An approach to geoscience education beyond 2000 AD

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During the 20th century, the rate of progress of civilization, particularly due to tremendous leaps in science and technology has drastically changed the scenario. The technology has brought revolutionary changes even in the methodology of education, skill-building and infrastructure. But it has also created problems and danger of ever-increasing gaps in the levels of human resource development, knowledge and skills between the advanced and the developing countries. This is an extremely crucial factor and deserves urgent attention, because if the gap is not arrested quickly and gradually narrowed, it may become almost impossible to compete internationally in the emerging scenario of global economic and social dynamics. This point has also direct bearing on the employment of our young graduates.

In July 1995 the Association of Exploration Geophysicists (AEG) had organized a workshop on 'Geophysical Education and Manpower Utilization in India'. The participants brought out the grim employment scenario of geophysicists.

There is an urgent need to properly monitor both resource- and socially-oriented demands of the society which only the geosciences can respond. And for this it will be necessary to bring appropriate changes of the course structures in the colleges and the universities to meet the new challenges.

Earth system sciences consist of the study of solid earth and integrated study of physico-chemical coupling of the earth with hydrosphere, cryosphere, biosphere, stratosphere and astro-geophysical phenomena at different time scales which is a highly complex and nonlinear process.

Geophysics is a multidisciplinary subject earlier confined mainly to study of the Solid Earth. It has now expanded to engulf hydrosphere, atmosphere, space sciences and biosphere.

Resources available from the Earth are water, coal, petroleum, minerals and other materials. Their availability and judicious utilization determine the level of development of a society.

The discovery of ozone hole and possible sea-level rise with increase in levels of chlorofluorocarbons, CO_2, NH_3, CO, NO, NO_2, SO_2 and CH_4 have shown that the biosphere is critically dependent on an extremely delicate balance between the different components of the Earth System and the activities of man. Waste disposal, land degradation, availability of groundwater in quantity as well as quality and pollution are issues intimately connected with environment.

Natural hazards like earthquakes, volcanos, land-slides, droughts and floods require systematic and detailed studies to mitigate and try to predict these calamities.

Quality of life (QOL) is mainly dependent upon per capita use of resources and indices of monitoring and security from natural hazards and environmental degradation. For about 1000 million people around 2000 AD and beyond, even if the QOL equivalent to a modest European country is targetted, then the resource needs per capita will be enormous.

It is clear from the above that any effort to improve the QOL requires that the Earth Science is put to the central stage due to its direct applicability and social context. We have already lost precious time in our development programmes by not recognizing this crucial priority. This realization needs urgent recognition by the planners, the educationists and those in power at various levels to put in direct focus development through integrated management of natural resources and deeper understanding and researches in Earth Sciences.

A large number of properly trained and knowledgeable personnel need to be deployed in a planned manner to face the uphill tasks ahead. Hence the role of geoscience education assumes vital significance, because a suitably trained and well-formulated work-force alone would be able to address problems of (i) energy, groundwater and material needs, (ii) sustenance of optimal environmental conditions, and (iii) hazard monitoring and mitigation. The socio-economic progress will be measured with respect to the degree to which the society can meet its needs of (a) population, (b) urbanization, (c) food production, (d) industrialization, (e) economic growth, and (f) quality of life.

For each of the above factors 'natural resources' and 'security' from natural hazards and environmental degradation are among the core requirements. To fulfil these, more surveys, data collection, better data processing and interpretation are needed within a specified time frame.

This will require students well trained with adequate information, knowledge and concepts on one hand and skills and expertise to handle the requisite technology on the other. Therefore, the curriculum has to be made much more flexible so that it can quickly absorb the emerging and expanding horizons of modern geosciences and respond to new challenges as and when posed.

This will need two streams of courses comprising of core subjects and optionals. The latter could serve to cope with the multidisciplinary nature of Earth Sciences. Certain applied aspects of geosciences deserve to be taken up as engineering courses so that focused technological expertise could be built to address the problem of exploration and management of natural resources. This will also go a long way in bridging the technology gap.

Special stress needs to be put on (i) interfacing the education with industry, R&D and other user agencies, and (ii) entrepreneurship so that geoscientists do not always depend on government jobs.

It is necessary that the output of our university/college system inculcates a new perception towards earning their livelihood as well as contributing to the socio-economic growth of the country.

The educational institutions and industry will also have to conduct periodic refresher courses for teachers, research fellows and professionals to suitably acquaint them with the latest concepts, methodologies and cutting edges of Science and Technology.

At present the geosciences are introduced at graduate and post-graduate levels. However, in view of depleting resources and ever-increasing groundwater and environmental issues, it is necessary that awareness and appreciation of earth sciences is inculcated among the students from school level itself. A basic

knowledge of the Earth, its bounty and need to properly manage its resources while preserving the sanctity of its environment are among the important issues which should be suitably introduced.

As the knowledge and expertise of geosciences need to be utilized for sustainable and eco-friendly development of the country and gainful employment generation, it is essential that during educational career itself the students are exposed to different requirements of related industries and user agencies.

The awareness of Earth Sciences and the consequences of their neglect must spread to a broader base. Ways and means need to be devised to educate (i) general public, (ii) media, (iii) legislators and parliamentarians, (iv) industry managers, (v) bureaucrats, and (vi) voluntary agencies.

I have tried to briefly outline an approach which may be considered for the geoscientific education pattern in the coming decades. The bases for this are the requirements of (i) keeping in view the crucial coupling between litho–bio–hydro–atmosphere and space and bring in a holistic approach towards better understanding and management of natural resources, hazards and environment, (ii) developing far stronger links between education and needs of the society, industry and user agencies, and (iii) making both public and decision makers aware of the crucial role of geosciences in the socio-economic growth of our country and need to support it.

For this, geoscientific education and awareness has to begin right from the school level. In case of specialized needs such as petroleum, groundwater, instrumentation and environment, certain focused technological courses on the pattern of IITs could be considered. The University curriculum needs to be made more flexible and dynamic, specially with regard to the optional courses. And it should put more stress on application of newer knowledge, and concepts to certain unique geological and geophysical characteristics of our Indian lithosphere.

It is strongly felt that in addition to the formal education, there is also an urgent need to enhance the perspective and information level of our planners, decision makers and general public about the geosciences and their application. Because of grossly inadequate appreciation of the potential of earth sciences hitherto prevailing over the past five decades of our independence, this socially most vital subject has not received the attention and support that it deserves. This neglect has already proved quite costly to the nation with respect to exploration and integrated management of our natural resources. The ever-increasing import bill of the fuel energy needs of the country, never-ending river water disputes, droughts and floods are some of the obvious results of this neglect. The protection of environment and mitigation of natural hazards are also among the essential ingredients for survival and growth.

Educational pattern for any forthcoming era has to be evolved based on the proper anticipation of the problems and demands likely to be posed by that era. We have to very quickly establish this phase-lead for education *vis-à-vis* the Society. Only that education can sustain or keep the Society and its individuals 'alive' in the very best sense of this word which adequately respond to their ever-changing problems and demands. If the Society and the individual are not able to achieve a positive growth against modern day competition and requirements, then that education pattern is not worth it and the Society may slowly decay.

Actually the approach presented above is not new. It was enunciated long long back very succinctly in this land through the immortal saying *vidyaya-amrut-a-shnute*. It means that only that 'learning' is worthy of being called 'vidya' which can keep us as individuals and society moving eternally on the path of progress. This indeed is the ageless formula to design an educational pattern.

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SCIENTIFIC CORRESPONDENCE

Citral: A cytotoxic principle isolated from the essential oil of *Cymbopogon citratus* against P388 leukaemia cells

Higher plants are reservoirs of various valuable secondary metabolites which can be exploited for different biological properties. During recent years many kinds of compounds of plant origin have shown antitumour activity. Taxol from *Taxus brevifolia*, vinblastine and vincristine from *Vinca rosea* and curcumol from *Curcuma aromatica* have been demonstrated to have promising anticancerous activity during clinical trials[1]. In the present investigation, the essential oil of *Cymbopogon citratus* and its isolated active principle have been tested for cytotoxicity against mouse P_{388} leukaemia cells. This plant has already shown promising insecticidal and antifungal activity against storage pests[2]. *Cymbopogon citratus* (*Andropogon citratus*) is known only in cultivated state. The Ayurveda describes this grass as pungent, bitter, sharp and hot. It is a medicinal plant used in fever, vomiting and rheumatism[3].

The leaves of *C. citratus* were collected from Medicinal Plant Garden, Banaras Hindu University. These were washed

Table 1. Physico-chemical properties of essential oil of *Cymbopogon citratus*

Parameter	*Cymbopogon citratus* oil
Colour	Pale yellow
Specific gravity	0.8875
Optical rotation	– 6.5 at 32°C
Refractive index	1.496 at 29°C
Acid number	7.84
Saponification value	98.76
Ester value	90.92
Carbonyl percentage	56.296
Phenolic content	Nil