Knowledge creation from our universities

Various levels of our political leadership are stressing the need for knowledge creation from our universities. In this connection, I wish to make the following points:

1. New ideas flower under 'individual-based' research, and the university environment is ideal for this. The intellectual environment in a university is dominated by young minds, who 'own the world', and will not hesitate to challenge (logically) the accepted ideas, and propose out-of-the-box ideas. [A famous quote, in the context of the uncertainty principle, is 'Ideas change not because those with old ideas change their ideas. Ideas change because young people accept the new ideas.']

2. While we encourage our students to think 'what others have not thought', we realize that all thesis just cannot devolve around new ideas. The papers with new ideas will be tested, and papers performing such tests constitute a necessary (and preponderant) research output. We have to recognize the importance of both types of research. Presently, ideas from Indian scientists have to await acceptance from groups abroad; other Indian groups neither strive to prove nor disprove them (they simply ignore them!). We must encourage interaction between the two. I feel, it would help greatly if both groups are from India; so we must encourage template-based research with Indian papers as templates. We must have special funding for this class of research proposals.

3. As we do internationally competitive research, two important handicaps are:

(i) The non-availability of advanced facilities to researchers in our universities. The newer universities require time to set up their own laboratories, and very few Indian institutions can boast of maintaining advanced experimental facilities. This handicap can be alleviated, as we have seen from the functioning of the three physics-centric Inter-University Centres (IUCs) created by UGC about 25 years ago, by setting up more such centres.

(ii) The paucity of established Indian journals. There is an uncanny feeling that reviewers of established international journals are more skeptical towards new ideas from emerging bylines, and that the time interval between the first submission of a manuscript from an emerging byline and its final acceptance is longer than average. Preprint repositories are now widely accepted in the developed world and by all leading publishers who allow draft manuscripts to be deposited in preprint servers for peer commentary before being submitted for publication. Uploading on such an e-print archive ensures priority while allowing the student time to convince referees and editors of a journal of appropriate visibility, as the foreign competing groups react with a time lag because of their inherent disbelief. We must encourage the setting up, and use, of such preprint repositories.

P. CHADDAH

UGC-DAE Consortium for Scientific Research,
Indore 452 001, India
e-mail: chaddah@csr.res.in

Fostering interdisciplinary climate science for sustainable development

The current trend of frontline research in climate science fosters the application of interdisciplinary approach as a holistic model to address the complex issue of climate change, its implications, mitigation and adaptation. This approach facilitates in understanding the various natural processes which are useful in coping with rapidly changing socio-economic, ecological and environmental problems associated with climate. The holistic model is also aimed at eco-friendly and sustainable development, especially for the underprivileged section of the society. And probably it can tackle newly emerging problems and paradigms to facilitate cutting-edge climate research. The challenges faced by climate science researchers need to be appropriately addressed; for example, ecology can be used to deal with slope instability, once considered a discipline of geologists/civil engineers only[1]. However, while applying interdisciplinary approach, subject experts must be involved to avoid inconsistent results that may mislead the scientific community.

The onus of an investigator to describe the merits and demerits during publication needs to be ascertained as both are equally important for further research and its application for social well-being. Because of ignorance about demerits, interdisciplinary work may generate results that are different from the ground reality and will critically limit the importance and defeat the research objectives. For example, the Naturalized Difference Vegetation Index (NDVI) is a remote sensing technique used worldwide as interdisciplinary approach for multifarious purposes, including assessment of natural resources, alpine treeline dynamics and carbon sequestration in space and time. NDVI is based on spectral reflectance of the target area and difference in image of different time series detects the spatial changes. The entire process involves various scientific disciplines such as physics, chemistry, biology, geology, geography and mathematics. But when NDVI results for alpine treeline dynamics are calibrated against ground investigation, an unacceptable deviation has been observed in northwestern part of the Indian Himalaya. The area (30°50′16″–30°53′18″N and 78°45′20″–78°48′20″E) shows treeline dynamics @10 m/yr using NDVI against the ground survey[2,3] which shows @1.7 m/yr. This large variation in the result raises doubts which can be rectified only by subject experts.

The following observation has been reported while using NDVI in treeline dynamics vis-à-vis climate change study. (i) Remote sensing data have certain limitations for on-the-spot treeline delineation at 2 m scale, especially for the areas that remain under snow about 4–6 months and trees acquire prostrate habit/thick vegetation blanket. (ii) NDVI varies with different humidity conditions

of ground/atmosphere, presence and absence of snow/cloud cover and phenological alterations and hence may show changes even when none exists[4]. (iii) Images of two different dates of coverage cannot be taken exactly in similar climatic conditions, because of dynamic characteristic of humidity, aerosols and solar radiation, resulting in some inherent errors. (iv) NDVI is also sensitive to anisotropic and satellite sensor effects, which is bound to influence the results.

Although this deviation in results is mainly attributed to the variation in definition, time series, instrument peculiarities, target area factors, differences in the mindset of experts and methodology, the high degree of difference limits the usefulness of the method and suggests that either NDVI is being used in some inappropriate fields or it requires more precautions for useful results. Remote sensing has become a vital tool for frontline research in almost every field, including natural resource management, hazard assessment, geology and mineral exploration, agriculture and forestry, land degradation, oceanography, environmental monitoring and specifically climate change science. Therefore, interdisciplinary science needs to be supervised by subject experts to avoid the mis-registration of imagery, associated errors and unrealistic results.

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P. S. NEGI

Wadia Institute of Himalayan Geology,
33 GMS Road,
Dehra Dun 248 001, India
e-mail: negi_psingh@wihg.res.in

Megathrust earthquakes and the associated volcanic subsidence

Understanding the relationship between the megathrust earthquakes and volcanoes has been debated by scientists for years and past studies have suggested that large megathrust events can trigger volcanic eruptions, cause ground deformation, thermal anomalies, more earthquakes and hydrothermal changes[1–8]. However, subsidence of volcanic areas was not previously known to occur during such events. Two contributions[9,10] have recently reported this phenomenon, although they have suggested separate mechanisms for the same.

Megathrust faults are similar to the thrust faults; however, their strike length is quite large, e.g. the Sunda megathrust runs south from Bangladesh, curving around the western and southern flanks of Sumatra, Java, Bali and eastern Indonesia to northwestern Australia, stretching over a distance of 5500 km (ref. 11). Similarly, there are examples of megathrusts that run offshore in the Philippines, Taiwan, Japan and southeastern China. The megathrust faults are also found on land and the biggest one traverses from Pakistan through India and Nepal, covering a distance of 2500 km along the southern side of the Himalayan mountain range[11].

Megathrust earthquakes occur once the accumulated strain is ripe to rupture the fault and this generally happens when a locked portion of such a fault experiences continuous stress for centuries or decades via plate motions. Thus, such earthquakes are caused when the friction along the megathrust fault plane is overtaken by stick and slip mechanism. Further, there are some morphological changes which generally occur between earthquakes and particularly, on an overriding plate, that could play a vital role in understanding the fault kinematics. It is observed that between earthquakes an overriding plate generally uplifts and during an earthquake it usually subsides. These changes are measurable and could indicate the potential link between an earthquake and the changes in the total morphology of the affected area. This was the motivation for the research conducted by Takada and Fukushima[9] and Pritchard *et al.*[10]. These studies have reported that subsidence of volcanic areas occurred after the M_w 9.0 Tohoku-Oki of Japan in 2011 and M_w 8.8 Maule earthquake of Chile in 2010, respectively. These critical studies were done using satellite radar interferometric imaging[9,10], which makes it easier to understand and analyse the ground deformations associated with the earthquakes (e.g. during Tohoku-Oki and Maule events). Thus, these two studies suggest a possible interaction between earthquakes and volcanoes and how this could have implications for earthquake and volcanic hazards[12], apart from other associated processes.

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A. A. SHAH

Department of Applied Geology,
School of Engineering and Science,
Curtin University,
Sarawak Malaysia
e-mail: afroz.shah@curtin.edu.my