to new strategies of control. The traditional method of controlling a system is to model it mathematically in sufficient detail to be able to control critical parameters. However, this method fails in chaotic systems since no model can be developed for a system with an infinite number of unstable orbits. The OGY method mentioned above was able to exploit the properties of chaotic mechanical and electrical systems; however, system-wide parameters in the human body can not be manipulated quickly enough to control cardiac chaos. Therefore, Garfinkel, Spano, Ditto and Weiss developed a similar method which they called Proportional Perturbation Feedback (PPF) and the important point is that it worked well in controlling induced arrhythmia. Similar efforts are being made to control epileptic brain seizures which exhibit chaotic behavior. This technique, controls by waiting for the system to make a close approach to an unstable fixed point along the stable direction. It then makes a minimal intervention to bring the system back on the stable manifold. An important benefit is the minimal amount of intervention required to control the chaotic event.

5.4 Some latest research work in chaos

Here I am listing some of the latest research work carried out in chaos.

a. Quantum Chaotic Transport in the Energy Bands of Semiconductor Superlattices.
b. Chaotic Ray Dynamics and Electromagnetic Interferences in Optical Fibers.
c. Fractal Resistance in Microtransistors.
d. Quantum Chaos for Ultra-cold Atoms and Bose-Einstein Condensates in Optical Lattices.
e. Transition to Chaos for Hot Electrons in a Wide Band Quantum Well.
f. Resonant Tunneling Studies of Quantum Chaos in Quantised System.
g. Chaos and Quantum Transport in Mesoscopic Cosmos.

6 Conclusion

So far we have discussed a few chaotic systems but there are many systems that can become chaotic. A few examples include:

a. A pendulum whose support point is oscillating up and down.
b. A double pendulum.
c. A dripping faucet.
d. A billiard ball on a perfectly reflecting billiard table with two parallel sides connected by two semicircles. This is called a Bunimovich stadium.

For physicists who, like me, were educated in a more-or-less traditional way, we were tacitly taught that we were going in a straight line from ignorance to understanding. In retrospect, our path was not even close to straight, as we had to avoid the swamps and craters of chaos that appear nearly everywhere we look. Previously we had to avoid those swamps and craters because they are often not analytically solvable, and solving problems analytically used to be our only major technique.

For some other systems, such as the logistic equations, solvability is not an issue; the calculation requirements, however, largely preclude their study with only a pencil and some paper. Computers have allowed an explosion in our understanding of chaotic systems in the past 35 years

or so.
We have discussed some but not all of the properties that all chaotic systems share. These include:

1. Sensitive Dependence on Initial Conditions.
2. The trajectory never repeats.
3. They are nonlinear.
4. The transition to chaos is preceded by infinite levels of bifurcation.
5. The infinite bifurcations preceding the transition to chaos are characterised by the Feigenbaum number.
6. Fractional dimensionality.
7. A Lyapunov plot of the distance between trajectories versus time will exhibit a straight line.
8. The initial points of the first return map always lie above a line making an angle of 45 degrees with the horizontal.

Since it is virtually impossible to know the initial conditions, i.e. the temperature, density, wind, humidity, etc., with perfect accuracy, Sensitive Dependence on Initial Conditions implies that a long-range weather forecast is impossible in principle. ("Long range" here means a week or more.)

A recent re-interpretation of Quantum Mechanics by David Bohm and his group introduces the notion of a quantum potential. This potential is non-local, which accounts for some of the strange "influence at a distance" that Quantum Mechanics predicts and that has been experimentally confirmed. But in Bohm's interpretation the motion of objects such as electrons going through an array of slits is governed by this quantum potential and the trajectory turns out to be chaotic. Thus to Bohm quantum systems are another deterministic chaotic system. Therefore in summary we conclude the following:

- Many things in our world are chaotic, yet order is also everywhere.
- Understanding this dichotomy is not only a fabulous challenge but also has profound implications for how we perceive the world.
- The study of Chaos has implications for probably all academic fields.

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HEALTH OF YOUNG PEOPLE

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This presentation contains information obtained from WHO publications and documents obtained through internet and no local information except a few personal experiences or opinions. It is felt that the health status of our young people is yet to be studied and documented.

Definition of young people

World Health Organization defines young people as follows on the basis of age:

Adolescence	10-19 years
Youth	15-24 years
Young people	10-24 years.
Puberty	11-16 years in boys and 9-14 years in girls

The definition of youth on chronological basis is relative and varies. It could be more constructive to identify youth with a state of mind, a level of psychosocial development dominated by imagination, the desire for adventure, and the urge to question all established standards in order to establish and assert one's individuality. It is a period of transition from dependence of childhood to independence of adulthood.

Problems of Young People

Young people have two sentiments: the will to create better world without discarding fundamental values and the fear that they will make things worse.

Circumstances associated with the growth and upbringing of the infant in the family or social environment may well determine the ability to function both as an individual and as a member of society. Young people's behavior is conditioned by biological, psychological and social pressures to which they are subjected before puberty. Early deprivation of emotional, nutritional or social well being may threaten the normal physical and psychological development.

With better health and nutrition and social conditions, children's height and weight are increasing and age of puberty is decreasing. But the social maturation remains same or diminished: example- crimes are committed with adult techniques but childish motivation.

For many adolescents, puberty may be the start of a vicious circle of disturbed behavior proceeding from insecurity to anxiety, from anxiety to aggression, and to increased insecurity. This may go to pathological intensity and lead to social maladjustment and delinquency.

Physically, growth spurt and establishment of reproductive capacity occurs during puberty.

Family is the source of basic necessities of life and health such as love and tenderness, food, water, rest, clothing, and sanitation. Traditionally, the family provides variety of role models preparing the way for adulthood. Now the families are split and spread all over the world and the family structure is very week. If the home fails to provide concrete foundation, then unknowingly it sows the seeds of problems now facing the youth of today. The father who always comes home late and is always trying to find fault here and there soon creates a state of insecurity in his growing children. In the long run, these young people will resort to something else while searching for happiness.

The technological revolution in communication and travel has produced new challenges. Experience of the older people has become irrelevant to modern concepts. The role of family is now played by the educational institutions and cinema. The role played by the friends could be significant.

Youth and education

As more young people attend school expectations have increased and more youth are unhappy about employment. Many adolescents who have to go to work early have to combine school with work or unable to go to school. They suffer from fatigue and work related accidents.

For young people in industrialized societies, the extension of education into adolescence, with prolongation of social childhood far beyond puberty is a new phenomenon with which educators have to come to terms. Majority of schools and colleges are still dominated by the

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assumption that the students do not have sufficient capacity for self direction to be trusted to work out educational programs and daily life patterns in genuine collaboration with elders. Even junior teachers are treated by the senior teachers like that.

The new view implies that education should not be used simply as a social classifying device based almost entirely on intellectual talent and ignoring a wide range of relevant human talents and individual needs. Where the traditional approach is still applied, there is an increasing sense of irrelevance and futility among a large number of young people, who are coming to regard education as merely a sort of **academic game.**

When educators are asked to help in the adjustment of youth, they must ask, "Adjustment to what?" Is it proposed that the youth should be adjusted to the miseries and injustices on the world, the hunger and poverty in the midst of plenty? Or do we wish them to conform to the comforts of a secure routine job and a narrow routine existence in a small closed community?

Status and role of youth

In most countries there is neither clear-cut definition of a young person nor any commonly accepted view of youth's role in society. The gap between attainment of physiological and sexual maturity and the moment when the maturity of the individual is socially acknowledged is becoming increasingly wide. Not surprisingly, therefore, many symptoms of disturbance, both individual and collective, are observed among students, not only because they are the most articulate and audible section of youth but also because, paradoxically, they are regarded as the most "socially illiterate"

The norms of the society

By abandoning or questioning traditional value systems without replacing them, we are exposing our children to a sort of suicide through disgust and discouragement. Society itself appears to demonstrate, by its scale of financial rewards, that grater value is attached to those who are successful in industry and commerce than to teachers,so cial workers,a nd ministers of religion.

Insecurity may be engendered by the fact that schools present a single, absolute, and rigid pattern of behavior and ethical norms and leave it to young people to discover on their own the actual relativity of principles of behavior. The discovery may result in a painful emotional crisis leading to cynicism and moral nihilism.

Health problems and the behavior of young people

Conditions originating in childhood and early life:

Inadequate nutrition and infections can lead to failure to obtain full growth, full psychological and mental development, and make less productive at work. Girls are more likely to give birth to low birth weight babies. Tuberculosis and rheumatic heart disease cause disability and death.

Toxic exposure, birth trauma and perinatal anoxia leads to minimal visual, hearing, speech, and brain damage and if not corrected early may cause serious defects in learning ability, school performance, self esteem, general behavior, and subsequent personality.

Child abuse can lead to serious behavioral and mental health problems.

Problems that arise in adolescence:

Health of young people has been neglected because they are less vulnerable to disease. Changes in social and sexual morals has increased the risk of unwanted pregnancy, sexually transmitted diseases [AIDS], tobacco, drugs and alcohol, accidents, injuries, disability and bad eating habits. Competition for jobs and education is causing mental stress. Mortality is lowest in this group but the deaths that occur are mostly preventable-accidents, suicides, violence, and pregnancy related deaths. Also tuberculosis and respiratory diseases are leading in many countries.

Inadequate diet leads to defective physical growth and maturation leading to physical stress. Inappropriate decisions about behavior and lack of support can lead to health risks. Mumps or polio leads to severe disability and infertility if not immunized properly. Iron deficiency and anaemia causes serious disability in girls. In sport or work, with heavy tools designed for adults, excessive stress on immature bones can cause permanent damage. Inadequate stress on bones and muscles can impair achieving maximal growth.

Differently abled young people experience psychological and social stress because of the strong need for peer approval.

Eating behavior:

Malnutrition can occur due to lack of food or unbalanced diet. Food fad and taboos can result in unbalanced diet. Processed fast food which attracts young people can be the cause of improper nutrition and development.

Sexual behavior and reproductive health:

Expression of sexual urge of young people is often greeted with anxiety or anger by adults and with fear, guilt and shame by the young people. The sexual impulses are on one hand denounced as impure and on the other encouraged by commercial exploitation of eroticism through the mass media. Anomalies in social attitudes may arise in relation to the awakening of sexuality in the adolescent, with its accompanying conflict of pleasure and guilt. These drive sexual feeling and behavior underground and make healthy development of sexuality within affectionate and responsible relationship more difficult.

Premarietal sex, teenage pregnancy and childbearing at young age can have adverse consequences in educational and economic activities and maturity. Adolescent fertility is high and marriage at young age increases family size. Unwanted pregnancy and abortion are serious health problems for females.

Sexual problems:

Young people may have sexual problems like sexual dysfunction, sexual variation like homosexual feelings, sexual harassment or sex abuse. These may be frightening for young people before they are experienced enough.

Alcohol and drug abuse:

Substance use is a social rather than solitary behavior in adolescence. Most often drug abuse starts as a result of "seduction" within peer group. Unemployment is a major course of alcohol and drug abuse. The reasons for continuing drug taking are: reinforce the experience; earn the approval of the others in the group, or to satisfy continuing feeling of aggression against society, parents or others. Pattern of pathological drinking is laid in adolescence. Consequences and dependence may occur several years later. It increases risk taking behavior and causes death due to violence and accidents. Problem behaviors like substance use, tobacco and alcohol are interrelated. One leads to others. They cluster together.

In US,

- Underage drinking is a factor in nearly half of all teen automobile crashes, the leading cause of death among teenagers.
- Alcohol use contributes to youth suicides, homicides and fatal injuries the leading cause of death among youth after auto crashes.
- Alcohol abuse is linked to as many as two-thirds of all sexual assaults and date rapes of teens and college students.
- Alcohol is a major factor in unprotected sex among youth, increasing their risk of contracting HIV or other transmitted diseases.

Violent and destructive behaviour:

The transition to adulthood is often painful with several stresses. Disruption of normal family relations is one of the most frequent causes of suicide: others include migration, isolation, intense competition and unemployment. In many instances no causes can be identified.

The manifestations of mental disorders in adolescence very often follow a common pattern of antisocial, psychopathic-like behaviour. Psychiatric conditions as paranoid tendencies, schizophrenia, depressive maladaptive personality traits,a nd somatic complaints.

Suicidal behaviour is the most tragic among the violent behaviours because it leaves unfulfilled promise of a young life and feelings of anger, grief and guilt in those close to the dead person. Females attempt more but commit less leaving permanent impairment. Ratio of attempted to committed is 40:1 in most industrialized countries.

Young people are increasingly the victims of violence and themselves physically violent towards others. One major cause is war. Social violence is in the increase. Causes may be poverty, unemployment, overcrowding and reduced control over upbringing. Contributory factors are drug and alcohol abuse, sense of failure, frustration and hopelessness, and frequent exposure to violence in streets and television.

Promotion of young people's health

A healthy environment providing both support and opportunities for young people is a necessary, but not in itself sufficient condition for healthy development. Much of the responsibility for health enhancing behavior falls on young peoples themselves who must increasingly take and act upon decisions of an educational, vocational, and personal nature with major consequences for the present and future. Educational institutions can provide healthy supervised physical exercise and can be major source of education and guidance about major health issues.

DUELike Project.- Universitas Indonesia

The University of Indonesia got funding under the project 'Developing Undergraduate Education' which is a special project to be implemented for entire University and not for individual study programs. The

program aims at changing the attitude towards learning and they have included compulsory credits in either sports or performing arts.

DUELike Project.- Universitas Gadjah Mada, Indonesia.

The program in Gadjah Mada University aims at future leadership. They are providing staff training to promote student performance and teach senior students to be good big brothers and sisters and the fresh year students on leadership skills. This program aims to convert the students with lack of self confidence, lack of decisiveness, mild risk taking, lack of adversity, lack of communication skills, and very low competition values into students with Vision, insight, commonsense, decisiveness, belief, courage and teamwork.

School Health:

National Center for Chronic Disease Prevention and Health Promotion has developed a coordinated school health program. It involves Health Education, Physical Education, Health Services, Nutrition Services, and Health Promotion for Staff, Counseling and Psychological Services, Healthy School Environment and Parent/Community Involvement

Parents:

State should provide parents and the family members with adequate information and support to enable them to respond to the health needs of youth.

Community organizations:

Community programs should provide opportunities for young people to give expression to their new found physical, mental, social and moral capacities. They should act as link between family, school and health sector and provide guidance to minimize risks involved in new experiences.

Policies and legislation:

Laws that deal with minimum age for marriage, alcohol consumption, the purchase of cigarettes, acquiring a driving license, doing military service, conditions of obtaining contraceptives, termination of pregnancy, and minimum age for leaving school should be reasonable, made known and enforced.

Health education:

Health education reduces risk of cardiovascular diseases in later life. It can promote reduction in starting smoking, better eating habits, better body mass indexes, cholesterol levels and increased physical activity. Peer leaders as facilitators gave better results than teacher led program. Teachers can be trained to identify stress and suicidal behavior of young people in addition to simple health problems.

Youth and Education:

Attendance at school is increasing but several young people never go to school or dropout at various levels of schooling. Attendance of females remains lower than that of males. Young people outside school could be educated by suitably designed programs. "Streetwise" is a comic designed for youngsters in Australia in 1984 by the federal government; stories not about supermen and women but disadvantaged and disabled, young and recognizable; the characters are from real world. They are true and familiar stories.

An active role for young people.

Involving young people in Primary Health Care as a strategy for improving their own health and that of their communities is gaining recognition. The reasons are:

- Young people always help their families and communities.
- Contribution to the welfare of the society, experiencing the rewards of it and achieving social recognition are essential parts of growing up.
- Young people are generous, open, and willing and enthusiastic.
- Young people are ready to respond physically, emotionally, intellectually, with freshness of approach, idealism, creativity, and boundless energy.

Youth and Employment:

Employment conditions that are subject to rapid change may call for new faculties of individual adjustment. They require a high degree of social mobility and mental flexibility. General school education, vocational training, and socio-cultural norms have to focus on developing the above in young people.

Community Medical and Social Resources:

The conflict between youth and society takes place at many levels- at home, at school, in the university, at work. The frustration of youth is further aggravated when friction is compounded by the anxiety, irritation and intolerance of adults who are key persons in the social system. Both groups can benefit from explanation and counseling. Many cities now have youth advisory centers

which provide informal services of advice and guidance on a whole range of problems of concern to young people. Public health authorities and general practitioners should also be involved in community youth services that co-ordinate all social and psychological resources in the area.

Health Objectives for young people 2010 American Medical Association.

The objectives of American Medical Association for the young people in US gives a good guidance to the research and activities we have to undertake to promote the health and wellbeing of the young people here.

	Objective	Baseline (year)	2010 target
1	Reduce deaths of young people- 10-14 years 15-19 years 20-24 years	 21.5/100,000(1998) 69.5/100,000(1998) 92.7/100,000(1998)	 16.8/100,000 39.8/100,000 49.0/100,000
	Unintentional Injury:		
2.	Reduce deaths caused by motor vehicle crashes.	25.6/100,000(1998)	
3.	Reduce deaths and injuries caused by alcohol and drug related motor vehicle crashes.	13.5/100,000(1998)	
4.	Increase use of safety belts.	84% (1999)	92%
5.	Reduce the proportion of adolescents who report that they rode, during the previous 30 days, with drivers who had been drinking alcohol	33% (1999)	30%
	Objective	Baseline (year)	2010 target
	Violence:		
6.	Reduce the suicide rate. 10-14 years 15-19 years	 1.2/100,000(1999) 8.0/100,000(1999)	
7.	Reduce the rate of suicide attempts by adolescents.	2.6% (1999)	1.0%
8.	Reduce homicides 10-14 years 15-19 years	 1.2 /100,000(1999) 10.2/100,000(1999)	
9.	Reduce physical fighting among adults.	36%(1999)	32%
10.	Reduce weapon carrying by adolescents.	6.9%(1999)	4.9%
	Substance use and Mental Health:		
11.	Reduce the proportion of persons engaging in binge drinking of alcoholic beverages. 12-17 years.	7.7%(1998)	2.0%
12.	Reduce past-month use of illicit substances. 12-17 years.	8.3% (1998)	0.7%
13.	Reduce the proportion of young people with disabilities who are reported to be sad, unhappy, or depressed.		
14.	Increase the proportion of children with mental health problems who receive treatment.		
	Reproductive health:		
15.	Reduce pregnancies among adolescent females	68/1000(1996)	43/1000
16.	Reduce new HIV infection among adolescents and adults	16479 (1998)	
17.	Reduce Chlamydia trachomatis infections		
18.	Increase the proportion of adolescents who abstain from sexual intercourse or use condoms if currently sexually active.	85% (1999)	95%
	Chronic diseases:		
19.	Reduce tobacco use by adolescents.	40%(1999)	21%
20.	Reduce children and adolescents who are obese or overweight.	11%	5%
21.	Increase the proportion of adolescents who engage in vigorous physical activity that promotes cardio respiratory fitness 3 or more days per week for 20 or more minutes per occasion.	65% (1999)	85%

Principles for promoting the healthy development of young people:

Programs to promote the healthy development of young people should aim at achieving the following:

- A supportive environment over a long period, with graded steps towards autonomy, enhancing self esteem and promoting a healthy life style.
- Good communication between young people and the key adults and peers in their lives.
- Approaches based on a sound understanding of young people's beliefs and behavior within any given culture.
- The use of people who respect the young, have a sound knowledge of their needs and are trained in communication skills.
- The focusing of programs on total lifestyle rather than on individual aspects of behavior.
- An inter-sectoral approach to programmes, with the full involvement of key groups who deal with young people, including the school, the family, the health system, religious and community leaders and community organizations.
- Involvement of young people themselves in the planning and implementation of programmes.

Conclusion:

Health is a state of complete physical, mental and social well being and not merely the absence of disease or deformity. Health at young age is health for all ages. Health of young people is health for all people. **Can we get alls ectors concerned with young people together to promote their health?**

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SUBFERTITLIY : RECENT ADVANCES *

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Reproduction is a basic and essential feature of every living being. Failure to conceive is a stressful and depressing condition in married couple. Especially among Tamil community this is considered as social stigma. Families separate, and even go to the extent to the suicide of one or both of the couple.

There have been many inventions and changes in the management of sub fertility in the recent past years offering some hope to these unfortunate couple. The first break through in management of sub fertility was in fact made some 30 years ago with the birth of first invitro fertilization of baby the test tube baby. Since the introduction of 1st test tube baby now more than a million babies are born with IVF .Now it is said that 1%of the Babies are born by IVF Techniques in Western Countries. Various new techniques has been invented and introduced for the last few years with improvement in management of subfertility.At the mean time there are concerns in safety of these techniques.

The IVF(invitro fertilization) simply means handling the egg and sperm outside the body and replacing the fertilized egg inside the body again.To be fertile a woman should ovulate, and should have a patent genital tract.

The male should have adequate and quality sperms.

Any abnormalities in any of these will impair the chance of conceiving. Among the subfertile couple around 40 percent are due to male factor and 30 percent due to female factors. In 15 percent cause of the subfertility cannot be identified and named as unexplained subfertility.A recent study has shown an increase in male subfertility, this may be due to changing environments and due to behavioural changes in men.

Causes of Female Subertility

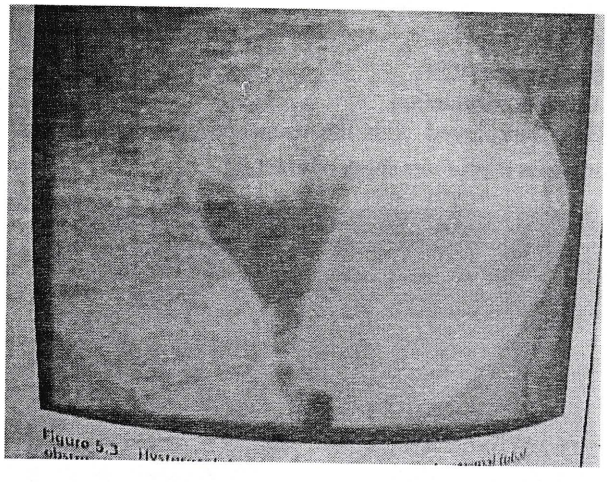
Around 30% of the subfertility cases are due to Female factor. Among these prime causes are ovarian factor and tubal factor.

Ovarian factors

Ovary may not function properly or fails completely sometimes. Ovarian stimulating drugs have been in use for many years but GnRH analogues revolutionized the ovulation induction techniques. In complete ovarian failures pregnancy has become possible with techniques of ovum donation and surrogacy.

Tubal factors

When tubes are blocked pregnancy will not be possible by normal means. When tubal reconstruction is not possible IVF is the option



Blocked tubes

Endometriosis

* Review Lecture

Male factors

Sub fertility due to male factor has been difficult area until the IVF techniques were invented. Following the innovation of ICSI techniques pregnancy has become a reality in couples with Azoospermic/Oligospermic.

IVF Techniques

Invitro fertilization means handling the egg outside the body, but nowadays this term is used vaguely for all the modern subfertility treatments.

IVF techniques are basically used when the natural mechanism of conception is not possible due to various problems.

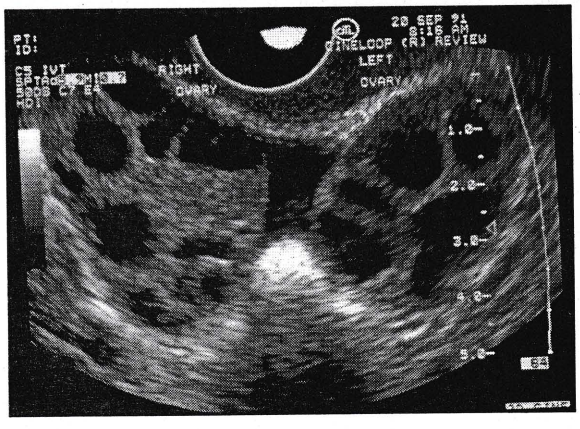
Indications for IVF

- Tubal blockage/damage
- Need of ovum donation
- Seminal fluid problems
- Unexplained sub fertility

Basic steps in IVF

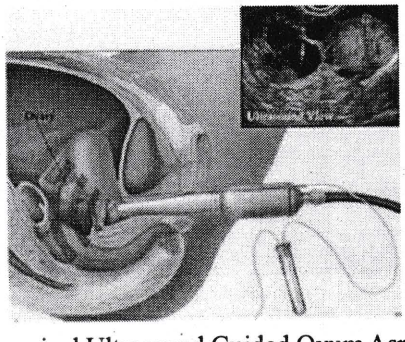
1. Ovulation induction

This is achieved with the usage of clomephene and hormones to promote super ovulation.



A Hyper stimulated ovary

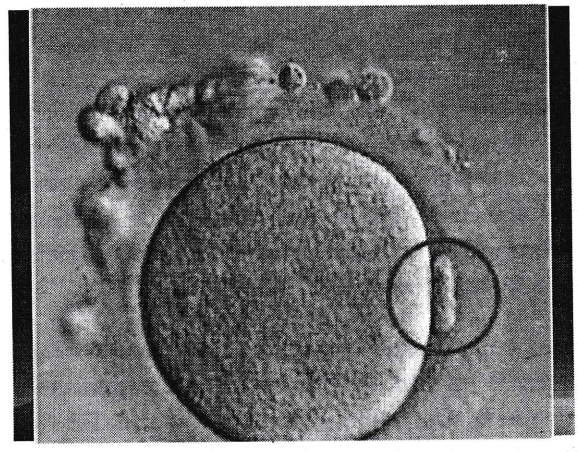
During the course the growth of ovarian follicle is monitored with the use of ultrasound scanner. When the ova are ready it is aspirated through ultrasonic guidance.



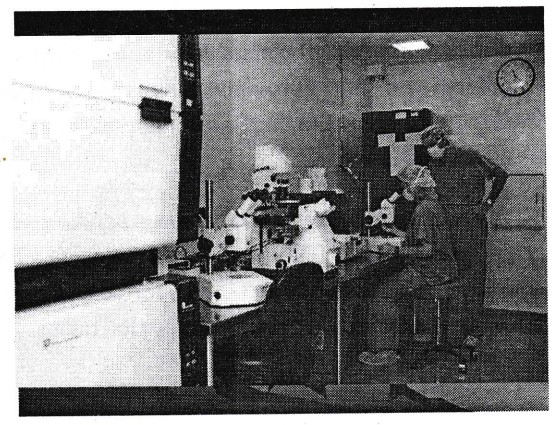
Transvaginal Ultrasound Guided Ovum Aspiration

2. Fertilization

Retrieved ovum and the processed sperm are kept in the culture media and allowed for fertililzation.when eggs are fertilized good embryo are selected for implantation and the other embryos are frozen for future u se.



A Fertilized Egg



Embryos are selected

3. Embryo Transfer

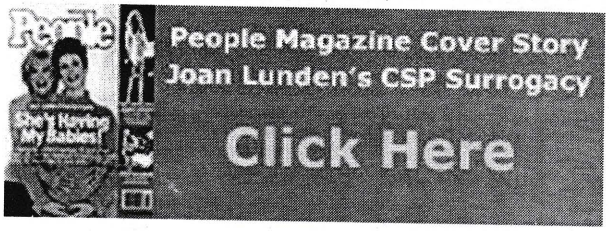
Embryos are transplanted into uterus and usually 2 embryos are selected for implantation.

The frozen Embryos and sperms could be kept for many years and used later. Buts eggs are difficult to handle, like women. A science breakthrough recently made this possible and now the eggs also could be frozen and kept for years. This had helped in women who are under going treatment for malignancies to preserve their eggs and to use them later.

Hire a Mum

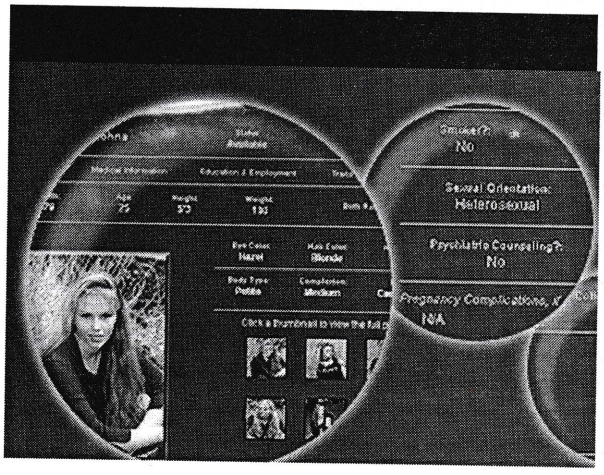
When the couple can't produce egg/sperm pregnancy is

achieved with the help of donors. People who donate eggs/carry another woman's baby is called surrogate mother.



Internet Egg donors

Now this has become a booming business in the western world and you may have seen many adverts of surrogate mothers. Egg from one sperm from another and the 3rd may carry the "tailor made baby".



Fig; Advertisement on internet for egg selling

Grandmas become pregnant

"With the development of hormones now it has become possible even post menopausal women pregnant at heir sixties.

ICSI: a one man's show

The invention of Intra Cytoplasmic Sperm Injection was a major break through in management of Male sub fertility. In this technique a single sperm is enough to achieve pregnancy. A selected sperm is injected into egg by drilling it. (Minimum of 20 million sperms are needed for natural conception.) This has helped many men with sperm production problems.

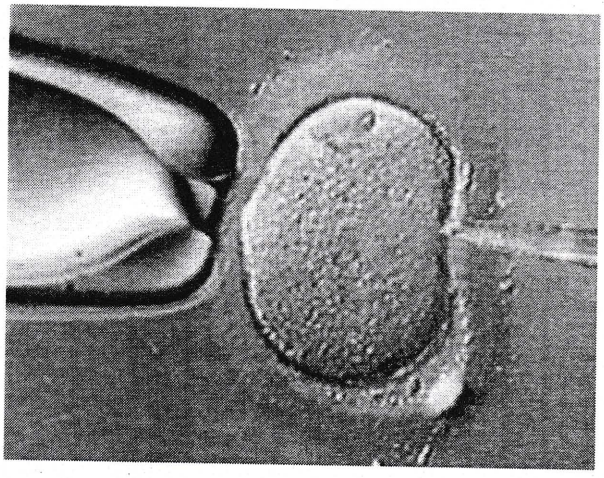
Problems with IVF

Costly Matter

IVF is not within reach of a poor couple as the costs may go above 2 million Rupees. But we have seen people selling their properties, borrowing loans as they feel its worth trying.

Poor success rate

It will be disappointing to know that the success rate even at the best of its centre is less than 25%.That is only one in 4 or 5 will become pregnant .So the couple who goes for IVF needs extensive counseling prior to the treatment.



Sperm being injected to Egg

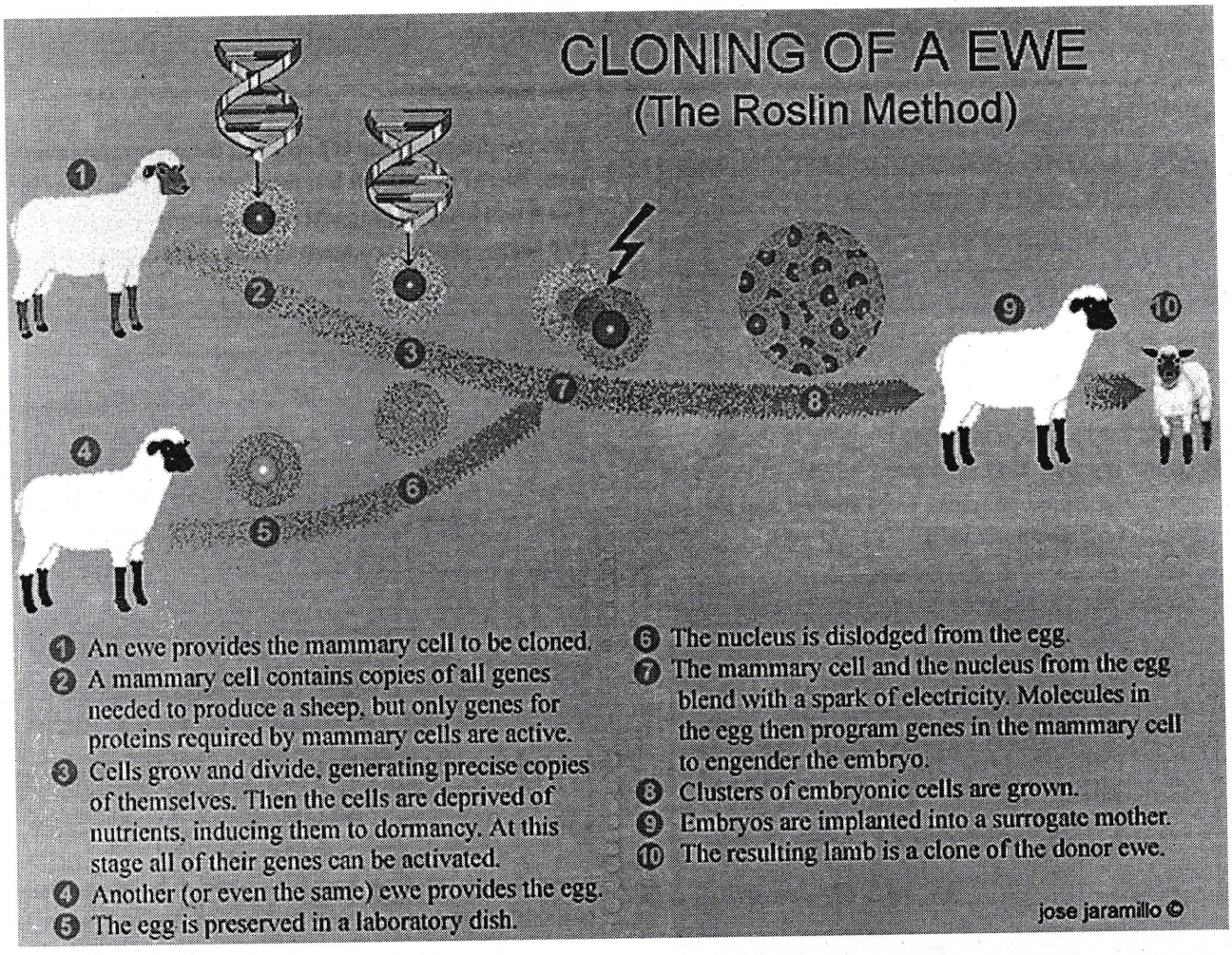
Cloning

Even though cloning has been started in plants and animals years ago cloning in humans has not started openly. Many claims on human cloning has been reported in media are said to be fraudulent. Many countries have banned human cloning.

Photocopy of living beings

In cloning genes from any cell of a living being is replicated using modern technology, giving a replica of the individual, even the finger prints will be the same.

Dolly

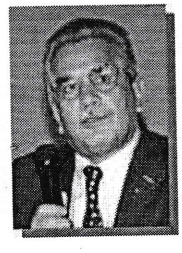


1st cloning in animals was performed from a cell of a sheep by Prof Ian Wilmut in Scotland, Named Dolly.

God of the Goat

An Italian professor and many others have claimed that they have produced cloning babies.Prof Antenorio has said that he will continue to work on making human clone

The first cloned baby



Prof Antenorio

Apart from making babies cloning is being used to make cell lines, for example to produce an organ which is needed in a human being because his/her organ is diseased.

பானை புனைந்தது போதும் இனி ஒரு man இனைப் புனைவோம்

Cloning also could be used in cloning /creating people with exceptional talents such as Einstein. It also may help grieving parents to bring back their child who was killed in an accident. People wonder whether this could be compared to a state of Immortality.

Many concerns also have been expressed about cloning. Like creating Einstein some might create Hitler also. Safety of such methods is yet to be proved. The 1st cloned mammal The Dolly died prematurely, the cause was unknown.

Are we going against nature's selection theory? Will this end up in a population of unhealthy generation? A study published recently found that there is an increased incidence of sex-linked disorders among IVF babies.Thereis also increased incidence of gene deletion disorders resulting in mentally retarded children. ` There is a theoretical risk for the male gender also arises with the cloning because the offspring could be made and reared on a female,t hereby obviating the need of a male!

THE PHYSICS OF TSUNAMIS *

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1. Introduction:

On December 26, 2004, a massive underwater earthquake off the coast of Indonesia's Sumatra Island rattled the Earth in its orbit. The quake measuring 9.0 on the Richter scale is the largest one since 1964. Dozens of aftershocks with magnitudes of 5.0 or higher occurred in the following days. But the most powerful and destructive aftermath of this devastating earthquake is the **tsunami** that it caused. The death toll has reached higher than 280,000, and coastal dwellers suffered devastating property damage.

The devastation of this tsunami overshadowed the devastation of any other tsunami we've seen in recent history, but scientifically, the course of events followed the same basic sequence of a typical tsunami. In this review, we shall look at what causes tsunamis, the effects of a tsunami strike and the physics that drives them. We will also examine scientists' worldwide efforts to monitor and predict tsunamis in order to avoid disasters like the one that occurred on 26th December 2004.

1.1 What is a tsunami?

Fig 1 Tsunami - A Japanese word

Tsunami is the biggest, most feared waves of all. It passes mostly unnoticed across the open sea, then rears up and strikes the shoreline with devastating blows. The country with the most detailed history of these killer waves is Japan, and the waves are known by the Japanese word **tsunami** with the English translation, "harbor wave". Represented by two characters (Fig. 1), the top character, "tsu," means harbor, while the bottom character, "nami," means "wave". The reference to 'harbor' waves emphasizes the greater heights that waves reach in inlets and harbours because the narrowed topography focuses the waves into smaller spaces.

In the past, tsunamis were sometimes referred to as "tidal waves" by the general public and as "seismic sea waves" by the scientific community. The term "tidal wave" is a misnomer; although a tsunami's impact upon a coastline is dependent upon the tidal level at the time a tsunami strikes, tsunamis are unrelated to the tides. Tides result from the imbalanced, extraterrestrial, gravitational influences of the moon, sun, and planets. The term "seismic sea wave" is also misleading. "Seismic" implies an earthquake-related generation mechanism, but a tsunami can also be caused by a non-seismic event, such as a landslide or meteorite impact.

A tsunami is a wave train or series of waves generated in a body of water by an impulsive disturbance that vertically displaces the water column.

1.2 Tsunamigenic Events

The natural occurrences capable of causing a tsunami are referred to as **tsunamigenic** events. The tsunamigenic events are:

- earthquakes
- submarine volcanoes
- submarine landslides
- impact of cosmic bodies (meteorites)
- man made explosions

Often the second / third events accompany major earthquakes, adding to the overall power of a tsunami or creating additional tsunamis.

Generation of Tsunamis is a seismic activity. But the propagation of the waves and their behaviour is understood via wave theories. Therefore to understand tsunamis, we have to first review,

(a) the structure of the earth and the science behind the occurrence of phenomena like earthquakes and volcanoes and
(b) the anatomy of waves

2. The Layered Structure of the Earth

The Centre of the earth is a solid core the *Inner Core* (Fig 2A, 2B). The density of this core is about 13 g cm^{-3}. Its

* Review Lecture

thickness is about 1300 km. The temperature at the Centre of the earth is about 4000°C and the pressure is nearly 4 million atmospheres.

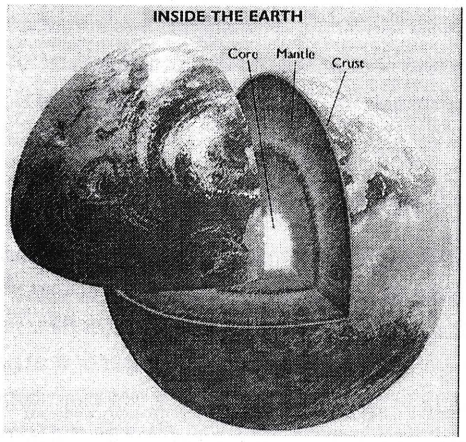

Fig 2A -Structure of the earth

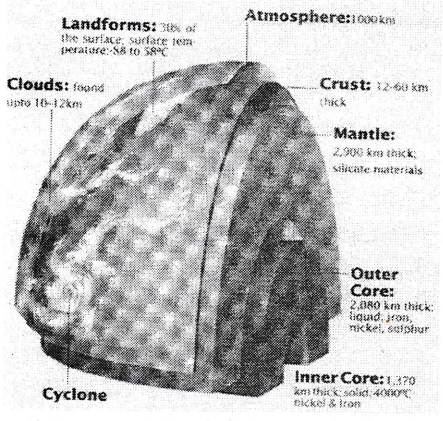

Fig 2B -Structure of the earth

The Inner Core is surrounded by an *Outer Core* of about 2080 km. The Outer Core appears to be molten.

The Outer Core is surrounded by the *Mantle* which has a thickness of around 2900 km. The *Mantle* is a shell of red hot rock. It is composed of silicate minerals rich in magnesium and iron. The upper portion of the mantle, about 250 km thick, is called the ***Asthenosphere***. In the *Asthenosphere* the rocks are partially melted, with thin films of liquid distributed between the mineral grains. The red hot nature of the lower mantle and the partially melted nature of the upper mantle (*Asthenosphere*) combine to make the whole mantle plastic or yielding.

The Mantle is topped by the ***Crust*** of the earth. The Crust is also called the ***Lithosphere.*** It comprises the oceans, ocean floor and continents. The thickness of the Crust varies between 12 (deep oceans) and 60 km (mountains). The lithosphere is distinguished from the Asthenosphere by the fact that it is cooler and therefore more rigid.

2.1 The Plates of the Lithosphere:

A new concept of geology is the theory of **Plate Tectonics**. Tectonics simply means the study of rock structures involved in earth movements. Plate Tectonics deals with such structures as are in the form of plates.

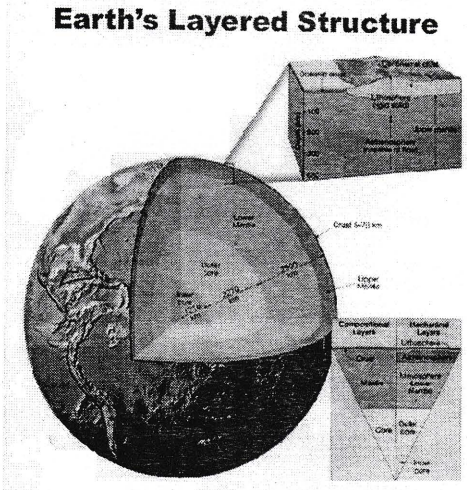

Fig 3 - Plate Tectonics

Plate Tectonics (Fig. 3) tells us that the Lithosphere (the top crust of the earth) is not an unbroken single shell of granite and basalt, but is a mosaic of several rigid (curved) segments, called **plates**. These plates 12 or 13 or more in number (Fig. 4) - include not only the Earth's solid upper crust but also parts of the Asthenosphere (upper portion of the mantle). The thickness of these plates varies between 50 and 100 km. These plates float on the thick treacle mass of (plastic-like) molten rock (the upper mantle of the Earth) and move together and apart like pieces of jigsaw puzzle.

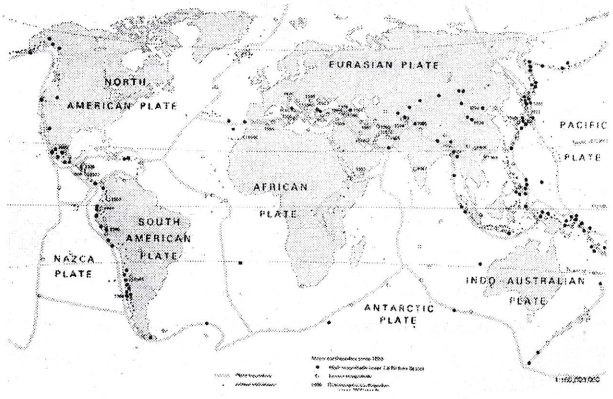

Fig 4 - The Plates

(Like a pie cut into 12-13 slices, the pie crust would be the lithosphere and the hot, sticky pie filling underneath would be the asthenosphere).

These plates carry the continents and oceans on their backs like giant rafts and float on the Asthenosphere and move slowly and continuously over the interior of the earth against one another approaching / meeting in some areas and separating in others - with the relative velocity between adjacent plates lying in the range 1 to 12 cm a year. Also like other floating bodies the plates seeks an equilibrium riding deeper where it is heavier and rising higher where it is lighter.

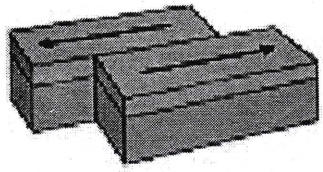

Fig 5A

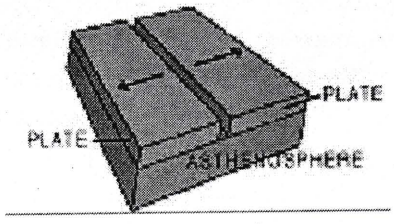

Fig 5B

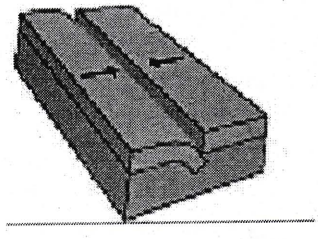

Fig 5C

Plate movements

The curved line where two plates come into contact is called a **Plate boundary.** When two plates come into contact at a plate boundary, a heavier plate can slip under a lighter one. This phenomenon is called **subduction** (Fig.5 C).

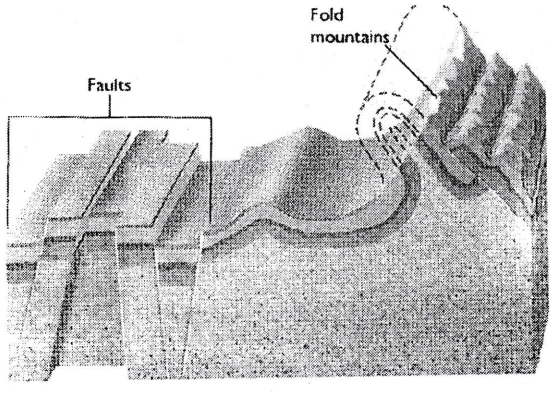

Fig 6 -Formation of mountains

In some places, patches of continental crust collide as one plate pushes up another. The Indian sub-continent was once separate from the rest of Asia. The force of the collision pushed rocks upwards to make mountains (Fig. 6). This is how the Himalayas were formed. This movement is continuing and the Himalayas are still being pushed very slowly upwards and Mount Everest is getting higher!

2.2 Earthquakes:

When rocks, mostly situated in the deep interior of the earth undergo compression due to very strong pressure exerted on them by some geological processes, rupture occurs with the release of a large amount of energy, often equivalent to the energy released when atom bombs are exploded. As a result a sudden oscillatory and sometimes violent motion or trembling in the earth, called the **earthquake** takes place. The devastation caused by this release of energy during earthquakes is well known. The energy can be released by either

(a) a sudden dislocation of segments of the crust (Fig. 5) (called tectonic earthquake) or
(b) a volcanic eruption or
(c) a Meteoric impact
(d) a man made explosion.

The theory of plate tectonics explains the occurrence of tectonic earthquakes as follows:

The vast majority of all big earthquakes occur at tectonic plate boundaries. This is because a floating plate sometimes move underneath another plate or slip past another plate at the boundaries (Fig. 5). (The interior of a plate tends to be stable and less subject to earthquakes). As the plates move strain accumulates and eventually slippage can occur near plate boundaries causing a **fault**. A fault is a fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other. One plate can slip or move with respect to the other horizontally or vertically causing a rupture of the earth's crust.

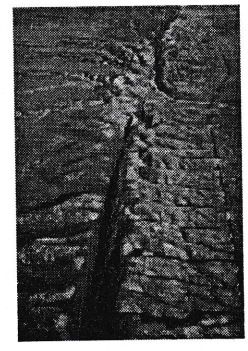

Fig 7-San Andreas fault in California

Fig. 7 shows the most famous strike-slip fault in the world the San Andreas fault in California, USA. This right lateral fault is more than 1300 km long. On 18 April 1906, a 430 km long segment of this fault ruptured and moved horizontally as much as 6.5m in 60 seconds. The great burst of energy generated by the fault movement was actually the release of elastic energy that had built up and been stored in the rocks for decades.

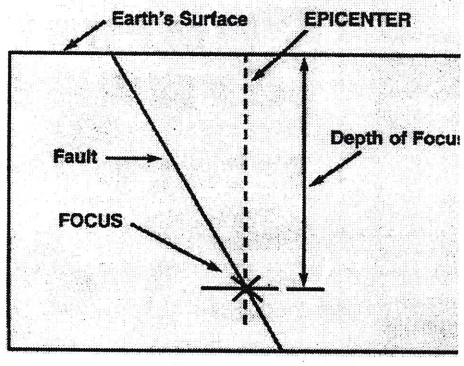

Fig 8 -Epicentre and Focus of an earthquake

When plates slide past each other strain energy is suddenly released. Even though the amount of movement is very small, the energy released is colossal. It is transferred into shock waves. This results in an earthquake. **The focus of the earthquake is the point within the Earth where the rupture first occurs, rocks break and the first seismic waves are generated.** (Fig. 8) The fault rupture begins at the focus of the earthquake.

The **Epicenter** is the point on the earth's surface directly above the focus. The **focal depth** of an earthquake is the depth from the Earth's surface to the focus where an earthquake's energy originates. Earthquakes with focal depths of 60 km or less are classified as shallow. Those with focal depths from 60 km to 300 km are classified as intermediate or deep. The earthquakes tend to occur along faults in plate margins, which reflect zones of weakness in the Earth's crust. The fact that a fault zone has recently experienced an earthquake offers no assurance that enough stress has been relieved to prevent another quake.

2.3. Seismic Waves:

Two general types of vibrations caused by earthquakes are

surface waves - which travel along the earth's surface and

body waves - which travel through the earth.

These seismic waves which propagate at speeds of more than 15,000 km per hour cause extensive damage to buildings.

2.4. Measurement of Earthquakes:

The seismic waves are detected, recorded and measured by instruments called **Seismometers** which can sense earth motion.

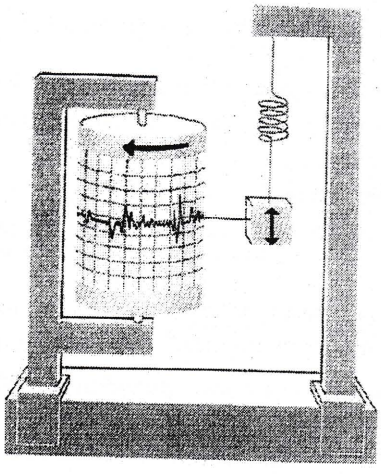

Fig 9 - A simple Seismograph

A **seismograph** combines a seismometer with recording equipment. A simple form of seismograph is shown in Fig. 9. This provides a permanent continuous record of the motion and the record itself is called a **seismogram**. Seismogram is a zigzag line made by a seismograph, which will provide information needed to determine epicenter, depth of focus, magnitude and estimates about energy released.

The magnitude is related to the amount of seismic energy released at the focus of the earthquake. To fix the epicenter, readings from at least three observatories are needed.

2.5. Magnitude of the Earthquake - The Richter Scale:

The Richter Scale was developed in 1935 by Dr. Charles F. Richter of California Institute of Technology. This is the best-known scale for measuring the magnitude of earthquakes.

The magnitude scale has neither maximum nor minimum values, the highest magnitude ever calculated was greater than 9. It is a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of waves recorded by seismographs. Adjustments are included in the magnitude formula to compensate for the various seismographs and the epicenter of the earthquakes.

On the Richter scale, the magnitude M of the earthquake is

generally expressed as

$$M = \log (A/T)$$

where A = the maximum amplitude (measured in microns) of ground motion

and T = the dominant wave period in seconds

Various types of magnitude (Surface Wave, Body Wave, etc.) are computed by various institutions and the Surface Wave Magnitude (Ms) for shallow earthquakes calculated by the United States Geological Survey (USGS) is considered to be more reliable and given by the following formula:

$$M_s = \log (A/T) + 1.66 \log D + 3.3$$

where T = the dominant wave period in seconds
A = the maximum ground amplitude (measured in microns) of the vertical component of the surface wave within the period range $22 \geq T \geq 18$
D = distance in geocentric degrees (station to epicenter) with D in the range $20^\circ \leq D \leq 160^\circ$

On the Richter scale, the magnitude of the earthquake is expressed in whole numbers and decimal fractions. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a 10-fold increase in measured amplitude. As an estimate of energy, each whole number step in the magnitude scale corresponds to a release of about 31 times more energy than the amount associated with the preceding whole number.

Earthquakes of magnitude
$M \leq 2$ are called micro earthquakes (At $M \approx 2$, a person on the ground will feel a tremor.

Earthquakes of magnitude
$M \geq 4.5$ are called strong earthquakes: strong enough to be recorded by sensitive seismographs all over the world. (At $M \approx 6$, buildings would be damaged)

Earthquakes of magnitude
$M \leq 8.0$ are called great earthquakes.

2.6. The countries vulnerable to earthquakes:

The countries that lie close to the plate boundaries are vulnerable to earthquakes. Japanese Islands, The Philippines, The Indonesian island of Sumatra are a few examples.

Sri Lanka lies in the large Indo-Australian plate seemingly far away from any of the plate boundaries. Many of us therefore believe that this fortuitous scenario makes Sri Lanka safe from earthquakes. Recent geological studies however give convincing evidence for a long suspected geological phenomenon that the Indo-Australian plate is splitting (Fig. 10). The split is just about 300 km from the southwest coast of Sri Lanka (Fig. 11).

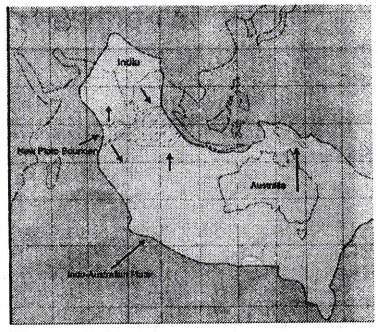

Fig 10 - Splitting of Indo Australian plate

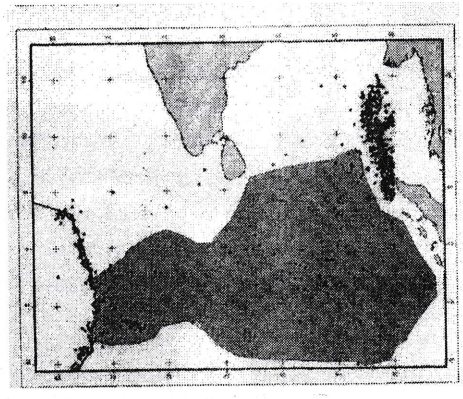

Fig 11 - Sri Lanka and the nearest plate boundary

The cause of this Indo-Australian split is thought to be the stress suffered by the very large Indo-Australian plate as it smashes into Asia pushing up the Himalayas and the Tibet plateau.

Therefore the vulnerability of Sri Lanka to earth tremors is certainly greater than before and a disastrous earthquake hitting Sri Lanka cannot be ruled out.

2.7. Volcanoes:

Active volcanoes are found in areas where

(a) new oceanic crust is squeezed up from deep inside the earth (ex: in Iceland) or
(b) the crust is disappearing down beneath the continents (ex: Andes mountains of South America)

A volcano is a vent (or hole) in the Earth's crust (Fig. 12). Through the vent hot molten rocks from deep in the Earth pour out onto the surface. A volcano acts as a 'safety valve', releasing pressure that has built up below the earth. Inside the Earth, molten rock is called **magma**. When it flows onto the surface as a result of a volcanic eruption, it is called **lava**. Molten lava is almost white-hot, reaching a temperature of 1200oC. On the surface, it cools and hardens.

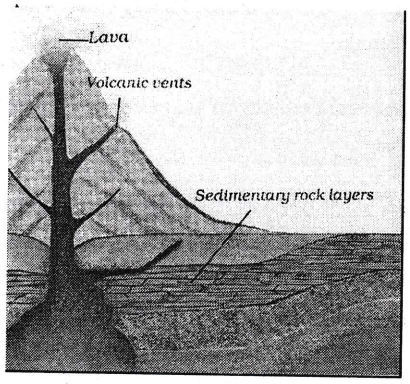

Fig 12 - Section through volcano

Almost all the world's active volcanoes, numbering 500-600 are located at convergent plate boundaries. Yet far greater volcanic activity continues unnoticed and without cessation at mid-ocean ridges where magma from the upper mantle is quickly being extruded on to the ocean floor to create new crust material.

3. Anatomy of a Wave

In order to understand tsunamis, it is necessary to get accustomed to the technical terms used to describe waves in general. Most of us are familiar with waves from days at the beach or local ponds. Waves are made up of (Fig. 13) a **crest** (the highest point of the wave) and a **trough** (the lowest point of the wave). .Waves are measured in two ways:

- The **wave height** is the distance between the crest and trough.
- The **wave length** is the horizontal distance between two consecutive wave crests.

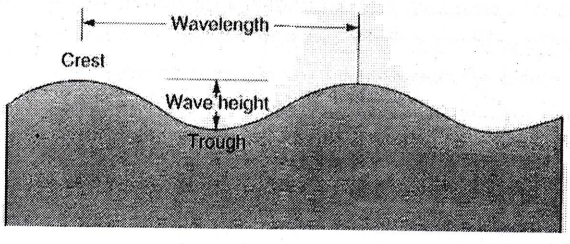

Fig 13 - Anatomy of Waves

The **wave period** of a wave is the time taken by two successive wave crests (or wave troughs) of that wave to cross a given point. The reciprocal of the period is called the **frequency** of the wave.

3.1 The Normal Ocean Waves:

Waves in the ocean are created by a number of things (gravitational pull, underwater activity, atmospheric pressure), but the most common source for ocean waves is the **wind**.

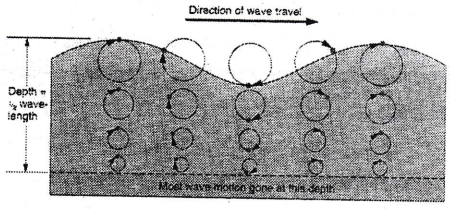

Fig 14A - Circular motion of Capillary Waves

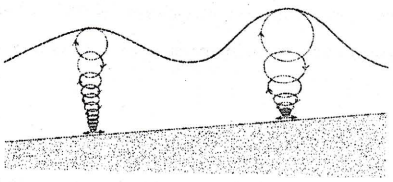

Fig 14B When deep water waves enter shallow water it rises higher

When the wind blows across a smooth water surface, the air molecules grab water molecules as they are carried across the water by the wind. The friction between the air and water stretches the water's surface, creating ripples in the water known as **capillary waves**. The capillary waves move in circles (Fig. 14A). This circular motion of water continues vertically underwater, though the power of this motion decreases in deeper water. As the wave travels, more and more water molecules are collected, increasing the size and momentum of the wave. The most important thing to know about waves is that they do not represent the movement of water, but instead show the movement of energy through water.

As a wave moves into shallower water, it rises higher. Circularly rotating water touches bottom, causing a flattening into a back-and-forth motion (Fig.1 4B).

Many of us may have observed the wind generated waves on a lake or at a coastal beach. The wind-generated swell one sees at Point Pedro beach, for example, spawned by a storm out in the Indian Ocean and rhythmically rolling in, one wave after another, might have a period of about 10 seconds and a wave length of 150 m.

In normal waves, the wind is the source of that energy.T he size and speed of wind waves are dependant on the strength of the wind.

3.2. Differences between tsunamis and other water waves

Tsunamis and normal waves have the same physical features and the physical parameters and are measured in the same way. But there are many differences between the two. Tsunamis, unlike wind-generated waves are shallow-water waves, with long periods and wavelengths. A tsunami, unlike the wind generated waves, can have a wavelength in excess of 100 km (Fig. 15) and period of the order of one hour.

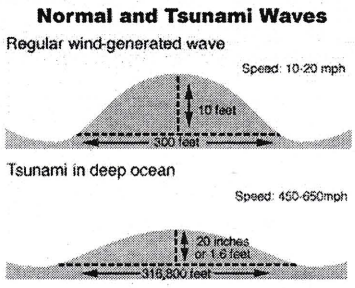

Fig 15 - Normal & Tsunami Waves

As a result of their long wavelengths, tsunamis behave as shallow-water waves. A wave becomes a shallow-water wave when the ratio between the water depth and its wavelength gets very small.

Shallow-water waves move at a speed (expressed in $m\ s^{-1}$) given by

$$\text{Speed} = \sqrt{(g \times d)}$$

where g = the acceleration due to gravity on earths surface $= 9.8\ m\ s^{-2}$

and d = the water depth (expressed in m) For example in an Ocean where the water depth is about 4 km, a tsunami travels at about 200 m/s or over 700 km/hr.

The chart below shows some of the differences.

Since the rate at which a wave loses its energy is inversely related to its wave length, tsunamis not only propagate at high speeds, they can also travel great, transoceanic distances with limited energy losses.

The primary differences between tidal waves and tsunami waves are in their size,sp eed and source.

3.3. The Birth of a Tsunami

3.3.1. The Birth of a Tsunami during underwater earthquakes

The most common causes of tsunamis are **underwater earthquakes.**

As has been mentioned earlier, the tectonic plates are in constant motion, moving along each other at a speed of 1 - 12 cm per year and these movements occur most dramatically along fault lines. These motions are capable of producing earthquakes and volcanoes. Earthquakes or volcanoes occurring at the bottom of the ocean are two possible sources of tsunamis.

In some cases of subduction, part of the seafloor connected to the lighter plate may "snap up" suddenly due to pressure from the sinking plate resulting in an earthquake (Fig 16A).

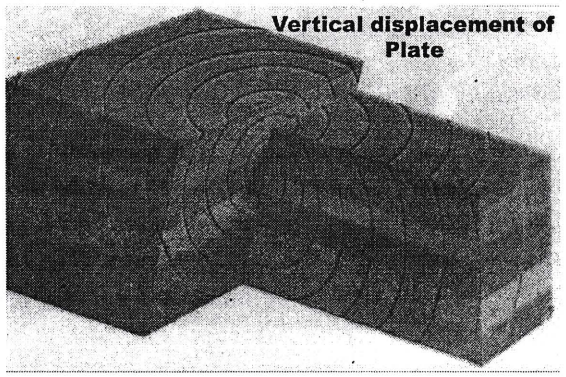

Fig 16A -Subduction : Vertical Displacement of Plate

Typical Tsunami Wave vs. Typical Wind-generated Wave		
Wave Feature	**Wind-generated Wave**	**Tsunami Wave**
Wave Speed	5-60 mph (8-100 kmph)	500-600 mph (800-1,000 kmph)
Wave Period (time required for two waves to pass a single point in space)	5 to 20 seconds apart	10 minutes to 2 hours apart
Wave Length (horizontald istance between two waves)	300-600 feet apart (100-200 meters apart)	60-300 miles apart (100-500 km apart)

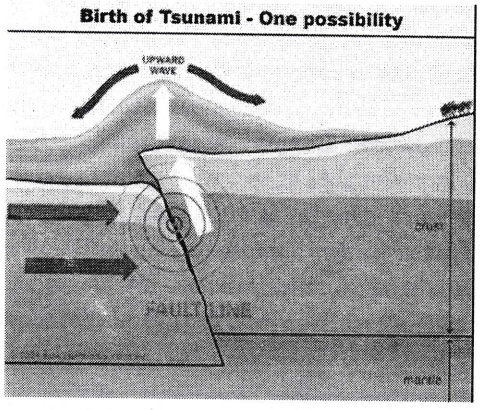

Fig 16B- Birth of Tsunami due to vertical displacement of a plate

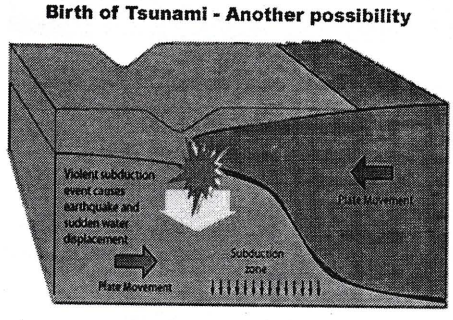

Fig 17A Birth of Tsunami due to violent subduction

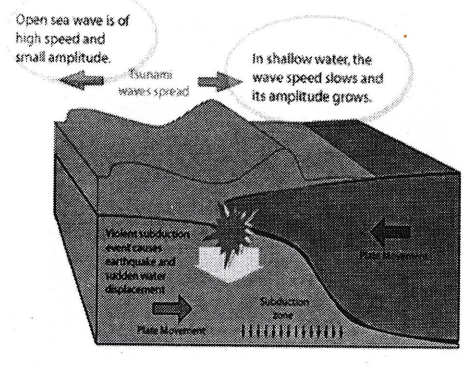

Fig 17B - Spread of Tsunami

Also, as has been mentioned before, when two plates come into contact at a **plate boundary**, a heavier plate can slip under a lighter one (Fig. 17A) - phenomenon called **subduction**. Underwater subduction often leaves enormous "handprints" in the form of deep ocean trenches along the seafloor.

When either a piece of one of the adjacent plates snaps up or a heavier one slips under a lighter one and sends tons of rock shooting upward with tremendous force, the energy of that force is transferred to the water. The energy pushes the water upward above normal sea level (Fig. 16B, 17B).

This is the birth of a tsunami. The earthquake that generated the December 26, 2004, tsunami in the Indian Ocean was a 9.0 on the Richter scale -- one of the biggest recorded in history.

3.3.2 Generation of Tsunamis during underwater \ landslides, volcanic eruptions and cosmic collisions:

A tsunami can be generated by any disturbance that displaces a large water mass from its equilibrium position. As has been mentioned before, the two main natural occurrences capable of causing a tsunami (the **tsunamigenic** events) are earthquakes and submarine volcanism. The other less likely tsunamigenic events are **submarine landslides**, and **cosmic collisions**. Oftentimes, volcanoes & landslides accompany major earthquakes, adding to the overall power of a tsunami or creating additional tsunamis. The mechanism is the same as that with the earthquake in that the extreme upward release of energy from the event affects the overlying water.

In the case of earthquake-generated tsunamis, the water column is disturbed by the uplift or subsidence of the sea floor. Submarine landslides, which often accompany large earthquakes, as well as collapses of volcanic edifices, can also disturb the overlying water column as sediment and rock slump down slope and are redistributed across the sea floor. Similarly, a violent submarine volcanic eruption can create an impulsive force that uplifts the water column and generates a tsunami. Conversely, submarine landslides and cosmic-body impacts disturb the water from above, as momentum from falling debris is transferred to the water into which the debris falls. Generally speaking, tsunamis generated from these mechanisms, unlike the tsunamis caused by some earthquakes, dissipate quickly and rarely affect coastlines distant from the source area.

3.4. [illegible]

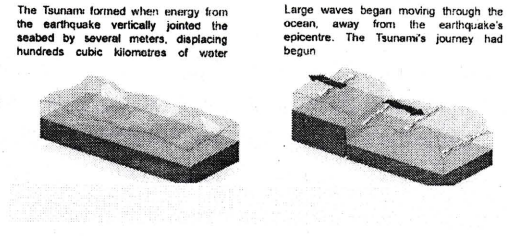

Fig 18 Formation and the beginning of the Journey of the Tsunami

Once the water has been pushed upward, gravity acts on it,

forcing the energy out horizontally along the surface of the water. It is the sort of the same ripple effect we get from throwing a stone into a pond of water, but in reverse: The energy is generated by a force moving out of rather than into the water. The energy then moves through the depths of the water and away from the initial disturbance (Fig 18)

.

The tremendous force created by the seismic disturbance generates the tsunami's incredible speed. The actual speed of the tsunami is calculated by measuring the water depth at a point in time when the tsunami passes by using the formula given earlier:

Speed = $\sqrt{(g \times d)}$

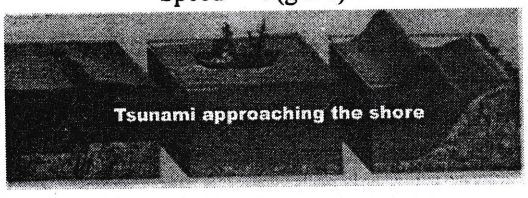

Fig 19-Tsunami not perceivable in deep sea

A tsunami's **ability to maintain speed** is directly influenced by the depth of the water. A tsunami moves faster in deeper water and slower in shallower water. So unlike a normal wave, the driving energy of a tsunami moves through the water as opposed to on top of it. Since the wavelength of tsunami is several hundreds kilometers, it is barely noticeable above the waterline in deep sea. A tsunami is typically no more than 3 feet (1 meter) high until it gets close to shore (Fig.1 9).

Once a tsunami gets close to shore, it takes its more recognizable and deadly form.

3.5 Behavior of a tsunami as it approaches land

As a tsunami leaves the deep water of the open-ocean and travels into the shallower water near the coast, the topography of the seafloor and shape of the shore begins to affect the tsunami's appearance and behaviour. Just like other water waves, tsunamis begin to lose energy as they rush to the shore. A part of the wave energy is reflected offshore, while the shoreward-propagating wave energy is dissipated through bottom friction and turbulence. Despite these losses, tsunamis still reach the coast with tremendous amounts of energy.

Since tsunami travels at a speed that is related to the water depth, as the water depth decreases, the tsunami slows down. The tsunami's energy flux, which is dependent on both its wave speed and wave height, remains nearly constant. Consequently, as the tsunami's speed (kinetic energy) diminishes as it travels into shallower water, its height (potential energy) grows. The shallow water and coastal land acts to compress the wave and convert the kinetic energy of the wave into potential energy by forcing the water upwards. Because of this shoaling effect, a tsunami, imperceptible at sea, may grow to be several meters or more in height near the coast (Fig. 20A, 20B, 20C). A typical tsunami approaching land will slow down to speeds around 30 miles per hour (50 kmph) and the wave heights can reach up to 90 feet (30 meters) above sea level.

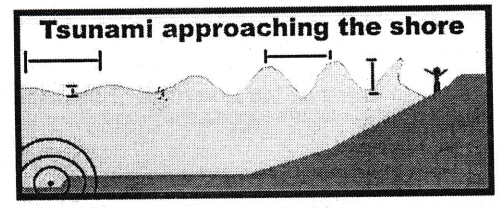

Fig 20A-Tsunami approaching the shore

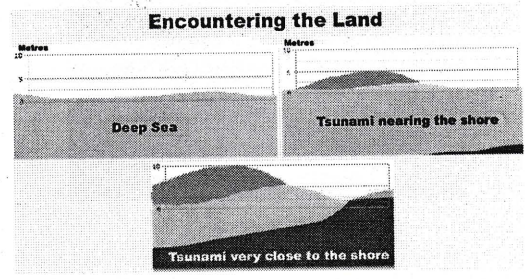

Fig 20B-Tsunami nearing the shore

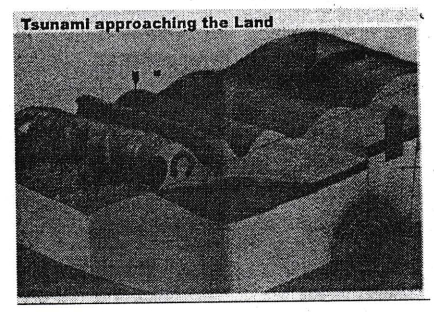

Fig 20C-Tsunami encountering the land

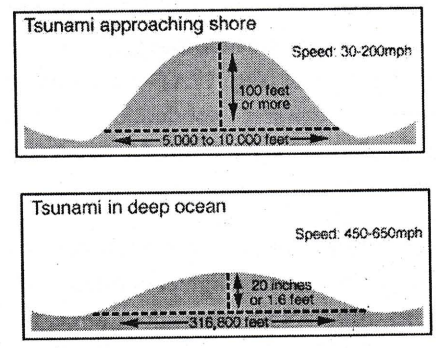

Fig 21 Comparison of the characteristics of tsunami in deep-sea and near - shore

As the wave heights increase during this process, the wave lengths shorten considerably. (Think of squeezing an accordion.).T he anatomy of tsunami in deep sea and at the shore is compared in Fig.2 1.

Fig 22-The Giant Wave

Therefore when the tsunamis finally reach the coast, they may appear as a rapidly rising or falling tide, a series of breaking waves or even a bore (Fig.2 2).

The areas of greatest risk during a tsunami strike are within 1 mile (1.6 km) of the shoreline, due to the flooding and scattered debris, and less than 50 feet (15 m) above sea level,d ue to the height of the striking waves.

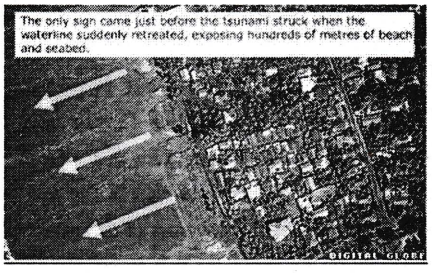

Fig 23 Sea water recedes before the arrival of the tsunami

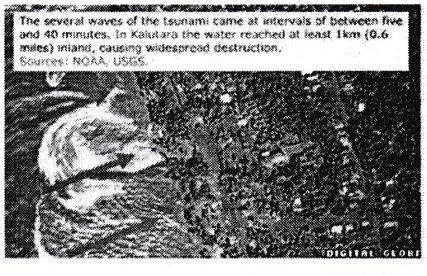

Fig 24-Sea water advances into the land

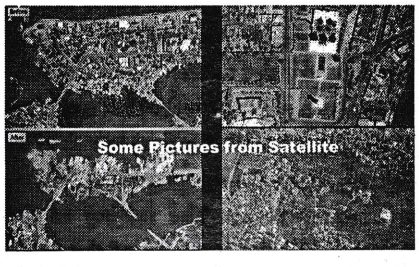

Fig 25-The damages : Satellite pictures

3.6. The effects of Tsunamis:

- A witness on the beach will see a noticeable rise and fall of beach water when a tsunami is imminent.
- Sometimes, the coastal water will disappear completely as it is drawn into the tsunami (Fig. 23). This amazing event is followed by the actual trough of the tsunami reaching shore (Fig 24).
- Tsunamis have great erosional potential, stripping beaches of sand that may have taken years to accumulate and undermining trees and other coastal vegetation.
- Tsunamis are capable of inundating or flooding, hundreds of meters inland past the typical high-water level, the fast-moving water associated with the inundating tsunami can crush homes and other coastal structures (Fig. 25).
- Tsunamis most often arrive as a series of strong and fast floods of water, not one single, enormous wave. However, a **bore**, which is a large vertical wave that arrives with a churning front, may appear. Bores are often followed by rapid floods of water, which make them particularly destructive. Other waves can follow anywhere from five to 90 minutes after the initial strike - the tsunami **wave train**, after traveling as a series of waves over a long distance, is releasing itself onto land.
- Tsunamis typically result in staggering body counts. This is especially true when they strike without warning.
- Tsunamis can level development and strip away coastlines, pulling everything in their path out to sea.
- A tsunami is even capable of reaching sheltered areas due to varying land features and the underlying seascape. For instance, a protected bay area with a narrow inlet can give a tsunami a "funnel" to travel through, amplifying the destructive power of the waves. Also, a river channel can provide room for a tsunami bore to rush through, allowing it to flood tremendous tracts of land.
- Until a tsunami strikes, it's difficult to predict how it will interact with the features of the affected land.
- The **wrap-around effect** occurs along island coastlines when multiple wave strikes hit different areas of surrounding land, resulting in different degrees of flooding.
- **Harbor resonance** is a chaotic and highly

destructive tsunami side effect created when waves continuously reflect and bounce off of the edges of a harbor or bay. Harbor resonance can cause the amplification of circulating wave heights and even increase the duration of the wave activity within the area.

3.7. Tsunami Types

Tsunamis are categorized in one of two ways:

- **distant tsunamis**
- **local tsunamis**

This distinction is made based on the time the tsunami takes to leave the source disturbance and reach land.

A **distant tsunami** travels more than 600 miles (1,000 km) from the source area before it reaches land. Distant tsunamis are more likely to occur in the Pacific Ocean and are capable of traveling across the entire ocean in less than one day. Since distant tsunamis make such long trips with a relatively constant speed, experts can predict their arrival with a fair degree of accuracy. This makes it easy to warn and evacuate people who could be affected by the wave.

A **local tsunami** travels towards nearby coastal lands within 60 miles (100 km) of the source. Local tsunamis are usually the result of submarine landslides and typically occur in a bay or harbor. Local tsunamis are particularly dangerous because they can reach land within a matter of minutes. This type of "sneak attack" makes it hard to warn the public about the tsunami's approach.

4. The 26 December 2004 Tsunami

The earthquake originated in the Indian Ocean off the western coast of northern Sumatra, Indonesia. The resulting tsunami devastated the shores of Indonesia, Sri Lanka, South India, Thailand and other countries with waves up to 30 m (100 ft). It caused serious damage and deaths as far as the east coast of Africa, with the furthest recorded death due to the tsunami occurring at Port Elizabeth in South Africa, 8,000 km (5,000 miles) away from the epicentre.

The epicentre of the main earthquake was 160 km west of Sumatra, at a depth of 30 km below mean sea level. This is at the extreme western end of the **Ring of Fire**, an earthquake belt that accounts for 81 percent of the world's largest earthquakes. The earthquake itself (apart from the tsunami) was felt as far away as Bangladesh, India, Malaysia, Myanmar, Thailand, Singapore and the Maldives.

The earthquake was unusually large in geographical extent. An estimated 1200 km (750 miles) of fault line slipped about 15 m (50 ft) along the subduction zone where the India Plate dives under the Burma Plate. The slip did not happen instantaneously but took place in two phases over a period of several minutes. Seismographic and acoustic data indicate that the first phase involved the formation of a rupture about 400 km (250 miles) long and 100 km (60 miles) wide, located 30 km (19 miles) beneath the sea bed - the longest known rupture ever known to have been caused by an earthquake. The rupture proceeded at a speed of about 2.8 km/s (1.7 miles per second) or 10,000 km/h (6,300 mph), beginning off the coast of the **Aceh** province and proceeding north-westerly over a period of about 100 seconds. A pause of about another 100 seconds took place before the rupture continued northwards towards the Andaman and Nicobar Islands. However, the northern rupture occurred more slowly than in the south, at about 2.1 km/s (4,700 mph), continuing north for another five minutes to a plate boundary where the fault changes from subduction to strike-slip (the two plates push past one another in opposite directions) thus reducing the speed of the water displacement and so reducing the size of the tsunami that hit the northern part of the Indian Ocean.

The **India Plate** is part of the great **Indo-Australian Plate,** which underlies the Indian Ocean and Bay of Bengal, and is drifting northeast at an average of 6 cm (2 inches) per year. The India Plate meets the Australasian Plate (which is considered a portion of the great Eurasian Plate) at the **Sunda Trench**. At this point the India Plate subducts the Burma Plate, which carries the Nicobar Islands, the Andaman Islands and northern Sumatra. The India Plate slips deeper and deeper beneath the Burma Plate until the increasing temperature and pressure drive volatiles out of the subducting plate. These volatiles rise into the mantle above and trigger melt which exits the earth's mantle through volcanoes. The volcanic activity that results as the Indo-Australian plate subducts the Eurasian plate has created the **Sunda Arc**.

As well as the sideways movement between the plates, the sea bed is estimated to have risen by several metres, displacing an estimated 30 km^3 (7 cubic miles) of water and triggering devastating tsunami waves. The waves did not originate from a point source (as mistakenly depicted in some illustrations of their spread) but radiated outwards along the entire 1200 km (750 miles) length of the rupture. This greatly increased the geographical area over which the waves were observed. The raising of the sea bed significantly reduced the capacity of the Indian Ocean, producing a permanent rise in the global sea level by an

estimated 0.1 mm.

The total energy released by the 2004 Indian Ocean earthquake has been estimated as 1.1×10^{18} joules. This is equivalent to about 0.25 gigatons of TNT. The earthquake is estimated to have resulted in an oscillation of the Earth's surface of about 20-30 cm (8 to 12 inches).

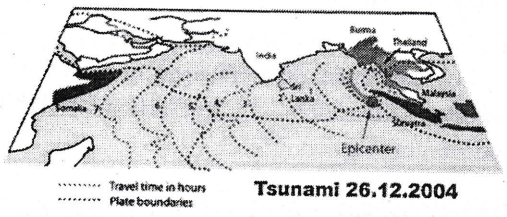

Fig 26-Tsunami 26.12.2004

Because the 1,200 km of faultline affected by the earthquake was in a nearly north-south orientation, the greatest strength of the tsunami waves was in an east-west direction (Fig 26). Bangladesh, which lies at the northern end of the Bay of Bengal, had very few casualties despite being a low-lying country relatively near the epicenter. It also benefited from the fact that the earthquake proceeded more slowly in the northern rupture zone, greatly reducing the energy of the water displacements in that region.

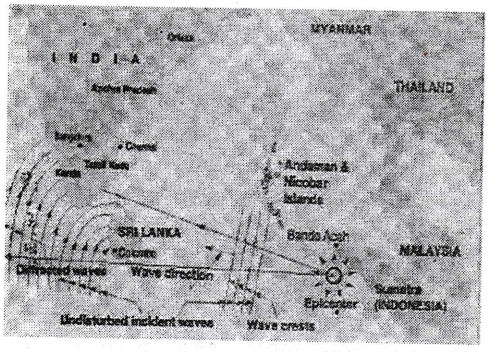

Fig 27-Tsunami and shadow region

Coasts that have a land mass between them and the tsunami's location of origin are usually safe; however, tsunami waves can sometimes diffract around such land masses (Fig. 27). Thus, the Indian state of Kerala was hit by the tsunami despite being on the western coast of India, and the western coast of Sri Lanka also suffered substantial impacts. Also distance alone is no guarantee of safety; Somalia was hit harder than Bangladesh despite being much farther away.

Because of the distances involved, the tsunami took anywhere from fifteen minutes to seven hours (for Somalia) to reach the various coastlines (Fig. 26). The northern regions of the Indonesian island of Sumatra were hit very quickly, while Sri Lanka and the east coast of India were hit roughly 90 minutes to two hours later. Thailand was also struck about two hours later, despite being closer to the epicentre, because the tsunami traveled more slowly in the shallow Andaman Sea off its western coast.

The tsunami was noticed as far as Struisbaai in South Africa, some 8,500 km (5,300 miles) away, where a 1.5 m (5 ft) high 'tide' surged onshore about 16 hours after the quake. It took a relatively long time to reach this spot at the southernmost point of Africa, probably because of the broad continental shelf off South Africa and because the tsunami would have followed the South African coast from east to west.

The total energy of the tsunami waves was about five megatons of TNT (20 petajoules). This is more than twice the total explosive energy used during all of World War II (including the two atomic bombs), but still a couple of orders of magnitude less than the energy released in the earthquake itself. In many places the waves reached as far as 2 km (1.24 miles) inland.

5. Monitoring, Detecting and Predicting the behaviour of Tsunamis:

Scientists are constantly trying to learn new ways to predict the behaviour of tsunamis. At this point, most data is gathered after a tsunami has already done its damage.

In a post-tsunami survey, a number of things are measured. Scientists are particularly interested in the inundation and run-up features after the waves strike land. Inundation is the maximum horizontal distance penetrated inland. Run-up is the maximum vertical distance above the sea level that the waves reached. **Inundation** and **run-up** are often determined by measuring the distance of killed vegetation, scattered debris along the land and eyewitness accounts of the incident.

Scientists have made great strides in monitoring and predicting the ongoing threat of tsunamis. One center continuously monitoring seismic events and changes in the tide level is the **Pacific Tsunami Warning Center** (PTWC). The PTWC is located in Ewa Beach, Hawaiian Islands, and serves the Hawaiian Islands and surrounding U.S. territories by working in conjunction with other regional centers. The **West Coast & Alaska Tsunami Warning Center** (ATWC) in Palmer, Alaska, serves the Aleutian Islands area along with British Columbia, Washington state, Oregon and California. This center is of particular importance because submarine earthquakes in

this region have created waves that moved throughout the Pacific Ocean before striking elsewhere.

Seismographs can detect the earthquakes or volcanic eruptions which may cause a tsunami. But as only a small proportion of strong earthquakes produce a tsunami, a warning system based solely on seismic data is prone to produce false alarms. Therefore sea-based instruments are needed to help scientists to decide if a tsunami has been triggered. These falls into two main types: pressure recorders in the deep ocean and tide gauges monitoring sea-level at the coast.

Tsunamis are detected by open-ocean buoys and coastal tide gauges which report information to stations within the region. Tide Gauge stations measure minute changes in sea level, and seismograph stations record earthquake activity. A tsunami watch goes into effect if a center detects an earthquake at 7.5 or higher on the Richter scale. Civil defense agencies are then notified and data from tidal gauge stations are closely monitored. If a threatening tsunami passes through and is noted by the Tide Gauge Stations, a tsunami warning is issued to all potentially vulnerable areas. Evacuation procedures in these areas are then implemented.

5.1 Deep-ocean Assessment and Reporting of Tsunamis

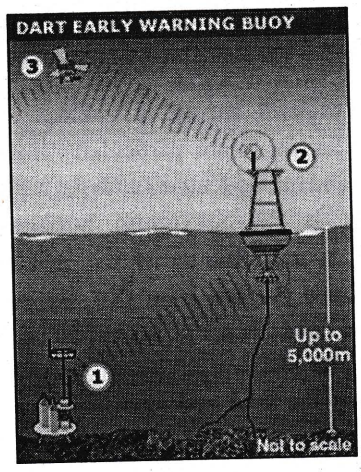

Fig 28-Dart Recording Device

A DART system (Fig. 28) consists of

(i) a unique pressure recorder (marked 1 in Fig 28) that sits on the ocean bottom. This pressure recording system called the Bottom Pressure Recording (BPR) system is capable of detecting slight changes in the overlying water pressure. It measures the weight of the water above it - which varies according to wave height. and

(ii) a moored surface buoy (marked 2 in Fig 28) for real-time communications. The buoy monitors the surface conditions and sends this, plus the data from the sea bed, to a satellite which relays it back to a receiving station.

An acoustic modem is used to transmit data from the BPR on the seafloor to the surface buoy. The data are then relayed via satellite Data Collecting System (marked 3 in Figure 28) to ground stations, which demodulate the signals for immediate dissemination to US National Oceanic and Atmospheric Administration's (NOAA's) Tsunami Warning Centers (TWCs).

The DART system is capable of detecting tsunamis as small as 1 cm high above the sea level.

5.2 Tide Gauges:

Unlike DART buoys, tide gauges in the Global Sea Level Observing System (GLOSS) are sited on land, either on mainland coasts or on islands out to sea. In the most basic form of gauges (Fig 29) the surface of the water is monitored with a system of tubes and floats.

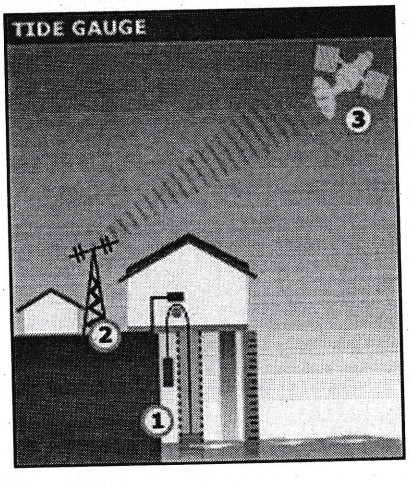

Fig 29-Tidal Gauges

More modern versions "ping" the surface of the water from above with radar or sonar; or use sea-bed pressure sensors attached to the sea-level observing station with a cable.

There are almost 70 GLOSS stations in the Indian Ocean. Before the tsunami, they were used to measure the sea level for long term climate change studies and their data were transmitted only periodically.

6. Concluding Remarks:

The most serious problem facing humans is the fact that tsunami waves, once in motion, cannot be stopped. Scientists and civil agencies can only devote resources to predicting tsunamis and creating effective plans for protecting coastal areas from their ravages.

On 26 December 2004, although the Seismic stations across the world registered the earthquake which caused the tsunami and global analysis centres realised that a big event was likely, this information did not reach people on the ground, as there was no warning system in place.

Despite a lag of up to several hours between the earthquake and the impact of the tsunami, nearly all of the victims of the December 2004 tsunami were taken completely by surprise. This is because, uunlike the Pacific, the Indian Ocean did not have a tsunami warning system to detect tsunamis and a system to alert residents of coastal areas that a tsunami was imminent.

Tsunami detection is not easy because while a tsunami is in deep water it has a very low height and a network of sensors is needed to detect it. Setting up the communications infrastructure to issue timely warnings is an even bigger problem, particularly in a relatively poor part of the world.

In the aftermath of the disaster, scientists and governments, under the auspices of the UN, have begun working on an early warning system for the countries in the Indian Ocean.

Perhaps the most important part of the tsunami early warning system is how to get the information to people who are in immediate danger. Primary responsibility for this rests with governments and most of the twenty seven nations bordering the Indian Ocean and many non-government organizations have started setting up individual programmes for issuing tsunami alerts to their own people. However, the Indian Ocean nations have been so far unable to agree which country or countries will host the regional alert centres to process international technical data and issue warnings across the area.

சேது சமுத்திரக் கால்வாய்த் திட்டமும் இலங்கையில் அதன் தாக்கமும் *

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தமிழ் நாட்டின் தென் கிழக்குக் கரைக்கும் இலங்கையின் வடபகுதிக்கும் இடைப்பட்ட ஒடுங்கிய கடற்பரப்பானது சேதுசமுத்திரம் எனவும் வரலாற்று நீர்ப்பரப்பு(Historical waters) எனவும் அழைக்கப்படுகிறது. வரலாற்று ரீதியாக இலங்கைக்கும்- இந்தியாவுக்கும் இடையிலான பல்வகைப்பட்ட தொடர்புகள் இக்கடற்பரப்பு ஊடாக நடைபெற்று வந்தமையால் இப் பெயர் கொண்டு அழைக்கப்படுகிறது. வர்த்தகம், குடியேற்றம், படையெடுப்புக்கள், ஆங்கிலேயர் காலத் தோட்டத் தொழிலாளர் வருகை மற்றும் அண்மைக்கால கச்சதீவு விவகாரம், இந்திய இலங்கை மீனவர் பிரச்சினை, ஈழ அகதிகள் இடப்பெயர்வு போன்ற பல்வேறு நடவடிக்கைகள் இக்கடற்பரப்பு ஊடாகவே நடைபெற்றுள்ளன. இந்தவகையில் இந்திய அரசினால் 02.07.2005ல் ஆரம்பித்து வைக்கப்பட்ட சேது சமுத்திரக் கால்வாய் சர்வதேச ரீதியில் முக்கியத்துவம் வாய்ந்த நிகழ்ச்சித் திட்டமாக இக்கடற்பரப்பில் மேற்கொள்ளப்படுவதால் இன்று கேந்திர முக்கியத்துவம் மிக்க ஒரு கடற்பரப்பாக இது மாறியுள்ளது.

சேதுசமுத்திர கால்வாய்த்திட்டம்

கால்வாய் அமைகின்ற கடற்பரப்பானது பாக்குநீரிணை (Palk strait) பாக்கு விரிகுடா (Palk bay) மன்னார் விரிகுடா (Gulf & Mannar) ஆகிய மூன்று பிரதான கடற்பகுதியைக் கொண்டதாகும். மன்னார் விரிகுடாவையும் பாக்குநீரிணையையும் பிரித்து நிற்கின்ற ஆதாம் பாலம் (Adam's Bridge) பதினான்கிற்கும் அதிகமான சிறிய மணற்றிட்டுக்களைக் கொண்ட ஒரு தொடராக, தலை மன்னாரிலிருந்து தனுஸ் கோடி வரையிலும் நீண்டுள்ளது. 2 முதல் 15 மீற்றர் வரையிலான ஆழ வேறுபாட்டைக் கொண்ட இக்கடற்பரப்பு- பெரிய கப்பல்கள் செல்வதற்கான அமைப்பைக் கொண்டிருக்கவில்லை. இதனால் இந்தியாவின் கிழக்கு கரைப்பகுதியிலிருந்து மேற்குக் கரைப் பகுதிக்கோ அல்லது மேற்கு கரையிலிருந்து கிழக்கு கரைப் பகுதிக்கோ கப்பல்கள் செல்ல வேண்டுமாயின் இலங்கையைச் சுற்றியே செல்ல வேண்டிய நிலை உள்ளது. இதனால் நேரம், தூரம், பணவிரயம் என்பன தவிர்க்க முடியாத ஒன்றாக காணப்படுகிறது. எனவே இக்கடற்பரப்பில் ஆழமான கால்வாய் ஒன்றை வெட்டி கிழக்கு-மேற்கு கரைக்குமிடையே இக்கடற்பரப்பு வழியாக கப்பல் போக்குவரத்தை மேற்கொள்கின்ற நிகழ்ச்சித்திட்டமே சேதுசமுத்திரக் கால்வாய்த்திட்டம் என அழைக்கப்படுகிறது. கோளம் தழுவிய ரீதியில் மாறிவருகின்ற சமூக,பொருளாதார அரசியல் நிலைமைகளைக் கருத்திற் கொண்டு மேற் கொள்ளப்பட்டு வருகின்ற இத் திட்டத்திற்கு சூழலியலாளர்கள் ஒரு புறம், அபிவிருத்தியியலாளர்கள் மறுபுறமாக பல்வேறு விமர்சனங்களை தத்தமது பார்வையில் முன்வைத்துள்ளனர். இவ் வகையில் இத்திட்டத்தின் மூலம் இலங்கையில் எத்தகைய தாக்கங்கள் ஏற்படலாம் என்பது பற்றி பல்வேறு அறிஞர்களும் தெரிவித்துள்ள கருத்துக்களை அடிப்படையாகக் கொண்டு இக்கட்டுரை வரையப்படுகிறது.

இத்திட்டத்தின் வரலாற்றுப்பின்னணி

1860 இல் ஆங்கிலேயர் காலப்பகுதியில் கடற்படையைச் சேர்ந்த ரெய்லர் என்ற தளபதியே முதன் முதலில் சேது கால்வாய் தொடர்பான யோசனையை வெளியிட்டார். 1861- 1903 வரை காலனித்துவ அதிகாரிகளால் தொடர்ச்சியாகப் பிரேரணைகள் முன் மொழியப்பட்டன. 1922ல் துறைமுகப் பொறியியலாளர் சேர் ஹொபோர்ட் பிறின் காவின் திட்டம் முன்வைக்கப்பட்டது. 1955ல் சேர் இராமசாமி முதலியார் தலைமையிலான சேது சமுத்திரத் திட்டக் குழுவினரின் மூலமும் இத் திட்டம் முன்வைக்கப்பட்டது. இந்த ஆரம்ப முன் மொழிவுகள் சிறு கப்பல்கள் பிரயாணம் செய்வதையே பிரதான நோக்கமாகக் கொண்டிருந்தன. பாக்குநீரிணையை ஆழமாக்கும் திட்டம் அப்போது இருக்கவில்லை, எனினும் தற்போதைய திட்டம் ஒரே நேரத்தில் தூத்துக்குடி துறைமுக அபிவிருத்தியையும் பாரிய கப்பல்கள் பயணம் செய்வதையும் நோக்கமாகக் கொண்டதுடன் பாக்குநீரிணையை ஆழமாக்கும் திட்டத்தினையும் கொண்டுள்ளது. ஆரம்பத்தில் இத்திட்டம் இராமேஸ்வரக் கப்பற் கால்வாய்த் திட்டம் என்றே அழைக்கப்பட்டது. அதன் கால்வாய் வெட்டுப் பகுதியானது பாம்பன் தீவுப் பகுதியிலேயே - இடை அமைவு பெற்றிருந்தது. பின்னர் கால்வாயின் அமைவிடம் பாம்பன் தீவின் கிழக்குப்பக்கமாக நகர்ந்தது, எனினும் இன்று பாரிய ஒரு அபிவிருத்தி நிகழ்ச்சித்திட்டமாக மாற்றப்பட்ட போது அதன் இட அமைவானது மேலும் கிழக்காக நகர்ந்து இலங்கை-இந்திய ஆள்புல எல்லைக் கோட்டைச் சார்ந்து இந்தியாவின் ஆள்புல எல்லைக்குள் மாற்றப்பட்டது. இந்தியப் பிரதமர் திரு மன் மோகன் சிங் அவர்களால் 02.07.2005இல் வெகு விமரிசையாக இத்திட்டம் ஆரம்பித்து வைக்கப்பட்டுள்ளது.

கால்வாய்ப் பிரதேசத்தின் சமுத்திரவியற் பின்னணி

கால்வாய் அமையவுள்ள பிரதேசத்தின் சமுத்திரவியல் பண்புகளானது சிக்கல் வாய்ந்த ஒரு

* Popular Lecture

அம்சமாக உள்ளது. பாக்கு நீரிணைப் பகுதி சராசரி 8 மீற்றர் ஆழத்தையும் பாக்கு குடா 11-12 மீற்றர் வரையிலான ஆழத்தையும், ஆதாம்பாலம் என அழைக்கப்படுகின்ற தொடர் மணற்றிட்டுக்களைக் கொண்ட பகுதி (Adam's Bridge) 1.5 மீற்றர் முதல் 3.5 மீற்றர் ஆழத்தினையும் கொண்டுள்ளது. அந்த ஆதாம்பாலப் பகுதியானது வேறுபட்ட கால்வாய்களையும் மாறுபாடையக் கூடிய சில மணல் மேடுகளையும் கொண்டுள்ளது. ஏறக்குறைய 14ற்கு மேற்பட்ட மணற்றிட்டிகள் இந்த ஆதாம் பாலத் தொடரில் காணப்படுகின்றன. இத்திட்டுக்கள் மீனவர்களால் "தீடைகள்" என அழைக்கப்படுகின்றன. இக்கடற் பிரதேசத்தின் அடித்தளம் சேறும், மணலும் கலந்த மணல் அமைப்பைக் கொண்டுள்ளது. சில இடங்களில் பவளப் பாறைகள், தொடராகக் காணப்படுகிறது. இவைகள் மன்னார் விரிகுடாப் பகுதியிலேயே கூடுதலாகக் காணப்படுகின்றன. இக்கடற்பிரதேசத்தின் சுற்றாடலில் கண்டற்றாவரங்களும், கடற்றாவரங்களும் பல்லின உயிர்ச் சூழலின் விருத்திக்குச் சாதகமாக அமைந்துள்ளமை குறிப்பிடத்தக்கது.

உயிரியல் மூலங்களைப் பொறுத்தவரையில் இந்தக்கடற்பரப்பில் 3600 வகையிலான தாவர மற்றும் விலங்கு உயிரிகள் காணப்படுவதாகவும், இதில் 117 வகைகளுள் முருகை, சங்கு, சிப்பி, கடலாமை, மற்றும் டொல்பின், திமிங்கிலம், கடற்பசு போன்ற அரியகடலுயிரிகள், பாலூட்டிகள் உள்ளடக்கப் பட்டுள்ளதாகவும் கூறப்படுகிறது. GEF (Global Environment Facility) அறிக்கை பிரகாரம் 2200 மீன்வகைகளில் 450 மீன்வகைகள் இந்தக் கடற்பரப்பில் உள்ளதாக மதிப்பிடப்பட்டுள்ளது. மன்னார் குடாவில் இராமநாதபுரம் மாவட்டத்தை சார்ந்துள்ள கரையோரங்களில் குருசடை உள்ளிட்ட இருபத்தொரு தீவுகளை உள்ளடக்கி "கடற்பூங்கா" (Marine Park) உருவாகக்கப்பட்டு அவை பாதுகாக்கப்பட்டு வருவது முக்கியமான அம்சமாகும். இதன்பரப்பளவு 560 ச.கி. மீற்றர் ஆகும்.

கால்வாயின் திட்டஅமைப்பு

இக்கால்வாயின் நீளம் 151.2 கி.மீற்றர்களாகும். ஆதாம் பாலத்திலிருந்து இலங்கை - இந்திய கடலோர எல்லைக்கு மேற்கே அதன் கடல் எல்லை ஓரமாக இது அமைவுபெறவுள்ளதாகத் திட்டமிடப்பட்டுள்ளது. கால்வாயின் அகலம் 300 மீற்றர். இக்கால்வாயின் ஆழம் 10-14 மீற்றர் வரை வேறுபடுகின்றது. கால்வாயானது முழுவதும் தோண்டப்படமாட்டாது. பாக்குகுடாவில் ஆதாம்பாலத்திலிருந்து 34.92 கி.மீற்றர் வரையிலும் - பாக்குநீரிணைப் பகுதியில் 54.32 மீற்றர் வரையிலுமே இது ஆழமாக்கப்படவுள்ளது. பாக்கு குடாவின் மத்தியபகுதி போதிய ஆழமுடையதாக இருப்பதினால் எஞ்சியுள்ள இப்பகுதி ஆழமாக்கப்படமாட்டாது. ஆழமானகால்வாயில் 85மில் கியுபிக் மீற்றர் மண் அகழ்ந்தெடுக்கப்படவுள்ளதாக Lanka Hydraulic Institute மதிப்பிட்டுள்ளது. தோண்டி எடுக்கப்படும் மண் பாக்குநீரிணைப் பகுதியிலும், மன்னார் குடாவிலும் கொட்டத் திட்டமிடப்பட்டுள்ளது.

இத்திட்டத்தின் அனுகூலங்கள்

இத்திட்டத்தின் மூலம் குறிப்பாக இந்தியாவின் மேற்குக் கரையிலிருந்து கிழக்குக் கரைக்கும் - கிழக்குக் கரையிலிருந்து மேற்குக் கரைக்குமான கடல்வழிப் பயணங்களை இலங்கையைச் சுற்றாமல் மேற்கொள்ள வழிபிறக்கிறது. இதனால் நேரம் - தூரம் - செலவுக்குறைவு ஏற்பட இடமுண்டு. இக்கால்வாய் அமைக்கப்படின் 254-424 கடல்மைல்களையும், 21- 36 மணித்தியாலங்களையும் மீதப்படுத்தலாம். மேலும் இந்தியாவில் மேற்கு - கிழக்கு துறைமுகங்களுக்கிடையிலான வர்த்தகம் விருத்திபெறும். குறிப்பாக தமிழ்நாட்டிலுள்ள தூத்துக்குடி, குடைச்சல், நாகபட்டினம், கடலூர் ஆகியன வளர்ச்சிபெற வாய்ப்புண்டு. தமிழ்நாட்டின் தென்மாவட்டங்கள் விருத்தி பெறவும் வாய்ப்புண்டு எனக் கூறப்படுகின்றது.

இந்தியா இந்து சமுத்திரத்தில் தனது பாதுகாப்பு நடவடிக்கைகளை அதிகரித்துக்கொண்டு வருவதால் அதனது கடற்படைக் கலங்கள் அரபிக்கடற்பகுதியிலிருந்து வங்காளவிரிகுடா பகுதிக்கு இலங்கையைச் சுற்றாமல் பயணம் செய்யும் வாய்ப்பு ஏற்படும். இதனால் யுத்தகாலத்தில்கூட இலங்கையின் உதவியை இந்தியா நாடத்தேவையில்லை. இந்திய தென்கரையிலுள்ள கடற்படைத்தளங்கள் மற்றும் கடற்படை நீர்மூழ்கி கண்காணிப்பு மையத்தை இலகுவாகப் பாதுகாக்க முடியும் எனவும் நம்பப்படுகிறது.

இலங்கையைப் பொறுத்தவரையில் கொழும்புத்துறைமுகத்திற்கும் இதேயளவு அனுகூலங்கள் உண்டு. எனினும் அம்பாந்தோட்டை துறைமுகத்தின் முக்கியத்துவத்தை இது குறைக்கும். காங்கேசன்துறை கொழும்பு கடற்போக்குவரத்து நேரம் - தூரம் அரைவாசியாகக் குறையும் - இலங்கையின் வடபகுதியைப் பொறுத்தவரையில் இக்கால்வாயிலிருந்து காங்கேசன்துறை, ஊர்காவற்றுறை, தலைமன்னார், பருத்தித்துறை ஆகியதுறைமுகங்களுக்கு குறுந்தூர கடல்வழிப்பாதைகள் அமைந்தால் இப்பிரதேசமும் விருத்திபெற வாய்ப்பு ஏற்படும் எனக் கூறப்படுகிறது. மேலும் இன்று யப்பான், சீனா, இந்தியா மற்றும் தென்கிழக்காசிய நாடுகளுடனான வர்த்தகம் விரிவடைந்து வருவதாலும் - திருகோணமலையின் கேந்திர முக்கியத்துவம் அதிகரித்து வருகின்றது - இதனால் இத்துறைமுகமும் வளர்ச்சிபெற வாய்ப்புண்டு. இந்தவகையில் வடக்கு, கிழக்குப் பகுதியிலுள்ள துறைமுகங்களின் வளர்ச்சி இப்பிரதேசத்தின் விருத்திக்கு வாய்ப்பாக அமையலாம் எனக் கருதப்படுகிறது.

பிரதிகூலங்கள்

இக்கால்வாய்த் திட்டத்தின் மூலம் பல்வேறு அனுகூலங்கள் ஏற்படலாம் எனக் கூறப்பட்டபோதிலும், சுற்றுச்சூழல் பாதிப்பு இதனால் மீன்பிடித் தொழிலில் ஏற்படும் பாதிப்புக்கள் பற்றி தமிழ்நாட்டிலும், இலங்கையின் வடக்கு, வடமேற்குப் பகுதிகளிலும் - பலத்த எதிர்ப்பு ஆர்ப்பாட்டங்கள் நடைபெற்று வருவதையும் அவதானிக்கூடியதாகவுள்ளது.

மன்னார் வளைகுடாவின் புவியியல் அமைப்பு ஆழம்குறைவான கடற்படுக்கையைக் கொண்டதாகும்.

பாக்குநீரிணை வழியே செல்லும் ஆதாம்பாலமும் ஆழம்குறைவான பாறைத்திட்டுக்களால் ஆனது. இவை கரையோரத்தை அண்டி நீர்மோதுகையையடுத்து அரண் செய்கின்றது. இந்நிலையில் கால்வாய் தோண்டப்படின் இத்தகைய மணற்றிட்டுக்கள் பாதிக்கப்படும். இதனால் மன்னார் வளைகுடாவை அண்டிய கரையோரப்பகுதி பெரும் கடலரிப்பு ஆபத்துக்குள்ளாகும் எனவும் இலங்கை சூழலியல் மன்ற நிறுவனம் (Environmental Foundation Limited) எச்சரித்துள்ளது. மேலும் கப்பல் போக்குவரத்தின் போது கரையோரக் கடலரிப்பைத் தூண்டும் எனவும் கடலிலுள்ள பவளப்பாறைகள் மற்றும் கடல்நுண்ணுயிர்கள், அங்கிகள் ஆகியவையும் இதனால் அழிவுறும் நிலைமை இருப்பதாகவும் சுட்டிக்காட்டுகிறது. அத்துடன் யாழ். குடாநாட்டின் நீர்மட்டம் கடல் மட்டத்தை விடத்தாழ்ந்தது, இதனால் குடாநாட்டின் தரைப்பகுதிக்குள் கடல்நீர்புகுந்து நிலத்தடி நீர்வளம் உவர்த்தன்மையாகும் மோசமான ஆபத்துள்ளது எனவும் எச்சரித்துள்ளது.

பேராதனைப் பல்கலைக்கழக பேராசிரியர் ரஞ்சித் கலப்பதி அவர்களின் கூற்றுப்படி, "கடலுக்கடியிலுள்ள சேறு பாரியளவில் இல்லாமல் போகும் அல்லது அழிந்து போகும் அபாயம் உள்ளது. இரு நாடுகளுமே வருடாந்தம் பாரிய சூழல் அழிவுக்கு முகம்கொடுக்க நேரிடும். கடற்படுக்கை, களிமண் அழிவின்போது கலங்கிய நீரோட்டம் ஏற்படலாம். இதனால் கடற்புற்கள், பவளப்பாறைகள் அழிந்துபோக வாய்ப்புண்டு. தோண்டப்படும் மண்ணைக் குவிப்பதற்குத் திட்டமிட்டுள்ள பகுதி இலங்கை கடல்எல்லைக்குள் மிக அருகில் உள்ளது. - இது இலங்கையில் பெருந்தாக்கத்தை ஏற்படுத்தும்" எனவும் கூறியுள்ளார். "நீரியியல் சம்பந்தமாக மேலெழுந்தவாரியாக மேற்கொள்ளப்பட்ட ஆய்வு சர்வதேச ரீதியில் அங்கீகரிக்கப்படவில்லை. இன்றைய மணல் அகழ்வுத்திட்டம் நம்பகத்தகுந்தது அல்ல, உள்நாட்டில் ஏற்படப்போகும் தாக்கம் பற்றி திரிபுபடுத்தப்பட்ட தகவல்களே வழங்கப்படுகின்றன. பாரிய சூழல் அழிவு ஒன்று ஏற்படலாம். படியப்படும் மணல் மூலம் ஆதாம்பாலத்தில் செயற்கைத் தீவுகள் உருவாகலாம் எனவும் ஆகவே, "இரு அரசுகளும் இணைந்து கால்வாய் தோண்டுவது பற்றி ஆலோசிக்க வேண்டும். சூழல் மாசுபடாத வகையில் சிறந்த திட்டமொன்றைத் தீட்ட வேண்டும்" எனவும் கூறியுள்ளார்.

கடல்வளத்துறை சுற்றுச்சூழலில் ஏற்படும் தாக்கம் காரணமாகவும், கப்பல் போக்குவரத்து நடவடிக்கைகளின் போதும் - மீன்பிடித்தொழில் பெரும் பாதிப்பு ஏற்படலாம் எனவும் இதனால் தமிழ் நாட்டிலும், இலங்கையின் வடபகுதியிலும் - மீன்பிடித்துறையை நம்பி வாழுகின்ற பல்லாயிரக்கணக்காண மீனவர்கள் பெரும்பாதிப்புக் குள்ளாவர் எனவும் அச்சம் தெரிவிக்கப்படுகிறது. ஏற்கனவே இலங்கையின் வடபகுதியில் போர் மற்றும், கடல்வலயத்தடைகள் காரணமாக அப்பகுதி மீனவ மக்கள் மிகமோசமான பாதிப்புக்குள்ளாகியிருந்தனர். இந்நிலையில் - சேது கால்வாய்த் திட்டம் நடைமுறைப்படுத்தும்போது எழுகின்ற பிரச்சினைகள் மேலும் தாக்கத்தை ஏற்படுத்தலாம் என எதிர்பார்க்கப்படுகின்றது. தமிழ்நாட்டில் 148க்கும் மேற்பட்ட மீன்பிடிக்கிராமங்களும், வடபகுதியில் 70க்கும் மேற்பட்ட மீன்பிடிக்கிராமங்களும் இதனால் பாதிப்படையும் எனவும், பவளப்பாறைகள், சங்கு, முத்து, கடலட்டை மற்றும் அரிய உயிரினங்களான கடற்பசு, டொல்பின், கடலாமைகள் என்பனவும் அழியவாய்ப்புண்டு எனவும் அச்சம் தெரிவிக்கப்படுகின்றது.

இந்தியாவின் இன்றைய பொருளாதார. இராணுவ மற்றும் தேசிய பாதுகாப்பு நலன்களைத் தக்கவைப்பதிலும் முன்னெடுப்பதிலும் இத்திட்டம் வளம் பெறும் நிலையில் காணப்படுகின்றது. எனினும் இக்கால்வாய் அமையவுள்ள பகுதியினைச் சார்ந்துள்ள தமிழ்நாடு மற்றும் இலங்கையின் வடக்கு, வடகிழக்குப் பகுதிகளில் - சுற்றுச்சூழல் படிநிலை மற்றும் மீன்பிடித்தையில் ஏற்படும் பாதிப்புக்கள் பற்றி கவலைவெளியிடப்பட்டுள்ளதுடன் இத்திட்டத்திற் கெதிராகப் பல ஆர்ப்பாட்டங்களும் கண்டனங்களும் எழுந்துள்ளன. சுற்றுச்சூழல் பாதிப்புத் தொடர்பாக இத்திட்டத்தின் மூலம் சில சுற்றுச்சூழல் பிரச்சினைகள் ஏற்பட்டாலும் இன்றைய சர்வதேச நிலைப்பாடுகள் காரணமாக சூழல்மாசடைவதைத் தடுப்பதற்கான வழிவகைகளும், நிதி ஒதுக்கீடுகளும் மேற்கொள்ளப் படுவதால் சுற்றுச்சூழல் வாதம் வலுவிழக்கிறது எனப் பொதுவான கருத்துண்டு. எனினும் இந்தியாவைப் பொறுத்தவரையில் அதன் எல்லைப் பரப்பினுள் இத்தகைய பாதுகாப்பு நடவடிக்கைகளை மேற்கொள்ள வாய்ப்பு இருந்தபோதிலும் இலங்கையின் வடபகுதிக்கடற்பரப்பில் எழப்போகும் சுற்றுச்சூழல் பாதிப்பைத் தடுப்பது என்பது எந்தளவுக்கு சாத்தியமாகும் என்பது கேள்விக் குறியாகியுள்ளது. இன்றைய போர்ச்சூழலில் வடபகுதியின் கரையோரங்கள் கண்டற்றாவரங்கள், பயன்தகு பனை, தென்னை மரங்கள் என்பன பாதுகாப்பு என்ற போர்வையில் வகை தொகையின்றி படையினரால் நாசம் செய்யப்படுகிறது. இதனைத்தடுக்க நடவடிக்கை எடுக்கும்படி பலதடவைகள் மக்களால் கோரிக்கைகள்விடப்பட்ட போதிலும் ஆக்கபூர்வமான பதில் எதுவும் கிடைக்கவில்லை. அழிவு தொடரவே செய்கிறது. இந்நிலையில் சேது சமுத்திரக் கால்வாய்த் திட்டத்தின் மூலம் வடபகுதியில் எழப்போகும் உயிரினச்சூழல் அழிவு தடுத்துநிறுத்தப்படுவது சாத்தியப்படப் போவதில்லை.

மீன்பிடித் தொழிலில் ஏற்படும் தாக்கத்திற்கு பதிலீடாக மாற்று ஒழுங்குகளும், நஸ்ட ஈடும் வழங்குவதற்கான ஏற்பாடு தமிழ்நாட்டில் எட்டப்படும் சாத்தியக் கூறுகள் உள்ளன. ஆயினும் இலங்கையின் வடபகுதி மீனவர்கள் ஏற்கனவே - மிக மோசமான பாதிப்புக்களைக் சந்தித்தபோது அரசினால் எதுவித நஷ்ட ஈடுபாடுகளோ மாற்றுத் தொழில் வாய்ப்புக்களோ வழங்கப்படவில்லை இந் நிலையில் இந்தியத் தரப்பால் மேற்கொள்ளப்படும் கால்வாய் அகழ்வுத் திட்டத்தினால் பாதிப்புறும் மீனவர்களுக்கு எந்த வகையில் இழப்பீடுகளும், மாற்றுத் தொழில் வாய்ப்புக்களும் வழங்கப்படும் என்பதும் கேள்விக்குறியே.

இலங்கையின் வடபுல துறைமுகங்கள் சேது கால்வாய்த் திட்டத்தின் மூலம் விருத்திபெற வாய்ப்புள்ளது. எனவும் இதனால் வடபகுதியின் விருத்திக்கு உதவும் என எதிர்வு கூறப்பட்டுள்ள போதிலும் இன்றுள்ள இராணுவ ஆக்கிரமிப்பும், உயர்பாதுகாப்பு வலயத்திலுள்ள விமான நிலைய விஸ்தரிப்பு, காங்கேசன் துறைமுக விருத்தி,

மற்றும் துறைமுகங்கள் கடற்படையினரின் பாவனையிலுள்ள நிலைமைகள் போன்ற விடயங்கள் இன்றைய சூழலில் வட பகுதியின் விருத்திக்கு எந்த விதத்திலும் இநதக் கால்வாய் விருத்தி உதவப் போவதில்லை. கால்வாய்த் திட்டத்தின் மூலம் வடபகுதி-துறைமுகங்கள் விருத்தியடைந்தாலும் அவை மூலம் கிடைக்கும் நன்மைகள் தமிழ் மக்களிற்கு எந்த வகையில் வந்து கிடைக்கும் என்பதும் சந்தேகமே.

வடக்கு கிழக்கில் இயல்பு நிலை திரும்பி தமிழ் மக்களின் கைகளில்- இப்பிரதேசத்தின் நிர்வாகம் கையளிக்கப்பட்டு அவர்களால் சுயமாக நிர்வகிக்கப்படுகின்ற நிலை வரும் வரையில் சேது சமுத்திரத் திட்டத்தின் மூலம் எதுவித பயனும் வடபகுதிக்கு கிட்டப்போவதில்லை.

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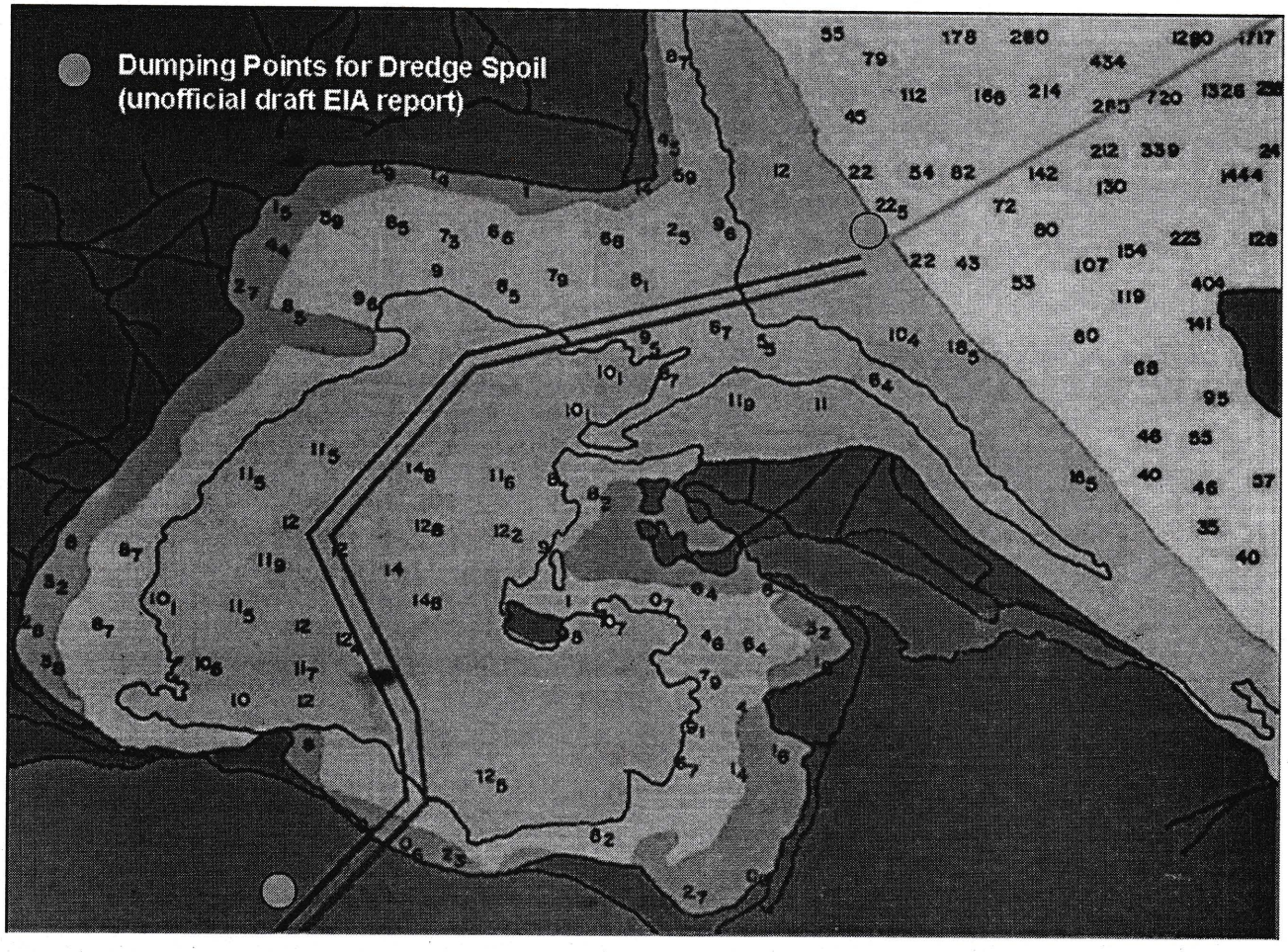
சேது சமுத்திர கால்வாய்த் திட்டம்



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