EVERYMAN'S SCIENCE

Vol. XLIV No. 2 (June '09 – July '09)

COVER PHOTOGRAPHS *(From the Top)*

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Printed and published by Prof. S. P. Mukherjee on behalf of Indian Science Congress Association and printed at Seva Mudran, 43, Kailash Bose Street, Kolkata-700 006 and published at Indian Science Congress Association, 14, Dr. Biresh Guha Street, Kolkata-700 017, with Prof. S. P. Mukherjee as Editor.

Annual Subscription : **(6 issues)**

Institutional Rs. 200/- ; Individual Rs. 50/-

Price : Rs. 10/- per issue

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INTELLIGENT DESIGN IN THE CREATION

"Hawking embarks on a quest to answer Einstein's famous question about whether God had any choice in creating the universe. Hawking is attempting, as he explicitly states, to understand the mind of God. And this makes all the more unexpected the conclusion of the effort, at least so far : a universe with no edge in space, no beginning or end in time and nothing for a creator to do."

—Carl Sagan, in Introduction to A Brief History of Time by Stephen W. Hawking, Banton books, London (1985).

In February 12, 2009 the world celebrated the bicentenary of the brith of Charles Darwin as well as Abraham Lincoln. It has been 150 years since Darwin published his book, Origin of Species, that proposed a revolutionary theory of evolution. A contemporary of Darwin, Alfred Russel Wallace, aslo had suggested the idea and, therefore, today scientists believe that Wallace should share the credit for the idea that shook scientific and religious establishments.

The theory states, amongst other things, that in any population of self-reproducing organisms, there must be variation in the genetic material and upbringing the different individuals have. Because of the differences some individuals are abler than others to adjust to the environment around them, they are also more likely to survive and reproduce. This struggle for survival is obviously not random but dependent on heredity and make up of individuals. Those that best fit their environment are likely to leave more offsprings than less fit members. This unequal ability of individuals to survive and reproduce will lead to gradual change of populations that are more adaptable over generations.

In his second book, Descent of Man, Darwin argued that man, other apes and monkeys had a common ancestor. Wallace had said that 'every species has come into existence coincident ... with closely allied species.'

Though Darwin and Wallace share the honor of being independent discoverers of the principle of natural selection, their views regarding the common ancestor and human descent gradually became diametrically opposite. Apparently, Wallace drifted towards spirtualism believing that some kind of divine force worked beyond adaptation or that there was some 'intelligent designer' who intervened. [see Editorial, *Science & Culture*, Vol. 75, March-April (2009) No. 3-4, p. 82].

Essentially the theory of evolution refuted the idea that whatever flora and fauna we see today were created in one go by God. This was, obviously, a terrible blow against the creation story given in the Holy Bible. Darwin's arguments were strongly supported by his detailed observations and the scientific world, overwhelmed by the clarity of his thought, helped him stand up against the storm of protests from the followers of the Christian faith who believed that God created everything and that too in six days flat.

For many, the Holy Bible was/is not a literary text but, rather, word of God just as the Holy Koran is to the Muslims. This creates confrontation between faith and Science. Many public schools in the U. S. did not allow teaching of Darwin's theory for years. Many argued and continue to argue that the theory of evolution is only a guess and pseudo-hypothesis devoid of solid evidence ; the theory that denies miracles and the role of the supernatural is work of an agnostic and the theory, not a proven fact, is not worthy of serious consideration.

In an article in *American Scientist* [May-June (2005) pp. 253-260] Edward B. Davis argues rightly that science and religion can coexist if only we accept that they have different roles to play. The purpose of science is to develop, without prejudice or preconception of any kind of knowledge of facts, the laws and processes of nature. The even more important task of religion, on the other hand, is to develop the conscience, the ideas and aspirations of mankind.

The theory of evolution was not and has still not been accepted by all and there is an alternate theory called Intelligent Design (ID) which has been discussed in an issue of *Nature* [vol. 434, April (2005), p. 1062 and p. 1063].

The journal reported a survey amongst U. S. teenagers that gave some surprising findings. Only 37 percent believed that the theory of evolution is well supported by evidences, 30 percent believed that the theory is just one of many theories and it is not well supported by evidence. Some 33 percent remained noncommittal. Further, only 43 percent believed that human beings had developed from less advanced forms of life over millions of years but also that God had guided this process. 38 percent believed that God created human beings pretty much in the present form at some time within the past 10,000 years or so. Only 18 percent accepted gradual evolution from humble beginnings with God having nothing to do in the process.

Of course, opinions did differ with the level of education and support for Darwin was more amongst the better educated. The percentages of adults who believed that evolution was a sound scientific theory were as follows : high school or less-20, some college education-32, college graduate-52, post graduate education-65, sample average-35.

There is now a growing force of ID movement in the U. S. university campuses claiming to bridge the gap between science and faith. The basic assumption of ID theory is that there is a divine hand in shaping evolution. Many highly educated academics also believe that biological systems are too complex and too varied and differences between species too great to support the idea that evolution is a random phenomenon. If it was really a question of adaptation then how come so many different species of animals coexist so comfortably in the same environment ?

The theologians are equally upset with both groups but, in general, believers are more comfortable with ID theory that gives God a role. No wonder 75 percent of all college students are willing to take a course in ID if offered.

No doubt, there is a great deal in creation and evolution that arouses curiosity ; consider some examples. In Africa, both male and female elephants have tusks for which poachers kill them. Occasionally some elephants remain tuskless and, because of this, they are not poached. Apparently, the proportion of tuskless elephants is increasing. Is this because of mere adaptation ? While there are examples of divergent evolution in the same ecosystem, there are also examples of convergent evolution in vastly separated locations. Till the eighteenth century there was in the north pole a bird called the Great Auk which was very similar to the penguins of the south pole. That sailors exterminated them for their meat is another matter. In the isolated island of Madagascar dogs evolved into monkeys like lemurs.

Some things are so bizarre. Every so many million years creatures big and small flourish and then face mass extinction for evolution to start afresh for another age. There is infinite variety in camouflage, anti-camouflage, in bird's plumage, their songs and mating riftuals. Could it be that there is a fun-loving creator ?

The Telegraph (Kolkata edition, Sunday March 15, 2009) reports that in Kundinji, a small village 40 km. from Calicut in Kerala, there are far too many twins everywhere. The village has 204 pairs of twins from 1 month old to 60 years. In 2008, there were 15 pairs in 307 deliveries i.e. about 50 per 1000 births. This happens in some other places. Umri village near Allahabad has 33 pairs amongst 600 people. Are the twins adjusting to something or is it because of some pollution in the environment ?

It is not difficult to oppose ID. Science advances by gradual filling up of gaps in our knowledge. One does not need God to explain whatever we do not understand now. Yet the fact remains that one feels more comfortable with the belief that the creation around us is not without any meaning at all.

Hem Shanker Ray

"Simplicity, of all things, is the hardest to be copied."
—Steele

PRESIDENTIAL ADDRESS

MINERAL RESOURCES AND THEIR PROBLEMS

DR M. S. KRISHNAN,* M. A., PH.D., E.N.I.

At the outset I wish to express my sincere thanks and gratitude to fellow members of the Indian Science Congress for the great honour they have conferred on me by electing me to the high office of President which has been occupied by a succession of men distinguished for their outstanding contributions to some branch of Science or technology.

The Indian Science Congress has been in existence for 42 years. It is still vigorously growing as can be seen from the interest taken in its session not only by professional scientists, but also by the enlightened public. This interest is in some measure due to the encouragements given to scientific and technological research by our Government and particularly by our Prime Minister. The importance of science and technology to the material advancement of any country in the present age is well-known and it is but proper that India should give increasing attention to research for being able to advance in various directions.

It looks to me that the time has come for making some important changes in the work programme of the Science Congress Sessions. In the olden days, it was possible to read and discuss several papers in each section of the Congress, but at present, the amount of time available is strictly limited and much of it is taken up by the symposia. The great majority of the papers submitted to the Science Congress are generally taken as read, and even if a few papers are taken up for reading, sufficient interest is not aroused in the discussions following the presentation. In my opinion, it is now worth considering whether we should stop accepting miscellaneous papers and concentrate on organising symposia on topics of special importance in which all the members of the sections concerned may take part. I am aware that this proposal is likely to be unpopular with a number of our members, but unless we do something like this we cannot carry on the pretence that the papers are submitted to the Science Congress for reading; it will save the Science Congress considerable expenditure on printing if only summaries of the symposia and of the few important papers read are published.

You are all aware that three years ago the Corporation of Calcutta made a generous donation of land in that city for enabling the Science Congress to put up its own accommodation. The Government of India have since kindly agreed to contribute towards the cost of the building so that in about two years it will be possible for the organisation to carry on its work in its own buildings.

From the point of view of the scientists the most important event during the past year was the conference held at Geneva during the last summer

* General President, Forty-third Indian Science Congress held during January 1956 at Agra, Uttar Pradesh.

on the peaceful uses of Atomic energy. Though India cannot yet claim to be in the forefront of research in the development of Atomic power, she played an important part in organising the conference and bringing together various countries of the world under the auspices of the United Nations. It is to be hoped that in future we will hear less of uranium and hydrogen bombs and more about the development of Atomic energy for the production of electrical power for use in Industrial plants and in medical and agricultural research.

I shall now pass on to the subject of my address which will deal with mineral resources and their problems.

MINERALS AND MODERN CIVILIZATION

It is generally known, but not fully realized, what important part minerals play in modern civilization. They provide the chief fuels and sources of power, viz., coal, petroleum and natural gas. Modern transport, communications, mass production in diversified industries and many marvels of Science are all closely connected with minerals. Many things we now take for granted, whether we regard them as necessities or luxuries—automobiles, steam and electric trains, ships, aeroplanes, radio, the various electrical and electronic devices and a large proportion of the countless products of the chemical industry—are all manufactured from minerals.

Many of the mineral products are so inter-related to each other and so essential to one industry or another, that it is no longer possible to say that one group of minerals is more important than the other. The metals and their innumerable alloys are indispensable for many ordinary and special uses to which they are put. Without them many modern chemical and metallurgical processes would be impossible, as the latter require materials to withstand extreme conditions of temperature, pressure, corrosion, acidity, etc. The metallurgical industry depends in its turn on the availability of a variety of refractories or heat-resistant substances with which furnaces are lined and containers made. The machinery and appliances used in the generation and transmission of electricity depend on the conductive properties of metals and on insulating materials like mica and special porcelain which prevent the leakage or loss of electricity. The shaping, cutting and polishing processes is dependent on their hardness and toughness; the best known amongst these being diamond, corundum, emergy, garnet and different forms of quartz. There are others which are used as protective coatings on metals, wood and other materials of construction to prevent rusting, corrosion and deterioration, these being included in the group called paint pigments. Still others, because of their brilliant colour, lustre and hardness, are used as ornaments—precious and semiprecious stones.

From the very dawn of human civilisation i.e. from the time when man began to develop intelligence to counter nature's vagaries and conquer her forces, he has used mineral products, a few at first and more as time went on. The earliest materials to be used must have been stones for building shelters, flint and quartz for making implements and ochres for ornamenting dwellings and the human body. Then followed the use of plastic clay for making pots and utensils. Naturally, occuring metals like gold, silver, copper must have attracted attention when found, for they were not only bright and lustrous but possessed malleability and ductility and the power to retain lustre. Between that stage and the discovery of the smelting of iron, a long period of time must have elapsed. In due course the smelting of a few other metals would have followed, these metals occuring mostly as easily reducible oxides and sulphides. A high stage of civilisation had already been attained by the time iron and bronze became available in large

quantities as fairly common metals. We have no reliable records as to when iron was first manufactured in India, but it was probably not less than 3500 years ago. Even in the 13th Century B.C. it was comparatively a rare commodity in the Levant and Egypt, for there are authentic archeological records to show that the smelting and production of high quality iron was then known to the Hittites of Asia Minor (who were an Indo-Aryan race) but practically unknown to the Egyptians. The inference that may be made from this is that the Hittites probably got their knowledge from their kinsmen in India or Iran. J. M. Heath, the pioneer in modern blast furnace manufacture of iron in India more than 120 years ago, has expressed the view that the use of iron in India predated the use of bronze and the Egyptain pyramids must have been built with the aid of iron implements imported from India or made with the knowledge derived from India. The earliest iron objects known in India are those found in the excavations made for the foundations of the Bodh Gaya temple which are probably of the 4th Century B. C. The iron implements found in pre-historic burial sites in the Tinnevelley district of Madras may be several centuries earlier. The famous Delhi iron pillar which is usually attributed to the 4th Century A.D. by archaeologists is much later, though the most celebrated. Iron was certainly an important article of trade, albeit for military purposes, in the first millennium before Christ, when the availability of horse chariots and iron weapons determined the fate of empires.

RAPID INCREASE IN THE USE OF MINERALS

Even at the dawn of the industrial revolution in Western Europe, which followed the invention of the steam engine, only a few mineral products were used. These were iron, copper, lead, zinc, tin, gold, silver, mercury, precious stones, sulphur, clays and building stones. Many metals, non-metals alloys and chemicals were still laboratory curiousities. Those metals which could be easily reduced from their ores by the use of charcoal or coal were the first to be made and used. The commercial production of aluminium, though it is one of the most abundant metals in the earth's crust, had to wait until the development of the electric furnace barely 125 years ago. About a hundred yeards ago, aluminium was in the same stage of development as titanium has been during the last decade. And even now the chief ore of aluminium is bauxite and not common clay which is one of the most abundant substances in the external part of the crust of the earth. Magnesium metal was isolaed about 140 years ago but did not have any major use until after the first world war. Titanium which is one of the more common elements in the earth's crust has been manufactured on a fairly large scale only during the last decade, because of the many technical difficulties which its metallurgy presents. Beryllium, which is the other light metal, will probably never become a major metal because its chief ore, beryl, is comparatively scarce and is unlikely to be produced in very large quantities.

It is well-known that mankind has used more metals and minerals during the present century than during all its long civilised existence. Modern industry is expanding at an ever-increasing pace, as almost every country is now bent upon industrialisation and the already industrialised countries are steadily expanding their activities. This will be evident from the output of a few typical metals and minerals during the current century shown in the accompanying graphs (See Figs. 1 to 6). The graphs are, however, not even because of the fact that the two world wars stimulated sudden and extraordinary increase in production, followed by depression, during which the output fell below the normal levels. This is particularly noticeable in the graphs for metals.

Minerals differ from other natural resources in certain important respects. We find them sparsely and sporadically distributed and they are waiting or non-renewable assets. The products of the animal and vegetable kingdoms are renewable seasonally

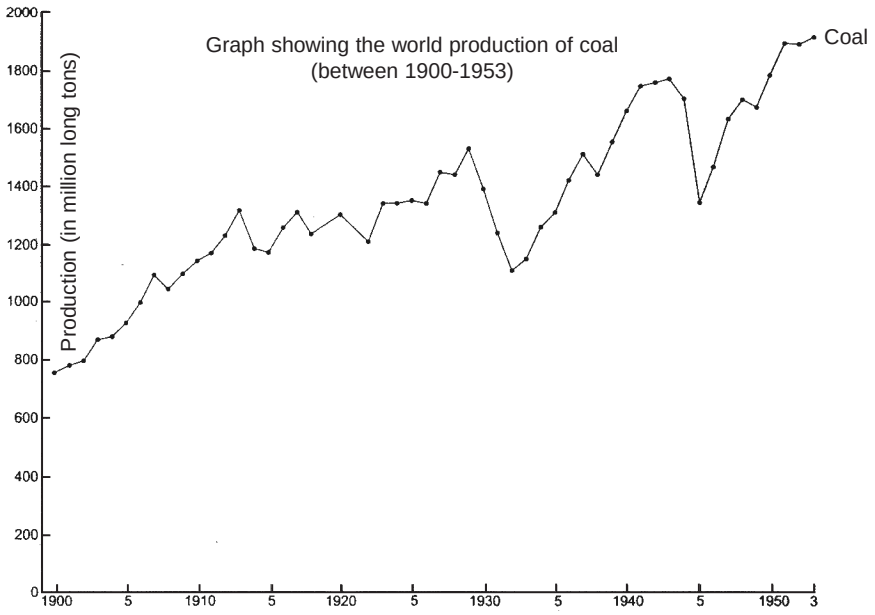

Fig. 1

or annually—not so the minerals. Under certain exceptional conditions, supplies are replensihed

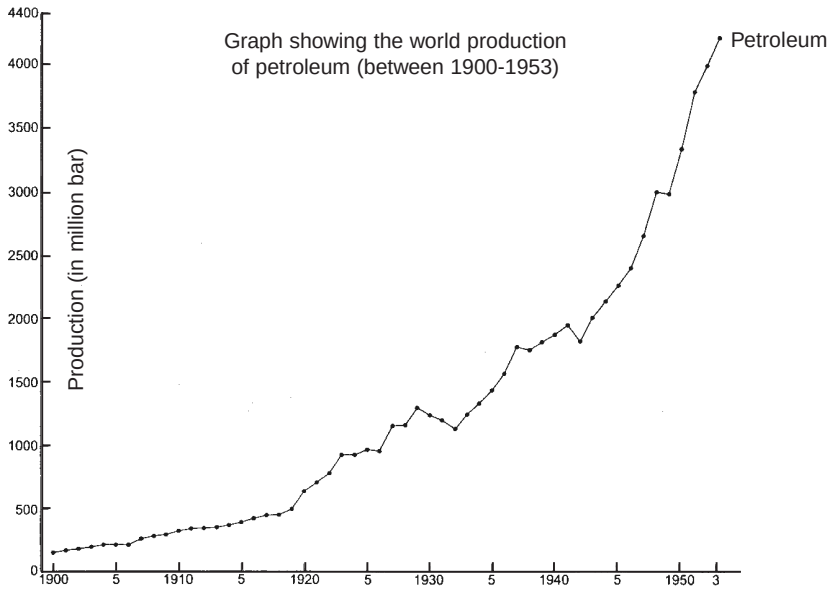

Fig. 2

quickly, e.g. sulphur in areas where volcanoes are active. But geological processes, sedimentary or igneous, generally take a very long time to produce any appreciable results. They would be of no use even if we are prepared to wait for a century or two, but they may really take many millions of years to yield worthwhile results! Many mineral deposits which originate from igneous rocks (especially metallic ores) are closely connected with mountain-building activity, while creating new

resources, may also destroy old ones. The last activity was the Alpine-Himalayan revolution, which geologically speaking, died down only very recently and the next one is not due, perhaps, for another 200 or 250 million years! The only way, therefore, of replacing the mineral deposits which have been depleted is to find new ones, wherever they may occur.

Minerals are classed as wasting assets. Some deposits originally thought to be of enormous size have been depleted so fast that they have now ceased production or lost their original importance. The Cornish tin mines which were the world's most important source for centuries are practically unproductive at present. The metalliferrous mines near Freiberg in Germany (where there is a famous

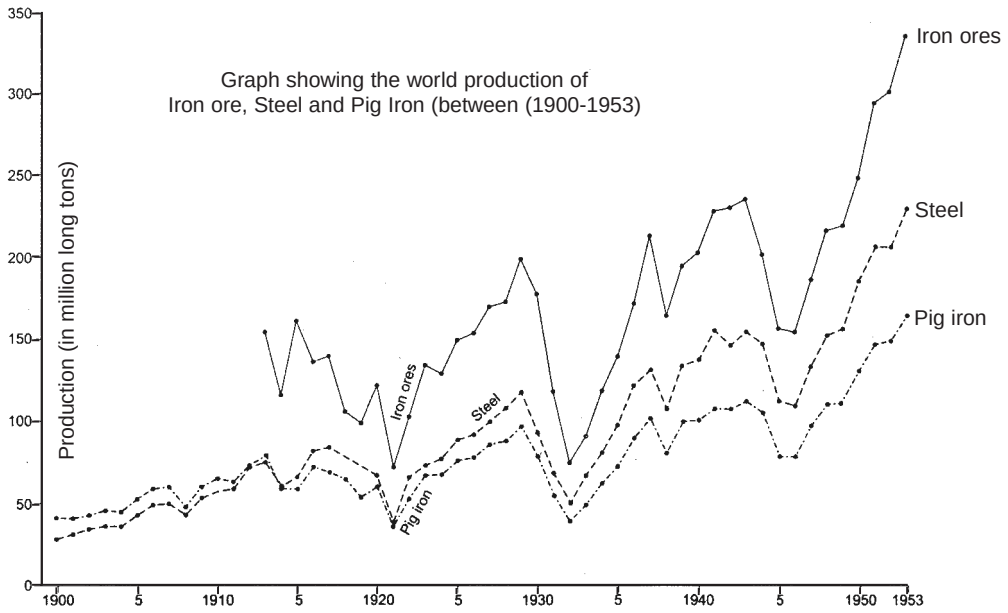

Fig. 3

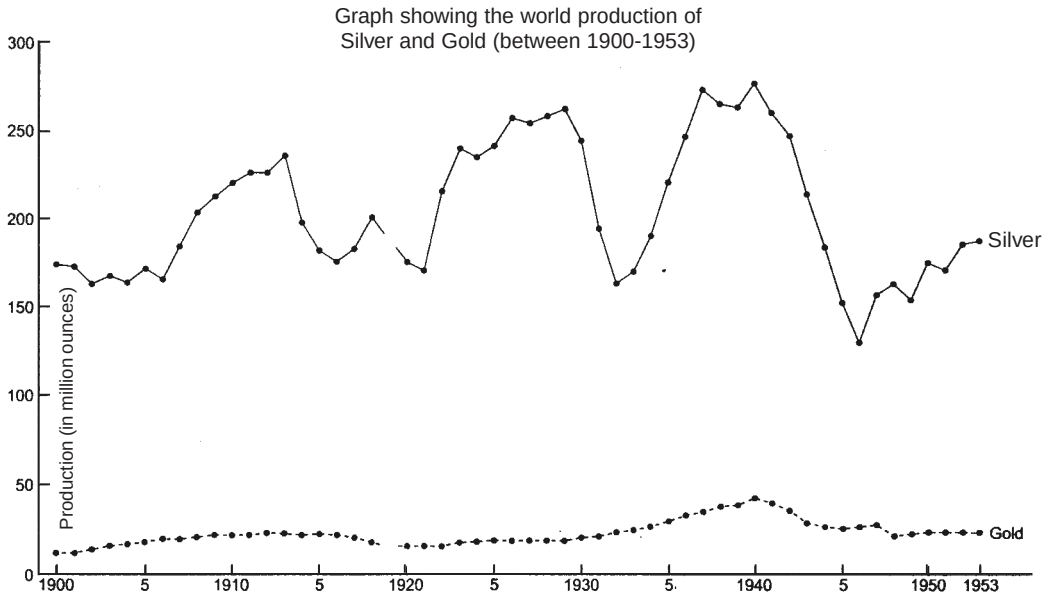

Fig. 4

mining school) are not active at present. The copper deposits of Michigan, the silver mines of Potosi in Mexico and the once fabulosly rich Comstock lode in Nevada have lost their importance. Many famous mining camps in U.S.A. and Mexico are merely the ghosts of what they were and will soon be forgotten. The most productive petroleum well so far known in the world, viz., Cerro Azul 4, at Tampico, Mexico, after having produced some 60 million barrels of crude oil, suddenly began giving only salt water. It started as a gusher in February 1916 when the oil shot up from the borehole to a height of about 600 ft. above ground and was giving a daily production of over a quarter of a million barrels for some time.

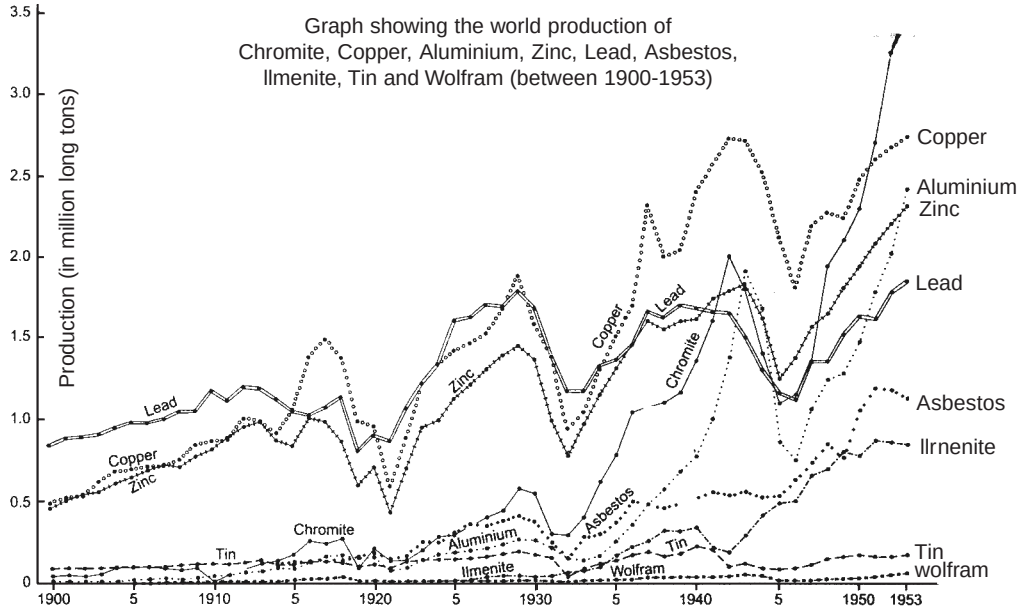

Fig. 5

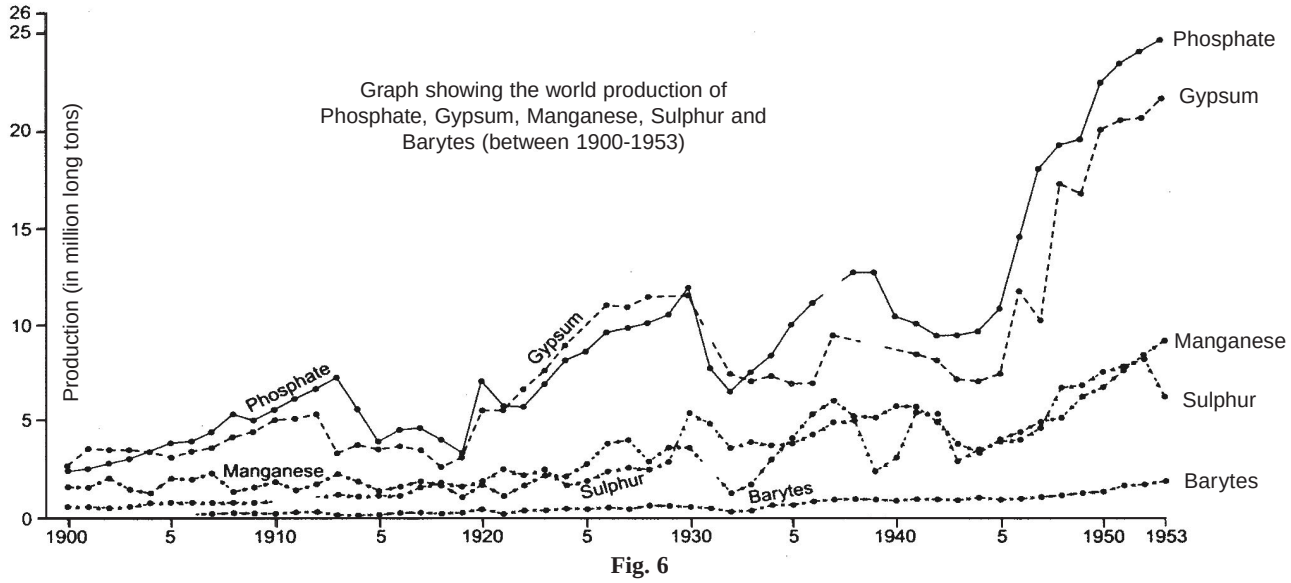

Fig. 6

By far the great majority of deposits are very sporadic in distribution and rich deposits are distinctly rare. Coal and petroleum are more widely

distributed, compared to metalliferrous deposits. The coal-bearing rocks of India occupy for instance 4 per cent or less of the area of the country, while the coal seams themselves occupy a small fraction of the coal measures. A large part (about 30%) of the production of copper by the U.S.A. comes from an area of barely 4 sq. miles near Butte, Montana. Over four-fifths of the world's production of molybdenum comes from a single property, the

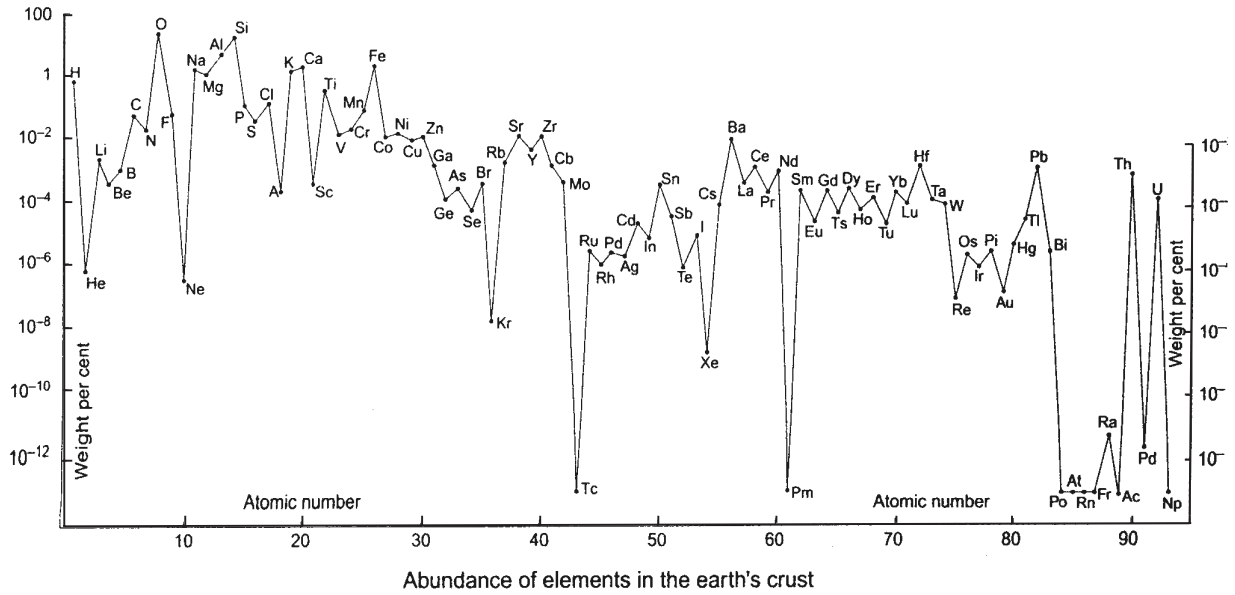

Fig. 7

Climax mine in Colorado. The Rand gold deposits which are responsible for half the gold output of the world occur in an area 50 miles by 20 miles. Similarly the Kolar Gold Fields of India occupy an area of 5 miles by 1 mile.

We shall now turn our attention to the question of the abundance and distribution of the elements in the earth's crust and to problems of mineral development.

ABUNDANCE OF ELEMENTS IN THE EARTH'S CRUST

The earth has a radius of 6371 km of which about half consists of a core, presumably of the composition of an alloy of iron and nickel. There is an intermediate layer 2870 km thick which is thought to consist of silicates of magnesium, iron, chromium and also sulphides, tellurides and selenides. The crust is 30 km thick of which the ordinarily accessible portion comprises barely 3 km (10,000 ft) though boreholes put down for petroleum have reached a depth of 20,000 feet. The composition of the crust is fairly well-established through the work of such well-known authorities as E. de Beaumont, F. W. Clarke, H. S. Washington, V. M. Goldschmidt, J. H. L. Vogt, V.I. Vermadsky, A. E. Fersman and others. The average composition is that of a rock intermediate between granite and basalt, which are most prevalent igenous rock types exposed at the surface.

The abundance of elements forming the earth's crust is given in Fig. 7 (see also Appendix I). Taking only the top 10 km. of the crust, including the atmosphere and the oceans, the 12 most abundant elements are those given below in Table – 1. They form 99.5 per cent by weight of the crust, all the other 86 elements together forming only one-half of one per cent.

Table–1. The Major Elements in the Crust

	Wt. per cent		Wt. per cent
Oxygen	49.5	Potassium	2.4
Silicon	25.7	Magnesium	1.9
Aluminium	7.5	Hydrogen	0.9
Iron	4.7	Titanium	0.6
Calcium	3.4	Chlorine	0.2
Sodium	2.6	Phosphorus	0.1

The most interesting fact about the composition of the earth's crust (and indeed of the whole earth) is that it is composed very largely of a few elements of comparatively low atomic number. Another fact is that elements having even atomic numbers are more abundant than their immediate neighbours with odd atomic numbers. A few exceptions there are, especially the rare gases Helium, Neon, Argon, Krypton and Xenon.

This may be due to their having escaped from the earth at an earlier stage of its history ; that this supposition is plausible receives support from the cosmic abundance of these gases. Hydrogen and Helium are indeed by far the most abundance elements in the universe. In the case of some of the other elements, the reason may be that we have taken only the crust and not the whole earth, in the interior of which iron, nickel, magnesium and chromium (and possibly also sulphur, selenium and tellurium, etc.) are believed to be abundant. On the other hand, elements with the highest atomic numbers disintegrate spontaneously into those of lower numbers, at least under the conditions with which we are familiar on the surface of the earth and these elements should be expected to be amongst the least abundant. Elements with atomic number 43, 61, 85, 87, 93, 95, 96, 97 and 98 have so far not been reported as occuring in the rocks of the crust, either because they are very scarce or are very quickly transformed and removed.

Those who are not familiar with geochemical facts are apt to confuse our familiarity with the various elements with their abundance in the crust. Quite a few commonly known metals such as chromium, zinc, nickel, copper, tin, lead, antimony, mercury, silver, platinum and gold, and non-metallic elements fluorine, nitrogen, boron, bromine, iodine will be seen to occur only in minor amounts, though they are in common use. Some elements such as rubidium, gallium, germanium, hafnium, indium etc. though comparatively abundant amongst the minor ones, are so dispersed that they are not commonly known. Gallium accompanies aluminium, hafnium goes with zircon, while cadmium, indium and germanium are close associates of zinc. Some of the so-called "rare earths" are more abundant than mercury, silver, gold and platinum. Scandium is more abundant than arsenic. Even titanium, which is one of the really abundant elements (about 0.44 per cent in the crust) is dispersed in ferromagnesium minerals to a great extent or occurs as small grains (as ilmenite and rutile) in many rocks, that important deposits of high grade are not common. The beach sands in some parts of the world containing ilmenite (Fe-Ti), Zircon (Zr), the monozite (Fe-Th-U) owe their concentration to weathering agents and to the action of rivers and sea waves. It would be quite uneconomic to dig up huge quantities of gnessic rocks in which these minerals occur sparsely distributed as minute grains, and try to concentrate them by mechanical means, though this is possible if cost is no consideration.

In contrast to the well-defined, large and economically workable deposits of copper, lead, zinc, chromium, nickel, mercury, silver and gold, many elements occur in a limited group of minerals which may sometimes form workable deposits. Such are the minerals containing lithium, beryllium, columbium, tantalum and rare earths which are found as sporadic lumps and pockets in pegmatites.

It will be clear from this that it is not the relative abundance of elements in the crust that

matters so much as the degree of concentration and the quantity in which they are gathered up by natural processes. Such concentrates are our ore and mineral deposits. As our knowledge grows about the characters of the elements, the minerals formed by them, the processess which serve to segregate them into workable masses, the physicochemical laws which govern their relationship and environment, we are able to narrow down our field of search and eliminate unfavourable environments.

The knowledge of the physico-chemical characters and of the processes of segregation of the elements enable us to understand the nature and association of minerals formed during the course of differentiation and fractionation of igneous rocks and those formed under sedimentary and metamorphic processes. The ionic potential (electric charge by ionic radius) determines, in sedimentary processes, the elements which remain in solution and are removed thereby and those which are precipitated by hydrolysis. A clear idea is thus gained of the process of clay and bauxite formation and the elements which may be expected to be present in such deposits. For instance, the red mud got in the Bayer process of alumina manufacture is now a good source of gallium.

GRADE AND WORKABILITY

Most of the ore deposits are usually derived through the agency of magmatic processes, being associated with igneous rocks and emanations. Both the grade of the ore and tonnage have a definite relation to what we consider a workable deposit. What we call a *low grade* is dependent on economic considerations of winning the useful mineral first by separating it from the unwanted minerals and waste rock, and then processing or smelting it to concentrate the mineral or metal into a usable form. We may state that and present the following percentages of metals from the lower limit of workable grade in deposits :

Metal	percent
Aluminium	35
Iron	30
Manganese	25
Chromium	25
Zinc	5
Lead	4
Nickel	1.5
Copper	1.0
Tin	1.0
Silver	0.05
Gold	0.001
Platinum	0.001

These figures do not apply in all cases for the same element, for other factors such as the size of the deposit, its accessibility, the availability of suitable process for easy treatment, presence of other elements which may constitute valuable byproducts, etc., enter into the problem of workability.

Thus an iron carbonate ore containing 30% iron may be workable but not a hematite of the same iron content. A bauxite containing 40% aluminium may be workable, but not a clay, as source of aluminium. Copper ores containing 1 per cent copper can be exploited if occuring in very large tonnages, as in the "porphyry copper ores" of Western United States. Gold ores occuring as veins with 2 dwt. of gold to the ton are workable only under ideal conditions. In certain cases, because of specially favourable conditions or due to the availability of efficient processes of treatment, it may be possible to recover ores containing very

low concentrations of metal. Gravel deposits containing about 3 grains of gold to the ton, and granite containing one-half or one-third of one per cent of tungsten ore may be worked. A very interesting example is sea water which contains only 0.13% of magnesium, which is now used as the source of that metal. The average content of uranium in rocks of the crust is of the order of 0.0002 per cent, i.e. two parts in a million. But it will be a very costly proposition to mine half a million tons of rock to process it and recover 1 ton of uranium whose market value at present is roughly Rs. 35,000 to Rs. 40,000. Barely a decade ago a workable uranium ore had to contain not less than 2 per cent of that element. But the demand that has been created after the discovery of atomic energy makes it now worthwhile to mine and process an ore containing only 0.1 per cent uranium. It will be a long time before it becomes possible to work even the granitic rocks which contain 5 to 10 parts of uranium per million parts, for their uranium content.

WORLD RESOURCES OF MINERALS

A large number of minerals, well over a hundred in number, are in use at present. A large proportion of them enter into the international trade as only a few countries are large sources of certain minerals and most others are dependent on these sources for their requirements.

In a paper presented before the United Nations Conference on Natural Resources in 1949 by the U. S. Geological Survey and the Bureau of Mines, the world resources, as known at the time are given for a few of the more important minerals and metals. Table–2, reproduced from that paper, indicates the reserves in millions of tons, the then production and the life of the reserves based upon current consumption.

The figures given in Table–2 can only be an approximation to the truth and may, therefore, be taken as indicating the order of magnitude. In the case of iron and coal there are doubtless larger resources than shown in the above table. In fact, a study of the world resources of iron ores made in 1954 shows much higher figures than those given in the table. For copper, lead and zinc it is rather interesting that the estimated life of the reserves has remained more or less stationery at 30–45 years over a period of more than two decades, the reason being that reserves are being found to keep pace with the depletion.

In making any estimate of the life of the known reserves at any time, various assumptions have necessarily to be made. One of these is the current rate of consumption which naturally varies from country to country and from region to region. Table 3 gives an idea of the per capita consumption of the most important metals, coal and petroleum in the U. S. A., in Europe excluding U.S.S.R., and in the rest of the world. A glance at the table will show a great disparity in the rate of consumption which of course depends on the status of industrial advancement of the different regions. If the rate of consumption increases in the under-developed countries the life of the reserves will naturally be reduced.

Table–2. World Reserves and Consumption of Some Minerals

	World reserves (in million tons)	Production 1947–48	Supply present consumption (years)
Iron ore (Iron content)			
Actual	19,000	91	200
Potential	57,000		
Manganese (50% equivalent)	1,000	3.9	350
Chromite	100	2.1	47
Wolfram (60%)	4	0.032	125
Copper ore (metal content)	100	2.2	45
Lead ore ,,	40	1.2	33
Zinc ore ,,	70	1.8	39
Tin ore ,,	6	0.16	38
Bauxite ,,	1,400	6.5	200
Potash	5,000	3	1600
Phosphate rock	26,000	14.4	1800
Coal & lignite (coal equivalent)	5,165,00	1,500	2200*
Petroleum (Proved & indicated)	75,000	3,400	22
Ultimate	555,000	—	—

* Allowing for one third loss in mining.

\+ Million Barrels (roughly 7 barrels to a ton).

Table–3. Per Capita Consumption of Some Metals and Minerals (as in the year 1948)

	U.S.A	Europe ex. U.S.S.R.	Rest of world	World average	India
Iron (kg)	335.0	65.0	11.0	39.0	6.0
Copper (kg)	8.2	1.8	0.2	0.9	0.1
Lead (kg)	4.7	1.3	0.1	0.6	0.02
Zinc (kg)	4.9	1.5	0.1	0.7	0.1
Tin (kg)	0.42	0.14	0.01	0.06	0.01
Coal (met. Ton)	4.3	1.3	0.2	0.6	0.1
Petroleum (bbls)	13.8	0.8	0.4	1.3	0.1

OUTLOOK FOR DISCOVERIES

As is well-known, only a few limited areas in the world have been searched intensively for minerals. Such areas are to be found around the North Atlantic, viz., in Western Europe and North America. Even there the amount of detailed exploration that has been done varies greatly from one area to another. Parts of the Canadian "shield" for instance, are yet to be examined in detail. Similarly, there are parts of the Rocky Mountain belt which have not yet been investigated properly.

In other parts of the world it may be stated that only a few small areas have been examined in detail. The greater part of South America, Africa and Asia remain to be explored with care. In Asia and Africa there are regions which have not yet been mapped geologically. Under the circumstances, it is reasonable to expect that intensive exploration and prospecting in such areas in these continents would lead to the discovery of a number of mineral deposits of which some at least would be of importance.

INVESTIGATION TECHNIQUES

Discovery will, of course, depend upon the care, perseverance and skill employed and the efficacy of the methods used. The days of the common prospector are more or less over in many countries where good geological surveys exist. Only in the more inaccessible parts of these countries would surface examination now give worthwhile returns. The geological surveys of most countries are now engaged upon the systematic examination of their territories with the help of geophysical, geochemical, raidoactive and other methods of prospecting aided by drilling and microscopic examination, chemical analysis, etc. of the minerals obtained during investigation. In areas covered by soil, geochemical techniques are very helpful to trace the distribution of certain elements with which they are associated. A careful study of the structural aspects of mineral deposits

is proving highly useful as it gives a better knowledge of the behaviour of the deposits both laterally and at depth. The methods available to the geologist are constantly being improved upon by advances made in the fundamental Science which contribute to the development of new types of equipment and new methods of work. Geophysical prospecting has, in the last three decades or so, given spectacular results, particularly in prospecting for oil where it has been used most extensively. Recent developments pertain to the use of the magnetometer from the air, i.e., aeromagnetic prospecting, which is specially useful in unexplored or poorly explored areas. Even in countries where a considerable amount of prospecting has already been done, new discoveries are being made at depth. For instance, the concealed coalfields in Sonthern England were discovered by careful geological work aided by deep drilling which proved the existence of several valuable coal seams at depths of 4,000 to 5,000 ft. from the surface. It is obvious that the use of the modern methods of prospecting in all parts of the world lead to the discovery of what lies at depth.

PROSPECTING FOR PETROLEUM

Formerly an appreciable part of the discovery of oil-fields was due to the results obtained from wildcat drilling. In fact several successful wildcat wells were drilled against the geological advice available at the time. In any case, whether the drill holes were successful or not, they furnished much valuable geological information. As a result of exploration for several decades it is now known that petroleum is found in sedimentary rocks mainly of marine origin. What sort of organisms gave rise to petroleum and what particular processes control its characteristics are still matters of controversy. When these sediments are moderately folded, forming domes and anticlines, they provide the necessary structure for the accumulation and storage of petroleum. The "reservoir" rocks must be porous in order to be able to hold large quantities of petroleum and gas, and pervious in order to yield them readily when pumping is resorted to. The porous strata should have an impervious cover to seal off and to prevent the escape of the petroleum and the accompanying natural gas from the adjoining strata. The strata must be unbroken by faults and thrusts, for these afford easy routes for the escape of petroleum and gas. Thus, though the Siwalik and the associated Sub-Himalayan zone bordering on the North Indian plains belongs to the same sedimentary belt as occurs on either side of India in Iran and Burma, it has been violently elevated, broken up, folded and pushed about by the earth movements which were responsible for the formation of the Himalayan ranges. We have, as a result, the highest mountain ranges in the world, attracting many mountaineering expeditions from all parts of the globe; but unfortunately, from the economic point of view, the very forces which produced these mountains have broken up most, if not all, of the possible oil-bearing structures. We still entertain some hope that a few favourable structures may be found in this belt as well as in the Ganga and Brahmaputra valleys of Northern India under the thick blanket of alluvium.

The discovery of the great majority of the oil-fields during the last three decades or so is due almost entirely to geophysical exploration. Many parts of the world have been investigated, resulting in numerous discoveries such as the fields in Central Canada, England, Germany and Saudi Arabia. Similarly also, the Nahorkatiya field in Assam owes its discovery entirely to geophysical prospecting. Without these aids, the discovery would have been much slower and only through expensive blind drilling at very great cost.

GEOLOGICAL ENVIRONMENT

The search for minerals has another aspect. By patient accumulation of data, general principles have been established which enable us to say that

certain types of minerals are found in specific geological environments. With that knowledge we can say that it is futile to look for coal or petroleum in crystalline rocks or even in Pre-Cambrian sedimentary rocks. Indeed, there is a record of one of our Provincial Governments, nearly three-quarters of a century ago, repeatedly helping an enthusiastic army officer in his search for coal in the crystalline and Pre-Cambrian rocks, against the advice of the Geological Survey. Certain minerals like chromite, vanadiferous and titaniferous magnetite, nickel sulphide, phlogopite, chrysotile asbestos, the platinum group of metals, etc. are found in igneous rocks rich in magnesium and poor in silica which geologists call ultrabasic rocks. The granite-pegmatites are the home of several minerals containing rubidium, caesium, lithium, beryllium, cerium, yttrium, tantalum, etc. Tin and wolfram are also found in granitic rocks. Many of the metallic ferrous deposits containing ores of copper, lead and zinc are generally associated with igneous rocks of acid to intermediate composition (granites or grano-diorites).

A very rough quantitative appraisal of different types of minerals available in the chief geological formations exposed in a country may be made if reliable fundamental geological data are available. These latter should of course include the strucutre, thickness and distribution of the various geological formations and the type of materialisation associated with them. To arrive at a general picture it is not necessary that the appraisal should be accurate in the first instance. The order of magnitude may be first ascertained in the preliminary studies, further search and closer investigation aiding in making this more and more precise in course of time.

GRADE AND TONNAGE

In most mineral deposits, there is some quantitative relationship between hte grade of the mineral and the tonnage available, i.e. the poorer grades are in greater abundance than the rich ones. The relative proportions of the tonnage of the different grades will depend upon the geological characteristics of the deposits. The ratio of these grades may vary from one group of deposits to another. This type of study has not been undertaken yet on a systematic basis, but as data become available from areas where the mining industry has been in existence for many years, it should be possible to establish, for each type of deposit, some kind of mathematical relationship which would aid future appraisal.

The present surface of the globe gives a section of the earth as exposed by geological processes. Below the present surface and within the depths accessible to mining, we can expect at various levels a general repetition of the same conditions and the same average distribution of rocks and mineral deposits. This assumption will be valid if we take the earth's surface as a whole. Broadly, therefore, we shall be justified in assuming that there are at least as many undiscovered deposits below ground as those that have been discovered and exploited. Indeed, if we could explore all the mineral deposits occuring down to a depth of say, 10,000 ft. from the surface, we should certainly expect to find several times the reserves of all the minerals which we are cognizant of at the present time. As things are, however, there is a great deal of exploration to do and there is no doubt that numerous important deposits await discovery in many parts of the world.

CONSERVATION OF MINERAL RESOURCES

It is well-known that in all countries there is a stage of development early in the process of industrialisation when only the richest deposits exposed at the surface are worked and utilised locally or exported. Much wastage occurs in this stage either through leaving behind the poor grade material unworked or throwing it away with waste rock on the dumps. This stage is soon followed by industrial development marked by the setting up of

metallurgical, chemical and engineering works. The national wealth and prosperity of the country concerned increase during this stage. Next comes a period of depletion of cheap domestic mineral resources and import of raw materials from outside for feeding the local industries. During this stage the general prosperity of the country is maintained but there is keen competition in markets both for buying raw materials and selling finished goods. Thereafter comes the stage of having to depend on foreign ore and other raw materials, leading gradually to loss of competitive power in foreign markets due to the necessity for purchase of much of the raw material requirements from outside. We in India are just passing the first stage and entering into the second. The further stages can be strengthened by the careful husbanding of our resources by the adoption of measures of conservation. This can be achieved if an all-out effort is made to adopt and enforce the best practices in mining; to insist that all workable grades are mined and that the poorer grades are beneficiated in order to make them usable; that all useful byproducts are recovered during mining, beneficiation and manufacture; and that each type or grade of material is put to the use to which it is best fitted by its properties. An outstanding example in India requiring the enforcement of conservation, to which repeated attention had been called, is the misuse of good coking coal for burning in boilers and locomotives for steam raising for which non-coking coal of a similar grade would do quite well. It is only during the last four or five years that serious steps have been taken to prevent the objectionable use of coking coal. Several other examples of waste or misuse can be quoted.

It is, however, necessary to develop a sense of proportion and weigh the local conditions carefully before strict measures are adopted to prevent waste. We are apt to complain that the excellent marbles of Makrana in Jodhpur and other places in Rajasthan are being used for building huts in the neighbouring villages, or that the beautiful shell limestone in the Trichinopoly district in Madras is carved into water troughs for cattle. In the absence of better uses, it is inevitable that they are employed locally for purposes for which some other and cheaper material could have been used.

During periods of high prices and scarcity, miners themselves adopt some measure of conservation by working the readily marketable lower grades of mineral present in the mines or by re-working the dumps to recover whatever can be sold in the market. Thus, during the last few years, under the stimulus of high prices, many manganese mine dumps were scenes of activity and appreciable quantities of marketable ore were recovered. During the war, many mica dumps were turned over to recover small pieces of good mica and such minerals as beryl, tantalite, samarskite, etc. This, however, is a process depending on special circumstances when either high prices or scarcity encourage the recovery of all useful material even from dumps. The modern State, whatever be its political complexion, now insists that natural resources should be conserved and takes steps to regulate the mining and mineral industries to the extent considered necessary in the interests of the nation. It encourages and helps the industry to set up plants for beneficiation and undertakes research to determine the most suitable processes to adopt for the particular mineral commodities selected for beneficiation. As private industry becomes more educated and alive to the need for conservation, it may itself take up research to solve the problem of individual units or of the particular mineral industry as a whole.

Conservation has to be effected at all stages of the development of the mineral deposits, in mining, milling and ultimate utlization. All technological advances in any of these stages automatically bring in improvements which are conductive to conservation. Conservation is also achieved by substituting a more easily available and cheaper

material for one which is costly or difficult to get. Substitution is often dictated by necessity and will be acceptable so long as the easily available substitute is good enough for the purpose for which it is intended. Thus, though it may be worthwhile using a good grade of mica for all types of electrical insulation, a poorer insulator would serve for some purpose. Mica substitutes are, therefore, coming into use in the countries which have to import this mineral in large quantities.

RECOVERY OF BYPRODUCTS

Barely a quarter of a century ago, many minor metals or elements present in important mineral deposits, such as those of copper, lead and zinc, were considered to constitute an unmitigated nuisance. Such were arsenic, antimony, cadmium, bismuth, molybdenum, tungsten, vanadium, etc. which are found in small quantities in metalliferous deposits and whose elimination costs a good deal of money. But, at the present day, the presence of such elements constitutes a valuable source of profit as they are separated, refined and sold in the market. Even coal ash, slag and flue gases and dust from chimneys have become important sources of sulphur, potash, germanium, etc.

About half a century ago, the only petroleum fraction which found use was the heavy fuel oil. The crude petroleum drawn from wells was run out into open pits or tanks so that the light fractions might escape, leaving the heavy oil behind, for no use had been found for the lighter constituents. Now-a-days these light fractions, which were considered useless in former days, are the most valuable constituents and every effort is made to prevent their loss.

Technological advances are constantly enabling us to use lower grades of minerals than before. Within a period of two decades or so, the ore charge for the iron blast furnace in America has gone down from an average of 56 to 60 per cent iron to 52 to 55 per cent iron. The standard grade for bauxite which was formerly over 55 per cent alumina has now dropped to below 50 per cent. Chromite and manganese ores of 45 and 40 per cent respectively are now-a-days saleable but a couple of decades ago, they had no market. When certain materials become scarce in time of crisis the prices shoot up to unprecedented heights e.g., wolfram was selling at a price of Rs. 25,000 or more per ton barely 3 or 4 years ago, while berryl selling at more than Rs. 1,000 per ton. But if the scarcity become chronic, substitutes will be found by intensive research and the scarce mineral will not be needed for the purpose for which it was originally used. These remarks will apply as much to artificial scarcity which may be created by political or ideological factors as to natural scarcity due to insufficiency of reserves or supply.

CHANGING PATTERN OF USE

It is an interesting fact that no mineral has become entirely obsolete and unusable. The pattern of use may change occasionally but so long as a mineral finds some use it continues to be employed until it is replaced by something more suitable or is used for some other special purpose. A good example is afforded by monazite for which the black sands of the Travancore coast were originally worked. It was then employed for the requirements of the gas mantle industry. But, after the first world war, the demand for the mineral fell and practically stopped, as gas had largely been replaced by electricity for lighting in Europe. In the meanwhile ilmenite which is associated with the monazite, found use in the manufacture of a paint pigment—titanium white. This mineral rapidly assumed importance and monazite was nearly forgotten for a while. But during and after the second world war, monazite has again attained prominence as a possible source of atomic energy because of its content of appreciable amounts of thorium and a little uranium. Ilmenite also continues to be utilized, so that at present there is a good demand for both these minerals.

Prophets are not wanting to predict calamities for particular mineral industries whenever important new developments take place. Some have predicted that, because of the coming in of synthetic mica and *samica,* the natural mica which India produces in large quantities will shortly disappear from the list of useful minerals. But I am sure that most geologists will agree with me that so long as good natural mica is available at a competitive price compared to any synthetic product or substitute, there will always be a market for it. It might go out of use only if something equally efficent and not costlier takes its place. The latest prophecy seems to be that atomic energy is going to make coal an unwanted material and that coal mining will be a thing of the past within a decade. But we may, well ask whether all the uranium needed for bringing about such a complete revolution in the industrial set-up and power production will be available (as also other materials needed for regulation and control of the nuclear reactions) at a price which will compete seriously with coal. Similar prophecies were made about coal when large developments in the production of petroleum as well as of hydro-electricity took place three or four decades ago. There are as yet no signs of coal becoming unnecessary to mine.

Conservation of natural resoruces is the slogan of the present age, so much so that a World Conference on this subject was held under the auspices of the United Nations in New York in 1949. Those interested in the subject will find much useful information in the six volumes of the report of this Conference published in 1953 by the United Nations Organisation.

INTERNATIONAL CHARACTER OF MINERAL RESOURCES

Modern industry uses a host of minerals. Some of these used to be called strategic in the sense that they were of importance for making the munitions of war. Amongst these would come, for instance, ores of iron, managanese, chromium, tungesten, copper, lead, sulphur, etc. but in this era of total war, almost everything becomes a strategic material-even ceramic clay and paint pigments—for each has an important part to play. Hence the necessity for finding and developing all the variety of minerals needed for various industries.

Several important studies have been made in recent years by individuals and committees to access the resources of minerals available in each country as also the local needs and exportable surpluses. But now, in many cases, the demand is outstripping supplies from well-known sources so that what appeared to be adequate reserves a few years ago are no longer so. Only some overwhelmingly important deposits have continued to be the major suppliers, while all the small or moderate-sized deposits have been depleted or even used up. There is thus a concentration of supply in the territories of a few individual countries. Not even the biggest countries in the world like the Soviet Union or the U.S.A. are self-sufficient in all minerals and they have to obtain a few minerals from other countries. Minerals, therefore, assume international importance and figure prominently in political and economic discussions between countries. No wonder then that all countries are paying increasing attention to the development of their mineral resources to reduce their dependence on others to a minimum.

Some 70 to 80 minerals are known to enter into international trade. In the case of a few like tin, tungsten, chrome, nickel, etc., the sources are few from which supplies must be obtained by all. In the case of some others the sources are many and therefore it is more easy to obtain them from several alternative suppliers. The growing industralization of several countries has been creating shortages because of which supplies are rapidly becoming limited to only a few sources which have a large surplus for export. In regard to the chief sources of supply of the more important

minerals, I take the liberty of quoting an extract from a lecture delivered at the Hyderabad Session of the Indian Science Congress by Prof. Alan Bateman of Yale University :

"As I foresee it, the chief supplies of minerals of the free world in the future will be as follows :

Mexico for lead and zinc, antimony, mercury and graphite; Venezuela for petroleum and iron ore; Brazil for manganese, iron ore, beryl, tantalum and mica; Bolivia, tin, tungsten and antimony; Chile, copper and nitrates; Peru, copper, lead, zinc and vanadium; Canada, copper, lead, zinc, asbestos and nickel; Morocco, lead, zinc, manganese, cobalt, iron ore ; Algeria and Tunisia, lead and zinc ; South Africa, manganese, chrome, asbestos, diamonds and corumdum, as well as uranium; Namaqualand and South West Africa will supply copper, lead, zinc, tungsten and germanium; the Rhodesia will supply copper, cobalt and some lead and zinc along with important quantities of metallurgical chrome and asbestos ; the Belgian Congo can supply copper, cobalt, uranium, lead, zinc, tin, tantalum and diamonds; British East Africa in the future will be able supply copper, cobalt, iron ore, possibly manganese and mica; Portuguese East and West Africa can supply diamonds, some mica some tungsten, possibly in the future some uranium; the West Coast of Africa has large reserves of iron ore and manganese, diamonds, and miscellaneous minerals; Turkey will have exportable surpluses of metallurgical chrome; the Philippines can supply iron ore and refractory chrome; Korea can supply tungsten; Japan can supply little of anything for mineral export; Indonesia in turn will have excesses of bauxite, petroleum and tin; Malaya, of course, should continue to be the largest exporter of tin; and India, it is expected, should have exportable surpluses of manganese, of mica and titanium ore; New Caledonia should continue to yield nickel and chrome ; and Cuba in the future should be a large supplier of nickel as well as considerable manganese and refractory chrome."

Times of emergency create abnormal demands for minerals. Familiar sources of supply beyond the confines of a country may be cut off, necessitating the opening up of poor deposits at home and taking resort to substitutes which may not always be very satisfactory. Frantic search is made and all new sources—good, bad and indifferent—are tapped at great cost, most of them to be abandoned at a later date as uneconomic. As examples we may cite the development of poor grades of manganese ore and bauxite in the U.S.A., aluminous clay in Japan. A similar situation arose during the war in all the other industrially advanced countries and compelled them to pay concentrated attention to problems of mineral sufficiency and deficits. But in some cases, however, intensive research has enabled the utilization of deposits considered marginal or unworkable in former days.

INDIA'S RESOURCES

During the last war, India was an important link in the supply chain of the British Commonwealth and had to face many difficulties due partly to lack of trained personnel and facilities and partly to lack of knowledge of the resources. With the subsequent change in Government has come the realization of the urgent need to assess the country's resources in minerals and to use them in new industries to meet her own needs. Our present knowledge goes to show that we have only a few surpluses and quite considerable deficiencies in the list of useful minerals needed for industry. There is a sufficiency or surplus in coal, ores of iron, manganese, aluminium, titanium, chromium, magnesium; mica, barites, kyanite, sillimanite and various types of clays. The chief deficiencies are in copper, lead, zinc, silver, nickel, cobalt, molybedenum, tungsten, tin, antimony and mercury amongst the metals; and sulphur, phosphates, fluour-spar, petroleum, potash, graphite, asbestos, amongst

the non metallic minerals. In almost every case our knowledge is confined to surface observations. We do not know enough about what lies below the surface even at shallow depths. There is, consequently, a chance of making good, some of the deficiencies by extensive and intensive search in suitable areas. Only during the last few years has the Geological Survey been strengthened suitably in personnel and equipment to face this task adequately. Geological data can be gathered only by hard, painstaking work in difficult and often inhospitable terrain and at considerable expenditure of labour, time and money. Many who are unfamiliar with the nature of geological work believe that because the Geological Survey has been expanded, new discoveries will come pouring in by the dozen. Such hopes are unwarranted, but we can expect to get more precise information on the known resources and perhaps to face disappointments in some cases at least, where the yield of results may be quite disproportionate to the time, energy and money spent. This applies particularly to the search for petroleum in which the risks are much greater than in the case of most other minerals. Even in areas known to contain petroleum, it is only one deep drill hole in about 15 to 20 becomes productive. It is known that the Assam Oil Company has been conducting intensive geological and geophysical work and drilling in many areas in Assam during the last two decades or more, with practically negative results, until the new field of Nahorkatiya gave indications of success barely two years ago. Drilling is being continued there and the full potentialities of the field are not yet known. In entirely new areas such as we are beginning to explore, the chances of success may not be any better. I say this not to discourage efforts in any way, but only as a warning against pitching our expectations too high.

I have already alluded to the changing pattern of use of minerals to meet the ever increasing demands by diversified industries. As Science and technology advance, new tools become available for the search of minerals and new uses for minerals emerge. It is therefore quite impossible to make a claim that we know everything about all our resources at any point of time. As new demands arise, there will be need for re-examination of even well-investigated areas and to search for whatever material or information may be required at the time. Hence a Geological Survey does not become superfluous at any time, for it can never have completed its job to finality. Only in 1931 a committee of the Central Government thought that there was not enough work for the Geological Survey, whose total strength at the time was some 30 geological officers for the whole of the "Indian Empire", and decided to prune it to about two thirds its size. The war which came soon after found us with this small personnel and great efforts had to be made to expand the Survey. Even though the Department is at present ten times its size in 1935, it is still inadequate to meet even the major part of the work it is expected to do, and further expansion is necessary. In addition, a Bureau of Mines has been established to look after the work of improving the techniques and standard of mining and of enforcing mineral Deposits, Groundwater and Engineering Geology and to conduct Geophysical Exploration. The coordinated efforts of all these will be directed towards the study of all the phases of exploration and development of our resources in minerals and will contribute steadily to the building up of a strong and prosperous nation.

HEAVY METALS IN AQUATIC ECOSYSTEM : SOME ENVIRONMENTAL IMPLICATIONS

Kailash Chandra Agrahari*

Heavy metals in aquatic milieu pose no direct danger to ecosystem as long as they are tightly bound to the sediments. However, they may be released due to changes in physico-chemical conditions of an aquatic milieu. In the process, sediments act as 'voice recorders' of the stream behaviour. Any environmental programme aimed at conserving river water quality would be incomplete without the proper study of sediments. It is equally important that measures should be taken to prevent contamination of aquatic sediments. The processes and techniques enumerated in the text should be assessed for their economic viability with regard to space and time.

INTRODUCTION

Heavy metals are those whose density is greater than 5 g/cm^3. Many of the heavy metals are known to be poisonous even at low concentrations, although their traces are vital for the growth and sustenance of several organisms. At high concentrations, heavy metals are specially toxic to animals and plants. The growing public concern over the deteriorating quality of our environment has led to a generalized usage when referring to heavy metals. For practical purposes, other terms such as 'trace metals', 'micro-elements', and 'micro-nutrients' are being treated as synonymous with the term 'heavy metals'. Of all the elements present in the earth's crust, 14 elements viz. B, F, Si, V, Cr, Mn, Fe, Co, Cu, Se, Mo, Sn and I are the essential trace elements. Rest of the elements are either not essential for the growth and development of organisms or their function in the biological systems has not been established. Heavy metals such as mercury, zinc, cadmium, arsenic, chromium, lead and copper are dangerous pollutants and are deposited with natural sediments in the bottom of a stream. The fate of individual metal ions originally derived from breakdown of rocks is controlled by several factors, involving temperature, precipitation, water movement, soil movement, changes in redox potential and pH condition, absorpiton-desorption process, chemical complexation, hydrolysis, decay of vegetation and biochemical-bacterial interactions. The relative interplay of these factors control whether or not a specific load of freshly leached metal ions eventually reaches a water body intact or widely dispersed[1]. In addition to these natural processes, the sediments today are also being affected and modified by the anthropogenic activities. Owing to enhanced levels of heavy metals in the aquatic ecosystems, possibility of accumulation of these metals in the human body and building-up with time to the toxic levels; phytotoxicity of heavy metals, bio-accumulation and magnification by aquatic organisms, possible intake through drinking water and aquatic food might take place. Of great significance, are the toxic heavy metals which, when present above their respective threshold limit, cause great health hazards. The toxic metals, in context to many

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organic compounds, are not decomposed by the microbiological activity. On the contrary, the heavy metals can be enriched by organisms and the type of bonding can be converted to more poisonous metal organic complexes as observed in the transformation of mercury into methyl mercury as happened in the Minamata Bay of Japan[2]. One of the most famous cases of heavy metal pollution occured in Minamata, Japan in the 1950s. The cause of this disaster has been traced to the dumping of about 27 tons mercury compounds by the Chisso Corporation into Minamata Bay during the 1950s and 1960s. The people of Minamata consumed fish and shellfish from the Bay in their diet and this lead to an accumulation of toxic methyl mercury in their bodies. Over 3,000 victims have been recognized as having "Minamta Disease". The episodes of Minamata and Itai Itai diseases in Japan have brought to a sharp focus for the far reaching public health.

OCCURRENCE OF HEAVY METALS IN AQUATIC ECOSYSTEM

The aquatic ecosystem, particularly rivers, has become a convenient conduit for the disposal of broad spectrum of industrial, domestic and hospital wastes containing organic and inorganic chemicals. When the effluent loaded water meets the river, reactions start taking place and a large part of the effluent in one form or other settles down and adheres or is adsorbed by the river sediments. Fine sediments comprising silt, clay, and organic materials generally have chemically active properties which sorb ions from solution. The heavy (toxic) metal thus adsorbed in the sediments present no direct danger to ecosystem as long as they are tightly bound to the sediments. They rather peform the important function of buffering higher metal concentration of water particularly by adsorption and precipitation, thus they help in the attenuation of heavy metal, in an aquatic environment. However, the heavy (toxic) metals (and many hazardous chemicals as well) in the sediments may not necessarily remain in that condition but may be released due to changes in the physio-chemical conditions of an aquatic milieu; the main causes of remobilization being elevated salt concentration, changes in redox condition, lowering of pH, increased use of natural and synthetic complexing agents which can form soluble metal complexes and microbial activity. As a result of remobilization of the heavy (toxic) metals from the sediments, the water may get contaminated and may not only be unfit for drinking purposes, but its enhanced pollution may cause health hazards. Obviously, the aquatic sediments act as a sink for a large number of contaminants present in water. The exchange of toxic materials take place at the sediments-water interface. It is however, stated that although a small part of the bulk heavy metals is mobilized from the contaminated sediments, yet this small fraction might represent a substantial environmental impact. Factors which influence the transfer of toxic material between sediments and overlying water are physical (temperature, hydrodynamics and mixing), chemical (acid-base, complexation, oxidation-reduction, sorption-desorption and precipitation-dissolution) and biological. The cumulative effect of the above factors, i.e. physical, chemical and biological causes the transfer of toxic heavy metals across the sediment-water interface, ultimately to come up in the water column at the river. It may, however be stated that most toxicity researches in an aquatic ecosystem deals with the amount and form of heavy (toxic) metals present in water or aquatic life, rather than the amount of potential toxic metals bound up in the sediments. So the value of average shale, a geo-chemical background value[3], is taken for a comparative study of the sediments of aquatic environment (although it may not refer to the level of the toxicity). The average shale values are shown in Table 1. The major reason for the particular sensitivity of aquatic systems to pollution influences may lie in the structure of their food chains. Compared with land systems, the

relatively small biomass in aquatic environments generally occurs in a greater variety of trophic levels, whereby accumulation of Xenobiotic and poisonous substances can be enhanced.

Table–1 : Contents of Minor and trace elements in average shale

Element	Average shales value in ppm
Mn (Manganese)	850
Ba (Barium)	580
Sr (Strontium)	300
V (Vanadium)	130
B (Boron)	100
Zn (Zinc)	95
La (Lanthanum)	92
Cr (Chromium)	90
Ni (Nickel)	68
Li (Lithium)	66
Ce (Cerium)	59
Cu (Copper)	45
Y (Yttrium)	26
Pb (Lead)	20
Co (Cobalt)	19
As (Arsenic)	13
Nb (Niobium)	11
Sn (Tin)	6
U (Uranium)	3.7
Be (Beryllium)	3.0
Mo (Molybdenum)	2.6
W (Tungsten)	1.8
Sb (Antimony)	1.5
Ta (Tantalum)	0.8
Se (Selenium)	0.6
Sc (Scandium)	0.6
Hg (Mercury)	0.4
Cd (Cadmium)	0.3
Ag (Silver)	0.27

SEDIMENTS AS 'VOICE RECORDER'

The stream sediment samples are considered as 'Voice Recorder' of stream behaviour which is either due to natural or anthropogenic causes. Determination of heavy metal concentration in surface water samples from rivers, collected at short intervals reveals fluctuation of several orders of magnitude. While in the case of sediments systematic relationship between metal concentration, particle size and distance downstream have been generally noted. Besides, many heavy metals are not readily soluble but become rapidly fixed to particulate matter in the receiving body of water. A general increase of metal concentration from coarse to fine-grained fractions has generally been noted. The fine grained materials, particularly clay minerals have a large surface area and are capable of accumulating heavy metal ions at the sediment-water interface, as a result of intermolecular forces i.e. by adsorption. The clay minerals, comprising a significant part of sediments are capable of sorbing cations from solution and releasing equivalent amount of other cations in the solution. It is reported that the exchange capacity increase markedly in the order :

Kaolinite < Chlorite < Illite < Mantmorilonite

The affinity of heavy metals towards clay minerals has been established[4] as follows :

Pb > Ni > Cu > Zn

Lastly, the extent, distribution pattern and provenance of the pollutants can be determined and traced only through the investigation of sediments.

The variation in the heavy metal contents of stream sediments can be expressed as a function of potential controlling factors by the following model of Dahlberg[5].

T = f[L.H.G.C.V.M.e]

where, T = Resulting heavy metal concentration

L = Influence of Lithologic units

H = Hydraulic effects

G = Geologic features

V = The type of vegetational cover

M = The effect of mineralized zone

e = The error plus effects of additional factors not explicitly defined in the model.

In the above model, factors other than G ascribe to natural pollution which can be recorded as background value.

POLLUTION OF OUR WATER RESOURCES

There is no life without water which is essential for the socio-economic development of human beings. There is plenty of water on the earth surface, the fresh water, however is limited and a large part of it is in a polluted state at present. Only 2.7 percent of the total global content of approximately 1.4 billion cubic kilometers is fresh and suitable for human use. Of this again, about 77.2 percent is permanently frozen, 22.4 percent occur as ground water and soil moisture, 0.35 percent is contained in lakes and wetlands and less than 0.01 percent in rivers and streams. Obviously, the amount of water actually available above the ground, that is, in the atmosphere, is a very small fraction and is estimated to be 1×10^{-5} of the total water resources of the world. So a great deal of water is in the salty ocean, and the rest of it is not always where and when we need it. Kofi A. Annan, ex-Secretary General of the United Nations, has realized the problem and expressed his concern in these words 'Global fresh water consumption rose 6 fold between 1900 and 1995 more than twice the rate of population growth. About one third of the world's population already lives in countries considered to be 'water stressed' that is, where consumption exceeds 10% of the total supply. If present trend continues, two out of every three people on earth will live in that conditon by 2025".

In our country, most of the rivers are highly polluted. The main sources of pollution in the country are domestic sewage, industrial effluent and agricultural run-off. Only about 25% of class I cities (population more than 100,000), have wastewater collection, treatment and disposal facilities. Less than 10% of the 241 smaller towns have wastewater collection system. Only 20% of all the wastewater generated in class I cities and 2% of all the wastewater generated in class II towns is treated.

The river Ganga, no doubt, is one of the most important rivers of our country. It has large drainage basin comprising an area of 861,404 sq.km. encompassing a large part of Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, West Bengal and Union Territory of Delhi and accounts for 25.2% of the India's total water resources. The water of this river is referred in our religious text to possess extra-ordinary properties in comparison to water of the other rivers. However, during recent years, pollution load in this river has enhanced and is beyond the self purification capacity of the river and 'holy' water particularly near the habitational centres has become so much contaminated that it is not only unfit for drinking but also for bathing and other purposes. Studies revealed the presence of toxic metals in the sediments of the aquatic milieu of the Middle Ganga Plain[6,7,8]. According to an estimate the sediment load of the river Ganga is 1450 million tones/year[9]. It is estimated tht 3 tones of silt is being carried away every year from every square km of the Ganga catchment area. The sediment fill in the river channel has varying thickness. These sediments act as a scavengers [anti-pollutant] in the aquatic ecosystem. The suspended sediment particles carrying the contaminant settle into the basinal sediments and with time get burried in the sediments. Similar deplorable condition is with other rivers as well like. Brahmaputra, Narmada, Godavari, Krishna, Cauvery, Mahi, Mahanadi rivers.

PREVENTION OF SEDIMENT POLLUTION

In view of pollution of the aquatic ecosystem, it is important that measures are taken to prevent aquatic sediment pollution. In this regard some of the important techniques suggested are enumerated below :

1. Natural and chemical flocculation ;
2. Dewatering and stabilization,
3. Chemifixation,
4. Chemical precipitation,
5. Lime treatment
6. Ion exchange process in the treatment plant,
7. Adsorption on activated carbon,
8. Reverse osmosis,
9. Liquid membrane extraction
10. High gradient magnetic separation.

Dredging of the sediments or covering them with impervious materials in conjunction with river regulation projects and recyling of the materials to reduce the discharge of polluting substances have been suggested by Ching-I et al.[10]. Besides, pretreatment of effluents and analytical procedure for the separation of different metal species are being adopted. Other processes include electrodeposition, electrodialysis, solvent extraction, γ/UV irradiation, evaporation ion flotation and freeze concentration. The chemical treatment technologies use chemical reagents added to a sediment to destroy contaminants. Besides, bacteria have long been used to treat sweage and industrial wastewaters, and they have been applied to the treatment of organic compounds in soils, sediments, and sludges. The ARCS (Assessment and Remediation of Contaminates Sediments) of USA program participated in a pilot-scale test of bioremediation on PCB-laden sediments from the Sheboygan river in Wisconsin.

Sediment washing is also a technique to abate the sediment pollution. This is an adaption of technology that has long been used in mining and mineral processing to separate solids suspended in water into sets of different sized particles. It was demonstrated by the ARCS program on a pilot-scale with 300 cubic yards of sediment dredged from the Saginaw River and Saginaw Bay. Sediments in the Saginaw are mostly sand, but the heavy metal contaminants are concentrated in the finer particles, the silts and clays, that are mixed with sand. By separating silts and clays from the sands, the process can substantially reduce the amount of material that needs to be treatred. At Saginaw, 80 percent of the material fed into the process emerged as sand clean enough to be used for beneficial purposes such as beach nourishment. The remaining 20 percent, the finer particles, contained the contaminants. The specific aims of the aforesaid ARCS program were to measure concentrations of contaminants at chosen sites on the Great Lakes, to determine ways of gauging the effects of these concentrations on aquatic life, to recommend ways to measure risks to wildlife and to human health posed by the contaminants, and to test technologies that might be used to clean up the sediments[11]. However, these processes and techniques should be assessed for their economic viability with regard to space and time.

CONCLUSION

Sediments are integral and inseparable part of river basin. Any environmental programme aimed at conserving the river water quality would remain incomplete without the proper study of sediments. Therefore, the prevention of sediment pollution is very important. Various measures for checking the sediment pollution have been suggested. However, the simplest course and comparatively easily feasible method is to divert the effluent nullah and drive the dirty water elsewhere and/or to treat the harmful pollutants at the source.

Management of the contaminated sediments has well been realized by the demand driven 'European Sediment Research Network' [www.sednet.org], however it deals with the management of the contaminated sediments of European countries. Similar approach is much required in our country also.

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DO YOU KNOW ?

Q1. Where does the sun rise in the west and sets in the west ?

Q2. Which martial arts name means 'skill' ?

Q3. In cooking which oil is known as liquid gold ?

RAINWATER HARVESTING : MANAGING WATER SCARCITY

Mintul Ali* and Saurabh Sarma**

"Be under no illusions: the impact of general water shortage is going to hit our cities. In the 21st century, wars will be fought over water."—says former UN Secretary General Kofi Anan. The food security and quality of life of people are closely related to water. The growing water shortage is bound to hit Indian Agriculture. Access to safe water should be a basic human right and it can be ensured by adopting various measures like watershed management through rehabilitation of existing systems like tanks, construction of check dams and rain water harvesting. Among the different water management techniques, rain water harvesting is gaining favour but it is yet to become an essential part of day to day living for which mass awareness and group action necessary can be promoted by different committees, societies, NGOs, self help groups etc.

INTRODUCTION

Sustainable water use is the need of the day as water scarcity will be the defining condition of life for many in this century. Almost 85% of the drinking water needs are today met from ground water which forms only 5% of total ground water extraction. Irrigation accounts for 85% of all ground water extraction and the remaining 10% is utilized by other sectors including industries[1]. Rapid development of ground water based irrigation in many states has caused ground water depletion. The first deteriorating situation of fresh water availability is gradually acquiring more dangerous and fear-provoking dimension of worsening water quality due to falling of water tables especially in urban areas. The fall of water tables signals severe problems in future agriculture production. According to the International Water Management Institute about 250 km^3 of water are extracted for irrigation each year in India, of which the rain put back around 100 km^3 only, resulting in gradual depletion of the aquifers[2]. To cope up with global water scarcity, United Nation's General Assembly in 1992, declared March 22nd as World Water Day to create awareness of the problem amongst individuals and communities. India also has joined other countries across the globe to deal with this huge problem. A survey conducted by the Tata Institute of Social Sciences (TISS) showed that 50 lakhs households in Mumbai, Delhi, Kolkata, Hyderabad, Kanpur and Madurai are water deficient.

It is well known that only a small fraction of rainfall reaches and remains in the soil long enough to be useful to crops while up to 70% goes waste as it runs off the fields[3]. Thus poor crop yields and crop failure or shortage of ground water are not so much the result of low rainfall but of too much wastage of valuable rainwater. Over the years, the policy makers have recognized the importance of runoff and some villagers have shown the way of managing rainfall by harvesting it for their drinking and irrigation purposes.

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Considering the situation of water resources today, it is desirable to augment water availability threefold by 2050 and improve its quality to desired levels by drastic changes in our water management strategy. The usual approach of augmenting water availability through major, medium and minor irrigation schemes has its own techno-economic limitations. The main problem is not only the collecting and storing water in huge quantities but also that of providing it within easy reach of the large rural population spread over 14.22 lakhs of rural habitations of India[3]. Our experience of thousands of years since the dawn of civilization has shown that minimum water requirements of every household anywhere can be easily met by the traditional methods of collecting rain water locally in village/community ponds and large man-made containers, diverting and storing water from local streams/springs and tapping sub-surface water below river/stream beds. These basic techniques have been successfully applied in many different ways by the people of different parts of the country depending upon the local climate, soils and rocks, both above and below the land surface, and the nature of land forms *viz*. plains, hill slopes, hill tops, valleys, plateaus, etc. These traditional methods of rain water harvesting are eco-friendly and the villagers themselves can easily adopt it at affordable cost to meet the present water scarcity especially in agricultural crop production and its allied sectors. Considerning the present scenario, an attempt has been made to collect information for enhancing the yield of water sources in the country.

TECHNIQUES OF WATER HARVESTING

The main and most important technique of rain water harvesting is 'rainwater storage on surface'. This is a traditional technique and various structures used here are underground tanks, check dams, weirs, etc.

Since, the agro climatic condition, the regional hydrogeology, local tradition and customs for the country are varied, it is very difficult to prescribe a single type of rain water harvesting structure for its sustainability. Therefore, one must consider different types of options available by which one can harvest the rain water. These options include the following.

- Roof water harvesting
- Diversion of perennial springs and streams water in to the storage strucutre
- Village pond / tanks
- Collection from hill slopes
- Contour bunding and trenching
- Check dams
- Gully plugging
- Percolation tanks
- Sub-surface dams
- Nadi and Talab (River and Ponds)

In an experiment conducted by ICAR Research Complex for North Eastern Hill Region, Umiam, Meghalaya it was found that preparation of *Jalkund* (water storage tank) is very useful for sustainable rain water harvesting especially in the northeastern hill region. Though, the region is characterized as a high rain fall zone of the country it suffers from water scarcity in certain times of the year due to its topography. The farmer of this region investing in micro water harvesting structure like *Jalkund* and its recycling can increase productivity and diversify their farming activities by growing high valued crops and rearing livestocks. The site of the *Jalkund* is selected at high ridges of crop catchments area where only direct precipitation is allowed during water harvesting period. Before onset of monsoon, the *kund* is excavated and its bed and lining is smoothened properly by plastering with mixture of clay and cow dung (in a ratio of 5 : 1). After this, the lining materials like low density polyethylene agri-film is used to check the seepage loss. Care should be taken to prevent damage to the lining material for which cushioning material such as soft grasses, pine leaves, etc. should be used below the

lining material. The *kund* is covered with thatch to avoid the evaporation loss of water particularly during off seasons.

'Recharge to sub surface/ground water' is another new concept of rain water harvesting technique and the structures generally used are pits and shafts, trenches, hand pumps, wells, contour bunding, contour trench, basin/percolation tanks, etc.

BENEFITS OF RAIN WATER HARVESTING

Rain water harvesting systems, which can easily be constructed with locally available materials and labour, are eco-friendly and help the individuals/ community to collect and store water within their reach. Besides assuring continuous and reliable access to water, the surface water storing also improves the yield of hand pumps and wells. Rain water is free from any pollution and, hence, provides good quality water in areas where ground water is contaminated. In fact, due to softness, rainwater can significantly reduce use of detergents and soaps needed for cleaning and water heaters and pipes become free from any deposits due to softness of rain water. It also promotes the feeling of self sufficiency among the people and fosters an appreciation for water as a resource and encourages conservation (Figure 1).

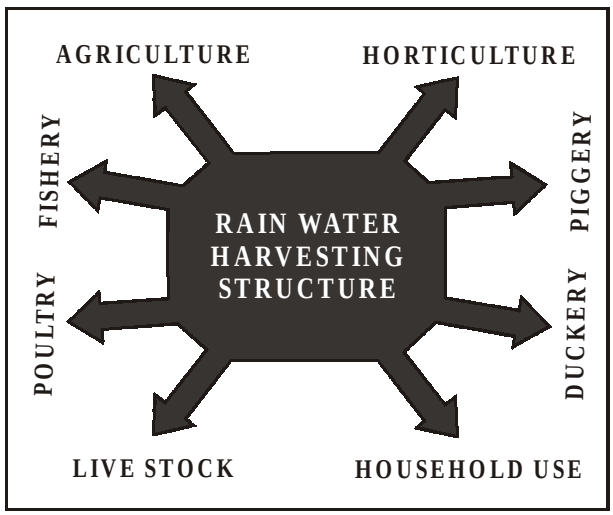

Fig. 1 Diversified use of Rain Water Harvesting Structure

The prime weakness of this system is the dependence on quantity and frequency of rainfall. During dry weather or prolonged drought the system may fail. The stored water may be polluted due to dirty catchments area or even industrial pollution may also reduce the quality of rainwater. Care/ treatment should be given so it does not become the breeding ground of mosquitoes or it is not contaminated by children and other domestic animals. Proper knowledge about the treatment of the stored water is a must to supply safe drinking water.

IMPLEMENTATION STRATEGY

The water harvesting system requires group action in a participatory way by committees, societies and the community with financial assistance from government and financial institutions. Its implementation can be best done through watershed management approach for initial decision making, planning, designing, construction, supervision, operation and maintenance, monitoring and evaluation of the constructed systems. The various state or central institution on water need to be associated to provide advise on scientific and technical issues. For participatory implementation and monitoring of the systems, mass awareness, self help groups, micro watershed management committee, etc. are very much essential. Depending on the agro climatic situation and various factors related to water, different water harvesting models should be evolved and techniques should be conveyed to the local people in local languages. The success of the systems mainly depends on operation and its maintenance. The post implementation monitoring and evaluation help in assessing the efficiency of systems and the benefits accrued by the community.

CONCLUSION

Rain water harvesting is a focused area of sustainable agricultural production, but attention should be paid for efficient management of the

available water resaurces. Although, rain water harvesting techniques appear to be simple but, the full benefit could only be gained by adopting a scientific approach of implementation together with community awareness, their involvement and legislative measures for protection of ground water from over exploitation. Harvesting of rainwater should be made mandatory so that the water stored could be used for other than drinking purpose. Of course, there is no more water than before, but local harvesting does seem to be a key to using it more efficiently on sustainable basis. With a good programme of harvesting rain water, one can avoid droughts even in times or places considered to have low rainfall.

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DO YOU KNOW ?

Q4. How many animals do the Americans kill each year to fill their stomach ?

Q5. In Japan what does Karishi mean ?

Q6. If you feed hen regularly marigold flowers, then will the yellow of the egg be more yellow ?

VETERINARY MEETS MEDICAL SCIENCE TO TACKLE HUMAN CANCER

R. V. S. Pawaiya and Ram Kumar*

Complete sequencing of dog genome recently has revealed startling evolutionary similarities with humans, bringing a turning point in the way of cancer research. Comparative oncology is the talk of the day, wherein spontaneously occuring dog cancers, most of which are similar to those of humans, will be studied to understand biology and cancer drug development and trials for quick usage in humans suffering from cancer. The situation in India with respect to comparative oncology is also discussed.

INTRODUCTION

Research in veterinary and animal sciences has always been the backbone to yield information for understanding the biology and disease processes in the humans. The research in cancer using laboratory animals has so far generated voluminous information and understanding of cancer, however, its application in treating and preventing the human cancer has been utterly unsatisfactory.

It appears that time has come for the veterinarians to play a significantly contributory role in treating and controlling human diseases, especially cancers. Veterinary pathologists have consistently suggested since the beginning that occurrence of neoplasms in domestic or pet animals is particularly similar to those occuring in humans, with respect to myriad of factors involved in its aetiology including environment, food and water. The inclusive approach in investigations of medical oncology would be immensely helpful in addressing various human cancers. However, medical fraternity continued to ignore the factual 'essence' underlying the arguments and rather preferred laboratory animals including mice, rats, rabbits, guinea pigs and hamsters as model animals to study various aspects of cancer, carcinogens, carcinogenicity and carcinogenesis. Traditionally, the cancer research including risk assessment to humans has been evaluated through experiments in laboratory animals or epidemiology studies in people. Although laboratory studies have advantage of being controlled experiments, their practical utility as an indicator of human risk is limited by the uncertainties of extrapolating from laboratory animals to human and from high doses to those typically experienced naturally. Similarly, epidemiological studies to evaluate human cancer risks directly at the exposure levels present in residences or environment are limited by their potential for misclassification, biased recall and uncontrolled mix-ups, as long time intervals involved between exposure and diseases have

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marred accurate recall, resulting in confounding[1]. The extensive research in cancer for about half a century has yielded an unprecedented amount of information and understanding of cancer and cancer cells. However, the translation of this knowledge into treating cancer patients and saving lives has been depressingly slow. On cancer therapeutic aspect, several drugs have been discovered which prevented and eliminated experimentally-induced cancers in laboratory animals, but when it came to human application, the much touted compounds have failed miserably and generally consistently. The rodent animal models, projected to imitate cancer in human, have not measured up to the expectations. This has forced the researchers to look for some alternative approaches to beat the dreaded disease. Intense activities are going on among cancer researchers in western countries to include veterinary oncology. Particularly dog cancers are studied as model for understanding tumour biology as well as drug development and trials for ultimate use to treat human cancer.

COMPARATIVE PATHOLOGY

The valuable observations in veterinary pathology in the past have helped in learning more about the diseases of man. This gave rise to a new term "comparative pathology", which was defined[2] as "that branch of pathology which emphasizes comparisons of disease phenomena between various species, usually with the ultimate objective of learning more about the diseases of man, but at the same time with an intrinsic interest in diseases of anomen (the pleural of anoman, the Leaders' acronym for animals other than man). Obviously, comparative pathology embodies more than veterinary pathology, which is one of its two major non-medical components, the other being experimental pathology.

During early periods of disease understanding, particularly of infectious diseases, comparative methods were recognized as an essential approach to the study of human diseases. In this context, the remarks by Theobald Smith made to the Pathological Society in Philadelphia in 1900 that were quoted by the discoverer[3] of viral fibroma and papilloma in rabbits, in his address on the occasion of 75th anniversary of the School of Veterinary Medicine in Philadelphia, are worth mentioning :

"Man frequently attempts the conquest of problems from the least accessible quarter. This is true of that stage in the development of medical science when the human species was the chief object of study. Within the past two or three decades, medicine has been gradually and almost unconsciously drifting towards animal pathology as the chief, if not the sole, means of clearing up the greater doubts which a broader science inevitably brings with it. We have lately definitely reached this second stage, the study of the more accessible, more varied diseases of animals. The preparations for this stage date well back, and the most conspicuous investigators of human pathology have always had a yearning towards the rich fields of animal pathology."

Early successes in the field of infectious diseases by using comparative methods were contributed by medical, veterinary and other scientists including the illustrious names of Koch, Salmon and Pasteur. This first flush of success followed by a kind of lull, however, the explorations for animal models of human diseases increased during seventies, particularly in fields of toxicology, hereditary and congenital defects, immunological abnormalities and chronic degenerative diseases.

COMPARATIVE ONCOLOGY

Like comparative pathology, it certainly implies that comparative oncology encompasses more than veterinary oncology. A working definition of comparative oncology could be formulated on the lines of that given for comparative pathology[2]. Here, veterinary oncologists use naturally occurring cancers in pet animals (dogs, cats, birds and other

household pets) as surrogates of human cancer risk and to better understand and treat cancer in humans.

The first real interest in animals in relation to cancer is reflected in studies (from 1700s) of their possible susceptibility to transplantation of human tumours[4]. Predictably, such attempts failed to produce any results. A transient investigational sparkle came in 1802 in London when the Medical Committee of the Society for Investigating the Nature and Cure of Cancer[5] formulated their thirteen questions, which show an exceptionally prescient and piercing thought. Notably, one member of the Committee was Dr Everard Home, an examiner at the London Veterinary College. The Committee's tenth question was : 'Are brute creatures subject to any disease resembling cancer in the human body ?' An explanatory note attached to this query reads :

'It is not at present known whether brute creatures are subject to cancer, though some of their diseases have a very suspicious appearance. When this question is decided, we may inquire what class of animals is chiefly subject to cancer : the wild or the domesticated ; the carnivorous or the graminivorous ; those which do, or those which do not, chew the cud. This investigation may lead to much philosophical amusement and useful information ; particularly it may teach us how far the prevalence or frequency of cancer may depend on the manners and habits of life. As establishments are now formed for the reception of several kinds of animals, and as the treatment of their diseases has at length fallen under the care of scientific men, it is hoped that the information here required may be readily obtained. If animals which live only on herbs, and never drink any liquid other than water, prove to be the least or not at all susceptible to cancer ; such proof may, in many cases, become a guide in practice.'

It is wonderful to look foreshadowed here what has come to be the conspicuous fact about the occurrence of tumours in different species of animals, species-wise variability in occurrence, even allowing for the fact that many are killed young for food, and also the hint that epidemiology is likely to be one of the most rewarding disciplines for the approach to comparative oncological studies.

Notwithstanding, animal cancers were given least attention during the nineteenth century, although some tumours that are still present, such as mammary tumours of bitch, were well known than. A Russian veterinarian Nowinsky in 1876 drew the attention towards the transmissible venereal tumour of the dog, which passes through coitus from male to female and vice versa and behaves like transplant derived from a single clone of cells. The tumour shows an abnormal but specific karotype, typically of 59 chromosomes, of which 17 are metacentric and 42 are acrocentric, as compared with the 78 of normal dog kidney cells, all of which are acrocentric except two sex chromosomes. In a recent study[6], blood samples were analyzed from 16 cancer ridden unrelated dogs from five different continents through forensic DNA analysis and showed that all the venereal tumour cells were originated from a common ancestor cell which was not from the dogs themselves. Comparing tumour cell DNA with dog DNA from reference samples held by US Kennel Club and Crufts, it was deduced that most likely it originated from a cancer in a single wolf or an "old" East Asian dog breed closely related to a wolf, such as husky or Shih Tzu which lived between 200 and 2500 years ago. The transmissible venereal tumour spread like wildfire thereafter from dog to dog through coitus, licking, or biting, the cancer cells themselves acting "parasitically" on each infected animal. Also, heavily disrupted chromosomes on tumour cells seem to have ceased further fragmentation and became "stable". The tumour can be readily transplanted subcutaneously into dogs, even by single cell suspension. Both as a spontaneous and a transplanted tumour, it tends to regress spontaneously after a while, particularly when transplanted into healthy adult dogs. However,

it could be metastasized when transplanted into pups, and may provide a useful experimental subject for therapeutic trials. The tumour is known to be markedly radiosensitive.

Discoveries of viral neoplasms avian leucosis by Ellerman and Bang in 1908 (Bang being a veterinarian) and Rous sarcoma in 1910, resulted into intense activity in virus cancer research that we have seen in the form of revolutionary discoveries of several cancer causing oncogenes for which J. Michael Bishop and Harold E. Varmus won 1989 Nobel Prize. However, many investigators questioned the truly neoplastic nature of the Rous sarcoma.

The ever growing interest of veterinary pathologists in the tumours of animals for about last four decades is evident by the great increase in published papers. The reasons being the expansion of number and size of Veterinary colleges, state-of-the art Veterinary Hospitals and Pet Clinics, increase in veterinary pathological investigations in general and increased interest and concern of animal owners leading to a call for greater use of and accuracy in histopathological and other methods of diagnosis. Again, dogs and cats which are major source of animal tumours, being a pet in many countries are allowed to live out their full life span under quality veterinary care and vaccination. Closer involvement of veterinary clinicians in diagnosing and treating animal tumours has compelled veterinary pathologists to make closer studies of these tumours to improve diagnosis. The study of spontaneous tumours in animals is fully justified for its own sake. The significance of such comparative studies was recognized, albeit slowly, by cancer research workers as evident from WHO histological classification of animal tumours that runs almost parallel to that of human tumours, a tangible outcome of WHO mediated meetings of medical and veterinary investigators[7] (WHO, 1974). The World Health Organization's Series on Tumors of Domestic Animals provides a sound basis for comparative oncology and to advance veterinary pathology by providing a widely accepted standard nomenclature of tumors of domestic animals and currently its second edition (2007) is available.

Noting high frequency of mammary cancers in canines, Mulligan in 1975 suggested that the incidence of mammary tumours in dogs should be investigated in countries with high (U. S. A.) or low (Japan) risk of human breast cancer. The importance of comparative oncology was emphasized, apparently for the first time, by renowned veterinary pathologist, Professor E. Cotchin of Royal Veterinary College, Hertfordshire, U. K. in his presidential address to the meeting of Royal Society of Medicine on 10 March, 1976, where, alongside certain constraints, be had brilliantly outlined the merits of studying spontaneous tumours in animals and their utilization for epidemiological, therapeutic studies and as environmental and dietetic risk assessment monitors for human populations[8].

RECENT DEVELOPMENTS

Pet dogs can reveal much about human cancers, not only because of animals' tendency to get afflicted with the same type of malignancies that affect people, but also mimic metastasis of cancer just as in human cancers. Spontaneous cancers in dogs are an underused group of naturally occurring malignancies that share many features with human cancers such as mamary carcinoma, osteosarcoma, prostate carcinoma, lung carcinoma, non-Hodgkin's lymphoma, melanoma, soft tissue sarcoma, head and neck carcinoma, mouth cancer, bladder cancer and virally induced lymphomas. Many of these cancers have strong similarities to human cancers including histological appearance, tumour genetics, biological behaviour and response to conventional therapies. Several histological types of canine mammary tumours resemble those that occur in human breast cancer with similar metastatic and prognostic behaviour. Like in humans, mammary and prostate cancers in dogs frequently metastasize to the skeleton, facilitating a golden opportunity to

study these cancers in dogs to understand the interactions between cancer cells and bone tissue favouring metastatic colonization.

Canine mixed mammary tumour could be a better morphological model for the human mixed salivary tumour and its great content of proliferating myoepithelium could have interesting significance. Osteosarcoma of dog which affect the limbs of larger dogs, upper humerus, lower radius and lower femur, almost ditto mimic those occur in youngster humans. There was time when diagnosis of osteosarcoma in a teenager meant amputation of the affected limb or else death. One can witness beautiful limbs of young teenager boys and girls that were amputated due to this killer cancer and preserved in the Cancer Institute, Adyar, Chennai. Today, limb amputation can be avoided by chiseling out the cancer affected bone tissue and replacing it with a bone graft or metal implant, a process initially tried and perfected in dogs by veterinary oncologists at American university. The credit goes to them that a significantly higher percentage of osteosarcoma affected teenagers can be cured today. Similarly, nonsteroidal anti-inflammatory drugs (NSAIDs), which in general shows remarkable anticancer activity against several canine tumours, especially canine bladder cancer, is now being used for clinical trials in human bladder cancer. The compressed course of cancer progression seen in dogs allows timely assessment of new cancer therapies.

Companion animals could serve as sentinels or "watchdogs" to identify lowly carcinogenic substances in our homes and surroundings as the disease will appear first in pets due to their compressed life spans, well before people, thus assisting in preventing human cancers by allowing ample time to take corrective or remedial measures.

Realizing the importance of comparative oncology, developed countries have begun, though belatedly, establishing pet tumour registries. The first comprehensive pet tumour registry was begun in California in the late 1960s, but the project was not emulated and idea languished. More recently, Cornell College of Veterinary Medicine and the Animal Cancer Foundation started a pilot programme to monitor cancers in dogs and cats. There are about 70 million pet dogs in USA of which about 10% are diagnosed with naturally occurring tumours. Majority of these dogs are seen by veterinary oncologists in private practices or at teaching hospitals, using therapies similar to those for humans such as surgery, chemotherapy, radiation therapy and biotherapy. The inclusion of this large number of dogs suffering from cancer in the study of human cancer is the 'essence' of comparative oncology. This pivotal field is bringing together the work of veterinary oncologists with medical oncologists, the pharmaceutical industry and academic cancer research centres with the vibrant hope of improving understanding of the biology of cancer and lead to improved cancer treatment options for both dogs and humans.

After about three years of groundwork and planning, National Cancer Institute (NCI) of America has recently launched the Comparative Oncology Programme headed by Dr Chand Khanna, a veterinary oncologist. The $ 1.2 millin programme at NCI's Centre for Cancer Research incorporates an integrated approach to drug discovery and development by using the knowledge of the recently sequenced complete dog genome[9] as well as many newly established centres for dog trials in an effort to achieve three pronged aims : The first is to develop a set of reagents, including oligonucleotide microarrays and proteomic assays, to help predict drug toxicity, efficacy, and mechanism of action in dogs. It relies on the pronounced genetic similarities between man and dog, which should result in a highly predictive model for human application. Second, like human clinical trials cooperative groups, NCI has established a multicenter Comparative Oncology Trials Consortium. The scientific and clincal leaders from human and veterinary oncology have come together to form a

multidisciplinary consortium, the Canine Comparative Oncology and Genomics Consortium (CCOGC) to initiate and facilitate collaborative efforts and exploit the opportunities provided by the dog in cancer research. The multicenter Consortium involving top-tier veterinary oncology institutes will collaborate using standardized protocols to take following actions (i). Develop a robust and well-annotated biospecimen repository of canine cancers and tissues, as funding of a large, accessible biospecimen repository is difficult using existing resources, (ii). Improve opportunities to link the efforts of veterinary and comparative oncologists with the work of basic cancer researchers and clinicians and (iii). Initiate non-clinical trials using pet dogs with cancers that are integrated into the development path of new cancer drugs. Mechansim development for review of these non-clinical trials in such a way that information from these studies, where appropriate, may help to focus the scope of early human clinical trials. Until now, non-clinical studies in dogs with cancer under programme have answered questions that would have been difficult or impossible to answer in either mice or humans. This will also provide opportunity for the early evaluation of new therapies for dogs suffering with cancer. Third and finally, it is essential to increase awareness of the suitable use of 'naturally occurring cancer models in pet dogs' within the cancer research community.

Until recently, a significant weakness in the study of cancer biology in canine cancer models has been the availability of reagents. With the realization of the need for more useful animal models in human cancer, the completion of the canine genome sequence, the increasing availability of dog-specific biological reagents and investigative methodologies, (e. g. antibodies specific for dog proteins or dog-specific oligonucleotide arrays) and the interest of the animal health biotech and drug industry, there is no doubt that this programme with new approach throws opportunities for veterinary pathologists and oncologists to fully exploit the many advantages of the dog in cancer and drug development research.

WHERE INDIA STANDS

It appears that veterinary oncology is least developed in India. The education in Veterinary Colleges as well as animal health research programmes and policies of the country prioritize and emphasize only on the economically important diseases of domestic animals. The work on non-infectious diseases like tumours is always viewed with skewed mindset and more often than not weighed against the economic viability of the animals.

The scenario of cancer incidences in India is unclear as there has not been any systematic study at national level to find out specific pattern of cancer occurrence in animals. However, appearance of increased Indian publications on animal cancers, albeit isolated and sporadic, points to the increased frequency of tumour occurrence. A twenty year survey study in Madras State (1945–1964) reported 4.9% lymphoid neoplasms 82% male and 18% female in dogs, whereas a study by Mukhopadhyay and Som in 1990, on 136 canine tumour cases from Calcutta, revealed highest incidence of skin tumours (42.6% followed by tumours of genital organs (23.5%), mammary gland (20.6%) and other organs (13.2%). Shekar (2001) in Bangalore recorded 59 malignant tumours out of total 72 canine mammary tumours. In Mumbai, Adak (2005) found 33.14% mammary tumours out of 347 canine tumour cases, and studies on canine neoplasms at IVRI, Izatnagar, Bareilly revealed highest incidence of mammary tumours (41.6–60%) followed by skin (14.8 to 40%), venereal (18.1%), vaginal (14.5%) and testicular (6.2%) tumours[10, 11, 12]. It is evident from these data that such increased and precise diagnosis of tumour cases, particularly in dogs could have been possible because of increasing urbanization, awareness and living status of people with consequent increase in the interest in pet animals, and also demand for better veterinary

services. Dogs were never included in the country's national livestock census until 1982 when their population stood at 18.54 million, increased to 29 million in 2003, out of which 16.7 million (57.59%) being domestic (licensed) dogs and 12.3 million (42.41%) others[13].

CONCLUSION

With the advent of comparative oncology focusing on the striking anatomical, genetic and biological similarities between canine and human cancers, useful results were obtained in clinical trials in dogs, designed to extend life or cure or prevent disease by identifying carcinogens, which became the foundation of human studies. It has become imperative to intiate such research programmes in our country for the ultimate benefit of both dogs and their owners. The need of the hour is to initiate and streamline the establishment of Pet Tumour Registries on the line of National Cancer Registry Programme of Indian Council of Medical Research initiated in December, 1981 for collection of authentic data on human cancer, which currently have eight urban, two rural, four urban-cum-rural and five hospital based registries[14]. Presently, the only Registry of Veterinary Pathology and Oncology (initiated in 1985 with the aim to establish repository of pathological alterations, their proper documentation with illustrative material of different animal diseases including tumours) of the country is functioning at the Indian Veterinary Research Institute, Izatnagar, Bareilly, U. P. Although carrying out its objectives to the best possible level, lack of adequate funds, resources and infrastructure have severely constrained the lonely Registry to perform to the expected level and potential. Even so, it offers a good starting point to move ahead and transform into an exemplary Comparative Oncology centre in the quest of cancer research as well as to keep abreast with the contemporary cancer research development.

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AROMATHERAPY–A FRAGRANCE OF GOOD HEALTH

Papiya Mitra Mazumder, Subrata Ghosh and D. Sasmal*

Aromatherapy can be defined as the art and science of using essential oils to relax balance and stimulate the body, mind and spirit. Essential Oils are the volatile aromatic essence produced by hundreds of aromatic plants. This article discusses the role aromatherapy can play in reducing stress and pain levels and also making the environment pleasant.

INTRODUCTION

The word "Aromatherapy" (aroma : pleasant odour ; therapy : treatment) was first coined by French Chemist Rene Maurice Gattefosse in 1910 after he experienced the power of lavender oil to heal a burn he had suffered during a laboratory accident. The term is a bit misleading since the aromas of oils, whether natural or synthetic, are generally not themselves therapeutic. It is the "essence" of the oil–it's chemical properties–that gives it whatever therapeutic value the oil might have. The deliberate use of aromatic material is probably as old as the human race with references to it's religious, medicinal and sensual use in many ancient texts. Hence "Aromatherapy" can be defined as the art and science of using essential oils to relax, balance and stimulate the body, mind and spirit.

WHAT ARE ESSENTIAL OILS ?

Essential Oils are volatile aromatic essence produced by hundreds of aromatic plants by the process of photosynthesis. In some countries they are called *olea aetherea* and are usually composed of solid portion known as stearoptene and the liquid portion known as eleoptene. Some of the stearoptenes are of commercial importance (e.g. thymol, camphor and menthol). Essential oils are generally obtained from plants by distillation with steam distillation *per se*, expression and extraction. Aromatherapy distillation requires correct balance of time and temperature to release the most valuable molecules from the aromatic plant material without destroying them. This careful distillation can take a much longer time, but it allows the plant to release it's full depth of aromatice complexity.

Essential oils commonly used are :

- Anise oil
- Caraway oil
- Cardamom oil
- Cinnamon oil
- Clove oil
- Coriander oil
- Eucalyptus oil
- Fennel oil
- Geranium oil
- Lavender oil
- Lemon oil
- Nutmeg oil
- Orange flower oil
- Peppermint oil
- Pine needle oil
- Rose oil
- Spearmint oil
- Sandalwood oil

APPLICATIONS OF AROMATHERAPY IN DAILY LIFE

- **Massage :** A massage is great, but an Aromatherapy Massage is even better ! Adding essential oils to a massage oil or lotion opens up

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new dimensions of therapeutic possibilities. For example, to help combat respiratory problems like coughing and congestion, add a bit a Eucalyptus oil to your carrier oil. To help relieve stress and tension, Lavender oil is a good choice.

Oils Recommended for any massage therapist : Lavender, Peppermint, Eucalyptus, Orange, Rosemary, Lemon and Geranium.

● **Bath :** Relax and enjoy an Aromatherapy bath by adding a few drops of your favorite essential oil !

Fill the tub with warm water, and then add your oil just prior to entering. Close the doors to keep the aroma in the room while bathing. The warmth from the water will gently encourage the evaporation of the oil and envelope you in its aroma! For extra moisturizing, combine essential oils with carrier oils, such as, Sweet Almond or Jojoba before adding to the bath. Jojoba is an excellent choice for making bath oil since it does not leave a "bath-tub ring."

● **Inhalation :** With a drop or two of essential oil on your palms, rub them together to produce a little heat, then cup your nose and inhale. Inhalation is excellent to use for a short quick burst of aroma !

● **Sauna :** Take advantage of the cleansing nature of a sauna or steam room by using essential oils. A convenient and recommended method is to dilute several drops of essential oil in a small spray bottle filled with water. Spray on the rocks, in the air, or even on the body. Essential oils, like Eucalyptus are excellent to use in a sauna to help clear respiratory congestion. Since most essential oils are flammable, use some caution.

● **Compress :** Add a few drops of essential oil to the water collected in a basin. Dip a folded cloth into the water then ring out any excess before applying to the affected area. Heat will intensify the effect of essential oils.

● **Facial Steam :** Place a few drops of essential oil into a basin of steaming water. Gently stir the water to disperse the oil. Place a towel over the basin and your head. Move your face over the aromatic steam with your eyes closed. Breathe deeply and let the aromatic steam open and cleanse the pores of your skin. This application is excellent for facial skin care and for the respiratory tract.

● **Environmental Fragrancing :** Using essential oil aroma is a more healthful way to add fragrance in any room and offers an alternative to the use of synthetic aromatic chemicals. In addition to the aroma, the oils can be selected to enhance a mood or stimulate a discussion. Diffusing lavender before bedtime is a wonderful way to relax and prepare for a good night's sleep. Rosemary and lemon are more energizing and can help you stay awake while cramming for an exam.

● **First Aid :** Many essential oils have some very practical applications. Lavender is known to reduce the pain and swelling of small burns. Tea tree oil is excellent first-aid for cuts or bites to avoid infection. Canker sores often disappear overnight after applying a drop of tea tree oil. Peppermint oil is an excellent choice to rub on the back of your neck if you have a tension headache. It is also useful to cool "hot flashes" and reduce nausea.

● **Natural Perfumes :** Essential Oils are Nature's Perfume and the fresh aroma has added therapeutic benefits. For example, the Essential Oil of Rose is hormonally balancing and promotes a sense of well being and confidence. Of course, there are a few oils that could be worn as "single notes", but the joy of blending can create a fragrance that is personal and powerful. Sandalwood is a lovely base note to blend the more exquisite florals, like Rose, Jasmine or Tuberose. This actually creates what are known as "Attars." After combining the essential oils into a personal natural perfume, many people add Jojoba Oil. This helps to extend the use of your perfume and it can be

applied directly to the skin without being too strong, or irritating. Jojoba is a good choice to use with natural perfumes because it will not go rancid like a vegetable oil carrier will do.

● **Infant Massage :** Infants who are massaged seem to benefit greatly from a stronger immune system, faster development and the sense of love that is nurtured during the massages. It is recommended that only mild essential oils, such as lavender, in lower concentrations (1-2%) are used on babies.

● **Pregnancy :** In addition to the known abortifacients, most sources recommend to avoid essential oils that affect the hormonal system and are emmenogogues (promote menstruation). Peppermint oil has been found to be useful in alleviating the nausea of morning sickness. Its cooling action may be of comfort during the final weeks prior to delivery, especially during the summer months. Jasmine is suggested to help form the bond between mother and child after the birth. A daily massage on the belly with jojoba, sweet almond, grapeseed or rosa rubiginosa can help reduce stretch marks by keeping the moisture and elasticity of the skin.

COMMON RECIPES OF AROMATHERAPY

These need mixing of various oils in a carrier oil.

For Headaches : Mix 5 parts Lavender with 3 parts Peppermint and 1 part Roman Chamomile.

For Meditation : mix 5 parts Sadalwood with 3 parts Frankincense and 2 parts Myrrh.

Stress Relief : Mix 3 parts Bergamot with 2 parts Lavender and 1 part Sandalwood.

Pain Relief : Mix 5 parts Camphor with 3 parts Cinnamon, 2 parts Black Pepper and 1 part Clove Bud.

Mental Clarity : Mix 5 parts Lemon with 3 parts Rosemary and 1 part Basil (optional)

For Hair and Scalp : Mix 3 parts Lavender with 2 parts Rosemary and 1 part lemon Jojoba.

PMS Relief : Mix 5 parts Geranium with 3 parts Clary Sage and 2 parts Ylang Ylang.

Sensual Blend : Mix 5 parts Jasmine with 3 parts Ylang Ylang and 1 part Clary Sage.

PRECAUTIONS FOR SAFE AROMATHERAPY

- Essential oils are recommended to be diluted with carrier oil before using on the skin as they are concentrated and can be irritating to the skin in the concentrated form.
- Essential oils are not recommended for internal use.
- Avoid contact with the eyes. If any oil accidentally gets in the eyes, flush with milk rather than water. The fatty content of the milk will dilute the oil, whereas water will not.
- Avoid camphor, fennel, hyssop, rosemary and possibly other stimulating oils, such as black pepper, cinnamon, clove and nutmeg. Only jasmine has been found to be "the one oil to have consistent anticonvulsant properties."
- Avoid using eucalyptus and oils from the mint family during homeopathic treatment, as they are known to erase the homeopathic blueprint.
- Some essential oils can increase the skin's sensitivity to the sun, causing sunburn and irritation. Hence avoid using prior to exposure to the sun (e.g. Bergamot).
- Avoid essential oils that affect the hormonal system and are emmenogogues (promote menstruation) during pregnancy, e.g. pennyroyal and mugivort.

CONCLUSION

Aromatherapy involves the use of essential oils, all of which are derived from plants. Essential oils can be useful in primary healthcare, for treating minor ailments and disorders, for prophylactic use to prevent the spread of infection. They have proved their efficacy in significantly reducing stress and pain levels. It is interesting to note that both the inhalation of oils and different forms of massage with them produce beneficial effects. Moreover, they make the environment more pleasant. Hence, it is clear that the use of aromatherapy in a healthcare setting holds lot of promise and the need for the day is a scientific and passionate approach to develop this form of therapy so as to become an inseparable part of our daily lives. No wonder Hippocrates said long ago that the way to health is to have an aromatic bath and scented massage everyday.

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DO YOU KNOW ?

Q7. Where was the first Blood Bank established ?

Q8. Who established the first hospital ?

THINKING ABOUT GETTING PREGNANT ? TAKE FOLIC ACID

Nupur Nandi*

Folic acid, a water soluble single vitamin, can prevent many congenital abnormalities of upcoming babies, mainly neural tube defects and some other ailments like anaemia, abortions, pre-term labour if taken by the mother in pregnancy period. However, for getting better result, folic acid should be supplemented 2-3 months before actual conception occurs ; here is the role of building up public awareness regarding importance of folic acid intake by women.

INTRODUCTION

In 1930s, the English physician Dr. Lucy Wills, while working in the slums in Bombay, made a clinical observation i.e. deficiency of a hitherto unknown vitamin (later named as Folic acid/Folate) causes anaemia in young pregnant mill workers.

Later in 1964, another obstetrician Bryan Hibbard felt that folate had a role in early embronic development.

In 1980, Richard Smithells was first to show a role for this vitamin in the prevention of Neural Tube Defects (NTDs).

Folic acid is a synthetic form of water soluble vitamin. The natural reduced form is food folate found in meat, legumes, but is very susceptible to oxidative destruction during the harvesting, storage and cooking of food. Bio-availability of the synthetic form is significantly more than food folate.

Folic acid is now considered as an important factor in reducing chances of NTDs, Megaloblastic anaemia of pregnancy and some other complications like spontaneous abortion, Intra Uterine Growth Retardation (IUGR) of baby, if supplemented mainly in periconceptional (2-3 months prepregnant upto first 12 weeks of pregnancy) period.

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FUNCTIONS OF FOLIC ACID / FOLATE

Folic acid is essential for the production of Methionine, which is a co-factor in RNA and DNA synthesis and is required for methylation of proteins, lipids and myelin. Folic acid is essential for growth, differentiation and repair, hence it is essential for featal development during pregnancy.

Folate deficiency or impairment in genetic folate metabolism is proposed mechanism that cause congenital birth defects like NTDs, cleft lip, cleft palate, cardiac defects.

Effect of folate deficiency in pregnancy also results in anaemia, spontaneous abortion, IUGR, preterm labour.

NEURAL TUBE DEFECTS (NTDS)

The neural plate folds in the brain and spinal cord region fuse in the midline by days 26 to 28 of embryonic life. Neural tube defects likely result from failure of closure in one or more sites. NTDs are second most common congenital birth defect.

World wide incidence of NTDs 1.4 to 2 per 1000 live births. Recurrency risk after one affected

child is 30—40 per 1000 live births and after two affected child is 100 per thousand live births.

NTDs are classical example of multifactorial inheritance-a genetic factor, folate deficiency, teratogen exposure.

TYPES OF NTDs

(a) ***Anencephaly***—is the most severe defect in which the forebrain meninges, vault of skull and scalp fail to form. It is lethal, resulting in stillbirth or early neonatal demise (fig-1)

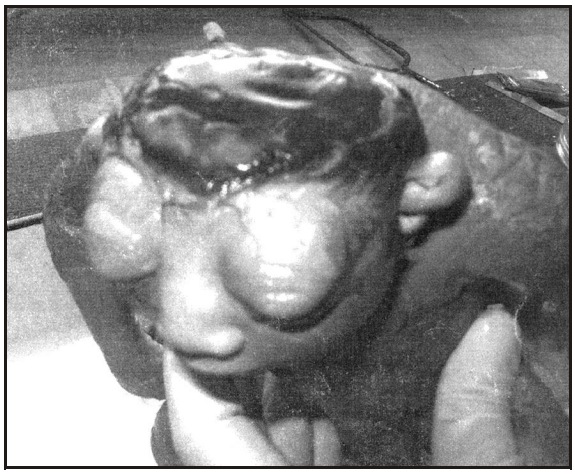

Fig-1 : Child with Anencephaly

(b) ***Encephalocele***—a protrusion of brain tissue, cerebrospinal fluid (CSF) and meninges through a defect in skull.

(c) ***Meningomyelocele***—here spinal cord, nerve roots, meninges, CSF herniates through gap in vertebral body.

(d) ***Meningocele***—here only meninges with CSF protrude through gap in vertebral body.

All types of NTDs create long term problem in the children that require management by a multidisciplinary team and is a huge economic burden to the parent and society.

Diagnosis—of NTDs can be done by prenatal screening using maternal serum AFP estimation and USG, if performed between 15-20 weeks of gestation with 95% accuracy.

No in-utero treatment is available for NTDs and option of termination of pregnancy is unacceptable for some parents.

FOLIC ACID SUPPLEMENTATION

Folic acid supplementation in the periconceptional period, i.e., 2 to 3 months preconception to first 12 weeks of pregnancy, is effective in primary prevention of NTDs.

The UK Medical Research Council (1991) set up a multicentric trial of folic acid in preventing the occurrence and recurrence of NTDs with an outstanding success and they concluded that folic acid taken periconceptionally could prevent majority of NTDs.

In 2004, Wald estimated that Folic acid supplementation (5 mg/day) preconception and continuing till 12 weeks after getting pregnancy reduce the risk of NTDs by 85%. In the women with previous baby affected by NTDs periconceptional use of folic acid decreases the recurrence by 70%. However, the bigger problem to prevent occurrence of NTDs is that about 50% of all pregnancies are unplanned even in developed countries.

These findings led the Centres for Disease Control (1992) and the American College of Obstetricians and Gynaecologists (1996) to recommend that women of all child bearing age (15-45 years) consume at least 0.4 mg of folic acid daily and who had previously affected baby of NTD should consume 4 mg/day of folic acid periconceptionally. Perhaps most disappointing is that even amongst women who knows that periconceptional folic acid can prevent majority of NTDs, compliance is poor since the concept of taking a tablet daily is not accepted when they are feeling completely healthy.

FOLIC ACID FORTIFICATION

Fortification should aim to produce a daily dietary folic acid intake between 0.5 and 1 mg based on the usual dietary practice of women of childbearing age. In Canada, folic acid is fortified

with flour and in UK bread is used to fortify folic acid. Fortification of Food with Folic acid is safe even when taken chronically to a dose as high as 10 mg/day.

PREVENTION OF MEGALOBLASTIC ANAEMIA

Before prophylaxis with folic acid was introduced on a widespread basis in pregnancy, overt anaemia was 1 in every 200 pregnancies in UK and could be as high as 25% of all pregnancies in developing countries. A deficient folate supply may result in impaired red cell formation causing megaloblastic anaemia. Folic acid requirement is increased during pregnancy for red cell growth and division. Prophylactic therapy is given to prevent megaloblastic anaemia in a dose of 400-500 μg/day (0.4–0.5 mg) and should be continued specially in 2nd and 3rd trimesters of pregnancy.

PREVENTABLE AREAS IN PREGNANCY

To reduce the occurrence of other birth defects like cleft lip, cleft palate and congenital heart, folic acid supplementation is advised 400-500 μg/day periconceptionally. For probable prevention of spontaneous abortion dose in same. To prevent IUGR and pre-term labour, folic acid supplementation is advised at a dose of 400-500 μg/day in 2nd and 3rd trimester of pregnancy.

ADDITIONAL RECOMMENDATION

Folic acid is given in higher dose in (a) Multifetal pregnancy (twins, triplets and so on), (b) Mothers wih existing haemolytic anaemia like sickle cell disease. Folic acid along with vitamin B_{12} is recommended for pernicious anaemia, (c) Alcoholic mother and (d) Mother getting antiepileptic drugs (where Folic Acid is metabolized rapidly)

CONCLUSION

Abundance of scientific data based on clinical trials available to the public have reinforced the observation that risk of delivering a child with NTDs significantly decreases with ingestion of periconceptional folic acid. Folic acid is essential also to prevent megaloblastic anaemia of pregnancy, reducing chances of spontaneous abortion and IUGR. In September, 1992, the US Public Health Service made a strong recommendation that all women of childbearing age in US, who are capable of becoming pregnant, should consume 0.4 mg of folic acid per day. Relevant bodies in Canada also recommend this.

Recommendation from the UK Department of Health is that all women, who are planning a pregnancy, should be advised to take 0.4 mg (400 μg) folic acid as a daily medicinal or food supplementation from when they begin trying to conceive until the 12th week of pregnancy. Also, women who are having an offspring with NTD should be advised to take 5 mg (5000 μg) folic acid per day. Finally, even prescribing folic acid should be free of charge.

Hence public awareness "to plan before you conceive and to take folic acid if you plan a pregnancy", should be built up in India also. Fortification of cereals with folic acid requires initiative by Government sector which is promising.

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A GEOGRAPHICAL STUDY ON DRINKING WATER MANAGEMENT IN SHIMLA MUNICIPAL AREA, HIMACHAL

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This study concerns municipal water management system in Shimla. Shimla city has a unique geo-environmental character which is not only shaped by compact territorial interaction with various physical constraints but also people's intervention framed Shimla as a strategic sensitive area. Drinking water is the most sensitive issue for survival of a living habitat. The Summer Capital of British India is now facing a severe problem on drinking water management system. Their suffering is not only related with distribution system but also concerning sources of water under physical and anthropogenic compulsions. The study has immense prospect on applied geography and obviously for the benefit of common people.

INTRODUCTION

"All too often, water is treated as an infinite free good. Yet even where supplies are sufficient or plentiful, they are increasingly at risk from pollution and rising demand... Fierce national competition over water resource has prompted fears that water issues contain the seeds of violent conflict."

—Former UN Secretary-General Kofi Annan

The amount of water present on earth is estimated at about 1.39 billion cubic kilometer, of which only about 2.5% is fresh water. The overwhelming part i.e. 97.5% is sea or brackish water unsuitable for human use. The greatest part of the fresh water, 87.5% is contained in ice caps or glaciers, in atmosphere, on ground or deep inside the earth.

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Safe water supply has risen towards the top of the international development community's agenda. According to a recent United Nations assessment, a global water crisis is being caused because the capacity of the hydrological cycle to supply water is being outstripped by the volume of human demands, pollution of water resources and poor managment. The crisis is apparent from the global to the local scale, not least in third world cities. Although the spatial concentration of large numbers of people, created by rapid urbanization in the second half of the 20th century, has produced a potential for distributional efficiencies not enjoyed by dispersed rural population. Urban water management has often failed to adequately supply large numbers of poorer residents. The estimated number of people without access to water of assured quality in developing world cities rose to 280 million in 1994. About half of those more fortunate urban residents 'with access' were obtaining their water up to 200 m away from home through public standposts and handpumps and dug wells, at varying

costs of money and time for fetching and carrying. Even where supply quantity is reasonable, inadequate maintenance creates waste and contamination through leak-extensions, which are unserviced or receive the drugs of the formal municipal network. People have to make their own informal arrangements using untreated surface water and shallow tube wells, which often prove unsatisfactory because of pollution of domestic, industrial and other unban waste. Urban water governance is in fact highly fragmented.

DRINKING WATER MANAGEMENT IN SHIMLA

This study aims to show how municipal water management in Shimla, Himachal Pradesh, India little changed since the previous time and with an emphasis on supply-side operation. It is ill equipped to deal with long-standing problems of supply inefficiency and distribution inequity. It points to the new model of utility governance in cities of the developing countries with its emphasis on demand-side management, as the potential for effective treatment of these problems.

Shimla City has a unique geo-environmental character which is not only shaped by compact territorial interaction with various physical constraints but also people's intervention framed Shimla as a strategic sensitive area. The suffering for 'Drinking Water' is not only related with distribution system which has immense prospect on applied geography, but also for the benefit of common people.

METHODOLOGY AND FIELD STUDY

The methodology followed in the present research can be divided into three phases. Pre-field method consists of collection of secondary data from reports and government publications. Field includes sample surveys in different wards of Shimla City. In the Post-field method, data so far collected are processed, tabulated and analysed quantitatively and qualitatively. This is followed by interpretation and strategy formulation.

The study area is divided into 25 wards, which are under residential, commercial, industrial or agricultural uses. Survey of the surface water resource was undertaken through an oral questionnaire. For this purpose many senior local person among the group of public service and municipal community were approached and inteviewed. Discussion were also held with senior functionaries of the local associations. Shimla Municipal Authority (Nagar Nigam) supplies details of their water service and records of past and present distribution scenario.

POPULATION SCENARIO OF THE CITY

Shimla and adjoining areas are inhabited by numerous hill people and tribes who lead simple lives in the lap of nature. Shimla has an own history of migrating people from adjoining plains Hariyana and Punjab, mostly after independence of India in 1947. The people of the hills differ from those of adjoining plains linguistically, culturally and economically and they could not develop their potential personalities and standards of living. The "hilly" Himachalis are essentially peace loving and hard-working simple people. But in Shimla, the migrating people dominate the maximum share of resource and control administration and decision-making bodies. Their difference of perception on environment is now a big problem in this region, whether it is an issue of Hotel construction on unstable slope or proper distribution and storage of safe drinking water of common poeple.

Shimla, the 'Mountain City of India' is also one of the largest resorts. It has many large scale constructions since 1851. The linear pattern town lies in an elongated manner from Rashtrapati Niwas on Observatory hill to Jakhu hill. The main road runs all through. Strung along this central belt are main offices, bazars and residences. The central

point lies between Town Hall and Christ Church. The market below, known as *Lakkar Bazar*, is a low narrow congested zone. About 3 km below the ridge, the heart of Shimla, lies annandale, a pretty ground. The reservoir for drinking water for the city is located under catchment area 13 km away. The electric supply is obtained from primarily Chabba power station. Shimla has no large scale major industry, but it is an important commercial centre of Himachal Pradesh.

The land use pattern in Shimla indicates the population composition and concentration pattern of the city. The land use pattern at the time of arrival of the settlers and the present land use pattern in the area are massively different. Survey of India 1921 map shows that 10-12% of the present municipal area were under residential and other construction coverage and rest of the area was under green, covering various slopes of Shimla region.

After 80 years. it is seen, from the Aerial Photo of Remote Sensing Agency of India and Survey of India guide map, that nearly 45 to 50% of the total muncipal area are under residential and commercial use, where as 25 to 30% is under natural area including massive deforestation alongwith greenaries and lastly, rest of the area, 15 to 20% is now under semi-public and public use (or under ongoing constructions). The vacant plots in Shimla, which are indicative of the element of speculation found in such commercial or refugee colonies, where the cost of the land keeps on increasing. Some rich people buy vacant plots and see them from getting higher returns on their investments in future, particularly in New Shimla area.

In 1991, the population of Shimla Town was 112707 covering 52.6 sq. Km. and now the population crosses 1,50,000 after 2005.

Although water is supplied by Shimla Nagar Nigam, many households use other natural sources or are dependent upon high price bucket water for drinking purposes. Homemakers have to wait in long queues to get water or to move a long distance waiting great part of day time.

The mass water crisis creates some unhealthy and unhygenic environment among the lower middle class and lower class residential. Not only health crisis but also many water bourne diseases, including pollution due to lack of cleanliness, affect the living of Shimla poeple throughout the year.

WATER RESOURCES IN INDIA : THE REGIONAL CRISIS

India's economy even in the 21st Centrury will be largely agriculture based. Therefore, the total demand for water is going to increase manifold. The water demand problem is highly uneven both in time and space. The monsoon rain (from middle of June to middle of August mainly) is the main source of ground water almost in the entire country. The distribution of rainfall however, greatly varies. The maximum average rainfall in Western Ghat and North-Eastern India is as high as 250 cm where as, it is less than 30 cm in the desert region of Western Rajasthan state in North-West India.

The groundwater potential essentially depends on rainfall distribution and hydro-geological characteristics of the aquifers. The ground water resource potential statewise in northern region is outlined in Table 1. The entire alluvial tract of Indo-Gangetic basin is the region where ground water has been extensively used for irrigation. However. approximately two-third area of the country is covered with crystalline and basaltic types of hard rocks. The avaliablity of ground water potential in these areas is limited. The search for potential zones of ground water in these types of formations and the management of ground water is a challenging job.

TABLE : 1 GROUNDWATER RESOURCE OF INDIA : NORTHERN REGION

State/ Union Territories	Total replenish-able ground water Resouce (MCM/Yr)	Provision for domestic industrial & other uses (MCM/Yr)	Available ground water resource for Irrigation in net terms (MCM/Yr)	Net Draft (1993) (MCM/Yr)	Balance ground water resources for future use (MCM/Yr)	Level of ground water development (%)	Utilizable irrigation potential for land development (Mha)
Haryana	8527.51	1279.13	7248.38	6079.69	1168.69	83.88	1.46170
Himachal Pradesh	365.81	73.16	292.65	52.80	239.85	18.04	0.06850
Jammu Kashmir	4425.84	663.88	3761.96	50.02	3711.94	1.33	0.70795
Uttar Pradesh	83820.85	12573.13	71247.72	26835.28	44412.44	37.66	16.79896
Punjab	18654.90	1865.50	16789.5	15757.7	1031.8	93.85	2.91715

Source : Central Ground Water Board, 1996

India's considerable development in ground water source since Independence in 1947 has allayed the looming water crisis arising from booming water demand and limited surface supplies, but at the cost of a widespread lowering of freshwater aquifers by up to 3 m per annum. Related changes in the natural environment are now in need of urgent attention. Aquifers have been contaminated, directly and indirectly, in three main ways.

Some Indian states have been notoriously ineffective in their water management. The National Ministry of Environment and Forests is well aware of the nexus of problems surrounding water supply and demand and, in the light of environmental and financial constructions, now acknowledges impracticality of further widespread tapping of new sources. The area stretching from Kashmir to Himachal is one of the most complicated geological regions of the Himalayas. The region falls into four broad stratigraphical zones : (1) Outer or Sub-Himalayan zone (2) Lower Himalayan zone (3) Higher-Himalayan zone and (4) Tibetan Himalayan zone.

Shimla is within the Lower Himalayan zone. The oldest and most characteristic rocks of the Shimla krol belt are the Shimla slates. These rocks are of dark unaltered states and micaceous sandstones. Metamorphosed rocks are overthrust on the Shimla slates.

Actually, underground water storage capacity of any place totally depends on porosity of rocks (by which the area is composed) and permeability which is actually a slope controlled indicator of underground water storage. According to the geological expert and the primary observations, the geological scenario of this area is not favourable for underground water storage and movement.

HISTORICAL BACKGROUND OF SHIMLA

Shimla is a symphony of regal splendour with an occidental passion from her old glorious past. Shimla was founded by British in 1819. Shimla, once and obscure Sanitarium created at the close of the Gurkha Wars after 1815, was the full blown 'Summer Capital' of British India from 1864 (it was the 'crown' of one of the most powerful

Government in the world, the Imperial Government of India. Viceroys and Governors and little tin-gods held the strings of an empire that stretched from Burma in the East to Afganistan in the West). Some called it 'the Workshop of Empire'.

After Independence of India, Shimla shifted from Punjab to Himachal Pradesh as the political and administrative distribution was made on the basis of language. From 25th January, 1971 Shimla became the capital of Himachal Pradesh which was decleared 'full state' from Union territory at that time.

It is believed that Shimla derives its name from 'Shyamla' another name of Goddess Kali where temple was found in a thickly wooded spot on the Jakhoo hill side in the early 19th century when the area was under the rule of Nepal.

No doubt that from the beginning, Shimla people enjoyed the urban atmosphere and good civic amenities due to its own royal services. From 1851, Municipal government was introduced here. In 1881, it had population of 13,258 only and it touched 52,00,000 in 1991.

CLIMATIC SCENARIO OF THE REGION

In the Himachal region, there is much diversification in climate due to variation in elevation(450 to 6,500 m) and aspect. In general, the climate of this area is distinguished from the Punjab plains by a shorter and less severe hot weather, a somewhat higher perspiration and colder and more prolonged winter. The two main climatic characterisitics of the region are the seasonal rhythm of weather and the vertical zoning. The climatic conditions vary from hot and sub-humid tropical in the southern low tracts to temperate, cold alpine and glacial in the northern and eastern high mountains.

Generally, the region experiences below normal monthly maximum temperatures. The highest monthly maximum temperatures are experienced in June after which the temperatures continue to fall and the lowest monthly minimum temperatures are experienced in January. Above 20°C mean marks a hot month. Mandi has as many as 7 hot months while Shimla has none. Normal monthly minimum temperatures are as low as 1.9°C in January at Shimla and 6.5°C at Dharamsala. Similarly, the normal monthly maximum temperatures in June are 15.6°C at Shimla and 22.8°C at Dharamsala. The annual range of temperature at Shimla is 14.4°C and the Dharamsala 17.0°C, while at Mandi it is 18.0°C.

However, the rainfall increases from the plains to the hills according to relief and aspect. About 70% of the annual rainfall is obtained during July to September ; about 20% from October to March and 10% from Apirl to June. During winter and spring, westerly depressions bring cloudy weather and light rain and often cause heavy snowfall in the higher regions. These wet spells may be followed by cold waves. The frequency of these depressions is about two in Novermber, four to five during December to April and again about two in May. Pre-monsoon showers occur in June and postmonsoon showers continue till the first week of October, but the total amount of both is low.

There is a close relation between rainfall and water resources of Shimla. Actually, surface water is the only choice in the particular region. Shimla City is dependent on four snowmelt and rainfed river water and one natural spring water for drinking water supply. According to the Shimla Meteorological Station Office–26% to 50% avg. rainfall indicates drought and more than 51% rainfall deficit indicates acute drought. Considering the rainfall of last five years in Shimla region, minor or moderate drought hit twice. Snowfall in Shimla is also not normal and regular. First three months of a year are prime time of snowfall in Shimla. Sometimes it is negligible and yet some other times it is before the normal time. So, water supply in four rivers is quite disturbed by these

minor changes in climatic conditions of lower Himachal. (Table-2)

TABLE 2 : RAINFALL (MM) IN SHIMLA

	January	February	March
2003	10.2	5.10	0
2004	96.9	0	0
2005	94.3	82.0	0
2006	73.3	6.6	0.6

Source : Indian Meterological Department Shimla.

PHYSIOGRAPHY AND SCULPTURING OF THE CITY

Himachal Pradesh is almost wholly mountainous with altitude ranging from 350 mt to 6975 mt above the mean sea level. It has a deeply dissected topography, complex geological structure and a rich temperate flora in the subtropical latitudes. Physiographically, as the state is divided into Five Zones, Shimla is within the humid subtemperate zone. Shimla is placed in btween Dhauladhar (in north) and Shiwalik ranges in north west Himalayas. The town of Shimla is spread over 'the Ridge' measuring about 12 km on the off shoots of central crescent shaped ridge where the suburbs are located.

The 19th century history and Municipal records stated that the first permanent residence of Capt. Kennedy in 1922 was on Mall Road (it is Central area of present Shimla town). In 1890, there were 30 houses at Shimla. The first house was totally made of wood and that time only wood was the most common material for housebuilding. Interestingly, all these were found in the widest area of Shimla Ridge . With the march of time as administrative influence of Shimla grew with the plan of Hindustan–Tibet road, and as most developing European colony, the town got new dimensions. Particularly in 1881, the population in February was 13,258 and number of occupied houses in summer was 1141, only after the introduction of Municipal System in 1851 and shifting of India's Summer Capital in 1864. No doubt the interruptions in topography and the locational interest were the two contrasting factors at the beginning. The rich European and Indian (very few) houses were made to follow the cottage type under Tudor.

Georgian or Gothic style was built with very good wood. As the drinking water was suplied from natural sources like nearby streams, the houses and offices were developed in core area of the city. Building stones like Slate, Quartzite, Gneisses and inferior quality Limestone were used for the buildings. As the ground water potential is very low and width of ridge is not favourable throughout Shimla, the population growth and distribution with settlement expansions are less variable and very slow. Due to physiographic interruption the economic prospect was never like any other urban area of plains of India.

After 1966, Shimla district merged into Himachal Pradesh from Punjab and became capital of Himachal Pradesh. After that Shimla conurbation developed in the eastern part—Sanjauli and in south-east (another wing of the Shimla Ridge)—Chhota Shimla and New Shimla. No doubt that the attraction of scenic beauty, administrative compulsion and tourism economy shape the resent Shimla Town within this obscure physiography.

WATER CRISIS : MANAGEMENT POLICY AND GOVERNANCE

A more comprehensive understanding of developing nation's urban water supply encompassing social as well as natural and built environments, has been strongly encouraged by the focus on environmental governance and related issues by welfare governments and various agencies including UN. Shimla is not an exception. The area has never enjoyed ground water resource because of physical compulsion. Total water consumption is rising in Shimla, but given the city's population growth rate and pressure of tourism developments,

the rise is not so rapid as that in most cities of a comparable size within India. But due to its mountain position, Shimla has an uniqueness in urban character. Indeed, the consumption needs of Shimla residents could be met from the city's existing water supply if there be no leakage from pipelines, or from bib-cocks that do not fit properly, water-metre failure, taps that are parmanently left on, and other forms of wastage.

As in most Indian cities and towns, a multitude of linkages between water supply inefficiency and distributional inequality are apparent. There are some VIP blocks—Himachal Pradesh University, The Maill High Court area, the Secretariate area and Chhota Shimla—which are always favoured by Nagar Nigam authority. The pipeline network including water-metre service with limited reach leaves thousands of residents, mainly towards the periphery, without supply. They depend on alternative sources that are unlikely to have been treated effectively. Many of the unserviced population pay far more for insufficient informal alternatives than do their fortunate counterparts within the supply zones, who are heavily, subsidised by the state indirectly. Water is recontaminated through pipeline leakage and consumers towards the edge of supply zones, in particular, tend to suffer not only reduced volumes and more interruptions in the supply but also greater contamination in the little formal supply they receive.

THE SITUATION AT PRESENT IS AS FOLLOWS :

- Shimla Nagar Nigam supplies water not only within muncipial area but also some added areas (called SADA) of New Shimla, Dhalli, Tutu covering a total of 2.44 lakh people.
- Demand of drinking water varies month to month ; it is seasonal because from April to September demand is highest due to peak tourist flow.
- The municipal authority calculates the water demand as per 100 litre per capita per day- and considering the scale nearly 30 million lietrs per day is the average demand to address the necessity of more then 2 lakh people.

The most interesting features of Shimla M. C. water services is that the authority reconstructed the demand figure according to the necessity of newly added areas and their possible supply maintaining a separation in urban area and rural added areas standardizing the average demand (per family) within municipal area. In peak tourist season, urban area has a demand of about 250 litre per capita per day where many urban periphery and rural added areas have served by mostly negligible to 25-30 litre water per capita per day.

Now when one looks into the possible solutions of this problem and analyses the programme taken by Himachal Government and Shimla M. C., a greater emphasis is necessary on integrated demand-side management which is now the key to dealing effectively with Shimla's water supply problems, be it effeciency, equity on environmental compulsions. The damagingly high level of wastage can be reduced not only by pipeline rehabilitation but also by repairs at taps and by turning off taps after use so as to avoid water running away unused. The most effective inducement to avoiding wastage at the tap, however, will almost certainly prove to be household water pricing. Shimla M. C. authority had started "water pricing" since March, 2001. Thus, a direct connection between the prices paid by consumers for their utilities and the quality of Shimla's environmental infrastructure is at last beginning to be made explicit.

For the time being, the difficulty for municipal and community managers is in identifying the nature and extent of ill-distribution at a particular area or some un-served pockets and communicating desirable use of that water to potential users. In the absence of a realistic alternative source, compulsory

'Rain Water Harvesting' for all permanent residential and commercial constructions is the most important and effective decision on behalf of Shimla Nagar Nigam. Private tankers are allowed for Hotels. Shimla M. C. strictly monitors roof top harvesting and floors which must be adequate to store 20 times (rain) water than by any other means. Municipality is also ready to be strict on security issues, particularly on construction and miantenance of water reservoirs. There are some environmental alertness about road sinking in reservoir area within Shimla M. C. Today, these alternatives seem to have been more effective for communities.

Today there are 13 municipal tap calls or public water distribution points without water meter and pricing. On an average, these points serve nearly 30 thousand litre water within Municipal area. But after 2001-02, there are no new installation of public taps.

There are some major complaints against Hotel owners and Guest Houses for tapping and illegal pipeline within municipal water service network. But, after introduction of water-metre, that problem is mostly solved and most of the Hotel owners use private water service system which is very costly. Tourists in the eight month's season pay for the high cost of water.

The small natural and man-made surface water sources found in many parts of the area will continue to be used as a source of water for large number of poorer residents, until better alternatives are available and accessible. Presently, Shimla M. C. authority is dependent on two on-going projects of lrrigation and Public Health department. Firstly, a project on river Giri which can supply more than 20 mld water within September, 2007 and secondly another project on Gumma river down stream which will supply 4.5 mld drinking water within middle of 2007. According to Shimla Nagar Nigam the completion of these two projects and constructions of other two revoirs will rightly address the present deficiency of drinking water supply in and around Shimla M. C. These are the very obvious and important areas for the development of local processing, involvement and management using relatively expensive technology. Many NGO's have also been involved in concerning community groups in use of water resource conservation and water-budgeting, petiting the courts, writing in local newspapers against the politically motivated water distribution, wastage and other initiatives.

CONCLUSION

Rapid population growth and commercialization are the leding culprits to justify urban water supply inadequacy including the recent worsening situation in Shimla. The crisis in Shimla's water supply at the beginning of the 21st century encompasses mutually reinforcing problems of efficiency, equity and the environment. The snowfall tragedy is a clear reminder of how dynamic natural environments, like the edge of the lower Himalaya, should not be taken for granted, especially when massive demands are made on them by way of physical resource extraction. A range of problems relating to drinking water distribution less tragic than the Hotel (including Guest House mushrooming) calamity but demanding managers' attention nonetheless, shows the need for vigilance in monitoring and interpreting changes in the natural environment. Effective urban water management needs to combine understanding of the natural environment's functioning, potential and vulnerability with a more inclusive appreciation of people's needs–those excluded from formal supply as well as those presently serviced.

Shimla needs an integrated water supply policy designed to improve the degraded environment while at the same time improving efficiency and reducing inequity. Water supply should also be integrated with related environmental infrastructure needs, such as sanitation and waste disposal considering the slope stability and conditions of

soil. The municipal water supply authority now acknowledges the distributional and environmental problems but are ill equipped to deal with them effectively. Their central strategy remains the traditional response of a major increase in supply to the town, but this seems unlikely to significantly improve supply to marginal areas (Baluagunge, Summar Hill, Dhilli, Bharari, Juti Kandi) and it is being done in ways that exacerbate the existing environmental situation. A greater role for community organizations in local utility management, in participation with the municipal authorities and NGOs is needed to achieve these priorities effectively. The government of Himachal Pradesh's unwillingness to devolve management powers to urban communities is understandable in the light of the likely political (as well as physical) difficulties, especially given the bureaucratic government style characterisitic of India. Greater emphasis on demand-side management is feasible in a top-down governance structure, but far more likely to be effective within a participatory framework. Water-pricing in Shimla is a good decision but politically motivated illdistribution system disturbs the entire structure.

To tackle problems of water supply efficiency and equity, demand-side approaches to utility management in developing world cities-towns have been advocated recently in some quarters. It is perhaps too early to assess their impacts and effectiveness. Although demand managment is not a major element in Shimla's water supply strategy, we expect evidence of a range of social and environmental benefits to become apparent in other Indian cities where it is emphasized. The strongest impetus to its adoption might well come, however, from the demands of urban resident whose basic needs continue to be inadequately met. So, Shimla is living for tourism and a huge influx of population (seasonally) is very common here. Finally,the most crucial function in this respect for municipality and community organizations, private companies and even government, is a widespread raising of consciousness of the right to basic needs like safe drinking water.

SHORT COMMUNICATION

PEOPLE NEED TO BE INVOLVED IN THE PROTECTION OF WATER AROUND THEM

Jayanta Bandyopadhyay*

A report of the UNDP on India's water starts with the observation that "ever since independence, poor Indians have been promised free safe household water". In terms of number of billionaires, India's place is near the top in the world. With more than 225 million people having no access to safe drinking water after 62 years of Independence, India is also at the top in another world ranking according to some reports.

Provision of safe drinking water to all should be a non-negotiable priority for the Indian state to protect the citizens' right to life. It is a real shame that though the domestic water needs are the smallest of all water requirements in terms of quantity, the satisfaction of this crucial need of all people will be celebrated as a virtual human right, in World Water Day events, international seminars and political statements.

The arrival of RCC technology and human ability to pump groundwater made it possible for us to intervene in the surface and ground-water on a very large scale. Storage and transfer of very large volumes of water from lakes, rivers and aquifers have been as much a backbone for the industrial societies as the fossil fuels. The rapid financial gains made from the use of such huge volumes of water made water a fuel for economic growth and led to widespread competition for and conflicts over it. Thus was born in the public mind the economic entity called 'water resource'.

Domestic supplies now have to compete with other demands on this resource. Recent economic history is also an account of growing human interferences in the lakes, rivers and aquifers of the world.

For India, out of the total annual precipitation of about 4000 billion cubic meters (BCM), the officially assessed annual availability of water is about 1120 BCM. This provides for an annual per capita availability of less than 1000 CuM, an amount that borders on a state of scarcity, according to international perceptions. With this annual amount, domestic needs, water for food production, industrial activities and cultural requirements are to be met. In doing so, water engineers in India have exhausted many rivers and aquifers, leaving little water for dilution of pollution or to satisfy all the needs of environmental flows for the aquatic ecosystems.

In the climatic condition of India dominated by acute spatial and temporal inequities in precipitation, the national averages do not bring out the stark realities of smaller regions with water extremes. The rainfall distribution over India is highly uneven over space and time.

Then we have the great tragedy of the groundwater commons ! Ownership of groundwater being treated as private, totally unsustainable extraction of water, for both irrigation and industry, has deprived large areas of Peninsular India of water from easily accessible aquifers. The tranditional knowledge base with which water governance is practiced in India finds it easier to

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declare water scarcities or excesses as 'natural disasters'.

Before blaming nature for the growing water scarcity, we need to find the devil within ourselves. If the water business goes on as usual, inefficient use of water and conflicts over it will continue unabated.

In order to ensure that the vital ecosystem processes and related services can continue, serious attention to ecosystem research and ecological management of water systems will be needed. Otherwise, with the rivers and lakes turning to mere drinages for pollutants and wastes, groundwater quickly moving away from the humans and global warming changing the precipitation patterns and eating into the stock of glacial waters in the Himalayas, India will be in trouble with the business as usual mode of water management.

India simply cannot continue with the traditional and simplistic approach to water management in the future years. The urgent need for change has been flagged by many independent water professionals and social movements, but the political leadership and the governments have resisted much needed reforms in water engineering and mangement. People need to be involved in the management and protection of water around their habitats. Irrigation systems or municipal infrasturctures need not be managed exclusively by the engineers.

An important opportunity has arrived for betterment of ecological knowledge on water systems through the National Action Plan on Climate Change. Activities of the National Water Mission within that Action Plan has addressed the very crucial task for understanding the impacts of climate change on India's water systems and preparing the country to adapt to possible changes in the climate.

Such scientific initiatives are urgently needed but will be successful only with a wider ecological knowledge base. Water future of India is in the hands of our people, water professionals, the business sector and the government. Only wise and unselfish action by all of them can regain the country's status as 'sujalang'.

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- Recognizing the Indian Diamond Industry as a major source of employment in a priority sector like export production with scope for substantial value-addition for the country, the establishment of the Indian Diamond Institute was conceptualized and later put into effect.
- The IDI is a Society registered under Societies Registration Act, 1860 and also under the Bombay Public Trust Act, 1950.

The IDI is ISO 9001:2000 Certified for Design Development and provision of Training, Consultancy & Certification Services related to Diamonds, Coloured Stones & Jewellery. w.e.f. December 07, 2006 vide Certificate No. 35936 issued by M/s. ABS Quality Evaluations, Inc.

3-WAYS OF LEARNING.....AND GL SERVICE

ON CAMPUS

With the benefit of the state-of-the-art infrastructrure in place and expert professional instruction, Diploma Students (Diamond) learn by cutting, polishing and examining over hundreds of diamond during their practical. While enrolled in IDI Graduate Jewellery Diploma Programmes, at

Sardar Vallabhbhai Patel Centre of Jewellery Design & Manufacture (SVJDM) students learn with the help of world class infrastructure besides receiving personalized instruction for their workshops and tutorials from the highly qualified and experienced faculty and develop the skill of professional.

Off Campus

In order to cope up with the need of the hour, IDI is soon establishing a world class Jewellery Design & Training Centre to be named as IDI-CITY Centre at Vesu, near Surat Air Port. IDI City Centre will be functioning as an extension, aimed at promoting Jewellery Industry of Gujarat through its variety of training programmes.

Home Study

Enables you to learn in the convenience at your home or office. IDI's professionally designed programme material can be sent directly to you. And undergoing assignment given followed by practical classes at IDI, you earn professional crebidility and confidence without disrupting your daily schedules.

Out-Bound

The institute has also developed the concept of off campus Outbound Training Programme tailored to the industry's needs in the areas of Polished Diamond Grading & Colore Gemstone Identification. It is being conducted in almost all the important cities like Chennai, Kolkata, Mumbai, Bangalore, Coimbatore, Cochin, Hyderabad, Hubli, Chandigarh, Jaipur, Delhi, Ludhiana etc. So far, institute has trained more than 2500 Jewellers all over the country.

DIamond Gemstones and Jewellery Reports

IDI's GTL cetificates are accepted all over, nationaly as well as internationally. You may add one more factor **Credibility** to your diamonds, colored gemstones, Jewellery-plain or studded as services rendere by IDI GTL are ISO 9001:2000 certified. IDI is also an authorized laboratory for Diamond Grading & Certification by Directorate General of Foreign Trade (DGFT), MoC&I, Govt. of India under Foreign Trade Policy 2004-2009.

Again, IDI is the only Gem Lab in the country to have Laser Raman Spectroscope (LRS) FTIR UV-VIS & high resolution and microscopes for accurate analysis of diamonds & gemstones.

IDI has a Bureau of Indian Standards (BIS) recognized **Assaying Hallmarking Centre** at its campus itself to cater the needs of jewellery industry.

R & D centre is funtioning in the Institute with the following objectives :

1. To give scientific and technological support to the diamond industries to upgrade the processing technology.

2. To develop indigenously low cost technologies for import substitution products used in the diamond industries so as to help the country to save foreign exchange and also reduce the cost of processing.

3. To carry out in-depth studies on illumination and noise level, thermal load, air velocity etc. to improve environmental conditions of the processing unit.

4. To bring awareness amongst workers about the use of modern machine concept and quality control checks to improve productivity/efficiency and yield.

Contact : Director, INDIAN DIAMOND INSTITUTE

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Web. : www.Diamondinstitute.net

Conferences / Meetings / Symposia / Seminars

2nd International Conference on Drug Discovery and Theraphy, February 1–4, 2010 Dubai, UAE.

The 2nd ICDDT 2010 will highlight cutting-edge advances in all major disciplines of Drug Discovery and Drug Therapy. This four-day event will feature recent findings from leading industrial, clinical and academic experts in the field, in the form of lectures and posters. The 2nd ICDDT 2010 will be unique in promoting the translational nature of modern biomedical research, with an equal number of speakers/ participants those who are basic scientists in drug discovery and those who are medical doctors associated with direct patient care and reserch. Several Nobel laureates have also shown a keen interest in attending the conference and plan to deliver keynote lectures.

The 2nd ICDDT 2010 will provide a forum for in-depth assessment of the challenges involved in the dynamic and fast moving field of biomedical research. It will bring together leading clinicians, medicinal chemists, pharmacologists, biotechnologists, and other allied professionals to discuss and present the latest important developments in drug discovery and therapeutics.

The '1st International Conference on Drug Design and Discovery' was held in Dubai from 4th-7th, February, 2008. Eleven Nobel laureates and more than 850 international delegates participated in this event! It was an outstanding success by all accounts.

For more details and to register, please visit the conference Web site at http.//www.icddt-whi.com

Register today and take advntage of the early-bird reduced registration fee !

The conference offers the following sessions :

1. Anti-Infectives
2. Biologics
3. Cardiovascular
4. Central Nervous System
5. Diabetes and Obesity
6. Drug Delivery
7. Drug Discovery & Therapy in Middle East : Challenges and Opportunities
8. Enabling Technologies
9. Generic Pharmaceuticals : Challenges and Opportunities
10. Global Roundup of Pharmaceutical Research Capabilities and Opportunities
11. Inflamation and Immunology

12. Intellectual Property
13. Nanotechnolgy in Biomedical Research
14. Oncology
15. Proteomics & Bioinformatics
16. Pulmonary Disorders
17. Regulatory Affairs
18. Successful Drug Discovery from the Research Lab to the Marketplace
19. Translational Biomedical Research
20. Women's Health Issues

Contact : Organizing Secretariat, ICDDT 2010 : Executive Suite Y–26 ; PO Box 7917, Saif Zone, Sharjah, UAE. Tel: +971-6-5571132, Fax: +971-6-5571134, Email:info@icddt-whi.com Web:www.icddt-whi.com

ANSWERS TO "DO YOU KNOW ?"

A. In the Planet Venus which rotates in a direction opposite to the other planets.

A. Kung Fu.

A. Olive oil.

A. About Four Billion.

A. Death by stress of overwork.

A. Yes. In fact Poultry farmers do this regularly to make the egg more attractive.

A. Barcelona.

A. Emperor Ashoka.

FORM IV

Rule 8

1.	Place of Publication	The Indian Science Congress Association 14, Dr. Biresh Guha Street, Kolkata 700 017
2.	Periodicity of Publication	Bi-monthly (Published every two months)
3.	Printer's Name Nationality Address	Shri Partha Pratim Hazra Indian M/S Seva Mudran, 43, Kailash Bose Street, Kolkata 700 006
4.	Publisher's Name Nationality Address	Prof. S.P. Mukherjee, Indian The Indian Science Congress Association 14, Dr. Biresh Guha Street, Kolkata 700 017
5.	Editor in Chief's Name Nationality Address	Prof. S.P. Mukherjee Indian IAPQR, AD-27, Salt Lake City, Kolkata–700 064
6.	Name and Address of individuals who own the newspaper and partners of Shareholders holding more than one percent of the total	The Indian Science Congress Association 14, Dr. Biresh Guha Street, Kolkata-700 017

I, S.P. Mukherjee, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date : 21. 07. 09

S.P. Mukherjee
Publisher
Everyman's Science

S & T ACROSS THE WORLD

NEW TECHNOLOGY FOR ROADS

The Public Works Department (PWD) plans to use new technologies to restrengthen its road network. The conventional bituminous roads wear off faster in extreme climatic conditions and with exceptionally heavy volume of traffic in Delhi. Though the normal life of a road is considered 4-5 years, most road surfaces start deteriorating within couple of years due to high volume of traffic in the city. PWD will use micro-surfacing on approximately half of the 190 kms while the remaining will be strengthened using the recycling technology. The plastic-bituminous mix will be used on a small portion.

The new technologies are being used after their successful test and trials. The plastic-bitumen roads are being widely constructed in cities like Bangalore, Madurai, Thiruvanathapuram and some other districts of Karnataka, Tamil Nadu and Kerala. Recycling road technology is also being used in Hyderabad. A stretch of Mehrauli-Badarpur road was re-strengthened using this technology and it gave very good results. This technology will be used on stretches where the volume of traffic is comparatively lower than other roads in the city. It's a time consuming technology and requires diversion of traffic, but is more environment friendly.

(Indian Building Congress, May 2009)

WAY TO CANCER THERAPY

The potential for molecular intervention in the cascades leading to cancer cell development are immense. Scientists in a European project have screened candidates for peptide that prevent the inactivation of a tumour suppressor protein. Project partners at the University of Tartu in Estonia made use of two proteins that interact to deregulate a tumour suppressor mechanism. Protein or tumour protein 53 regulates the cell cycle and is a tumour sppressor. One of its main negative regulators is mdm2 which binds with p53 to produce two molecular scenarios. First, the so-called 'guardian of the genome' p53 protein is inhibited and unable to perform its protective activity. The protein molecule is also marked for degradation. Detectable energy changes between the two molecules were employed as a screen for small molecules or peptide based agents that were able to interfere with the p53/mdm2 interation. The commercial potential of the screening process is resported to be substantial.

(University of Tartu, June 5, 2009)

WASTE SPACE INTO ENERGY SOURCE

There is a lot of wasted space on rooftops that could actually be used to generate power. US Department of Energy's Pacific Northwest National Laboratory has found that flexible solar panels could easily become integrated into the architecture of commercial buildings and homes. The flexible rooftop solar panels, called building-integrated photovoltaics, or BIPVs, could replace today's boxy solar panels that are made with rigid glass or silicon and mounted on thick metal frames. The flexible solar shingles would be less expensive to install than current panels and made to last 25 years.

This work is the result of cooperative research between Vitex System and Battelle and is expected to contribute to a new way of generating solar power.

(Pacific Northwest National Laboratory, June 4, 2009)

DROUGHT RESISTANT CROP

Hyderabad-based International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is developing crops, such as pearl millet, sorghum, chickpea, pigeon pea and groundnut for dryland farmers. These crops will have greater drought tolerance and can grow in semi-arid conditions.

In India, two-thirds of cultivated lands are semi-arid. Hence, an adverse impact on dryland farming can result in decreased livelihood options for a substantial percentage of the popultion. ICRISAT's research focuses on improving crops productivity, developing early maturing varieties and hybrids, and devloping drought and disease tolerance.

It also provides help to the dryland farmers through the community watershed management programme.

(ICRISAT, Jan 2009)