conservation rule and recursive improvement using the network properties have been employed[2]. Table 2 displays the totalized input and output after the multi-dimensional input and output have been projected to an institution space.

Visvesvaraya National Institute of Technology, Nagpur (VNIT) is seen to be the best NIT from the productivity or efficiency point of view. Note that faculty size and expenditure are totalized into a single input term, and earnings and bibliometric output are totalized into a single output term for each institution, and it is VNIT's relatively excellent performance in research and consultancy earnings that takes it to the top spot.

1. Prathap, G., *Curr. Sci.*, 2018, **114**(11), 2234–2238.
2. Prathap, G., *Scientometrics*, 2018, **115**(1), 577–583.
3. Prathap, G., *Scientometrics*, 2011, **87**(3), 515–524.
4. Krauze, T. K. and McGinnis, R., *Scientometrics*, 1979, **1**(5–6), 419–444.

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Is quantification of parameters essential for scientific substantiation?

The Guest Editorial about quantifying quality by Sathyamurthy[1] is highly pertinent in research disciplines. Currently all experimental results need to be projected in quantified measures. Various research fields such as nano, micro, small, medium, large and mega need to be examined from various angles of standardization or quantification. No uniform stick of quantification can be universally applied. For nano and micro-scale measurements one may be required to account for the Heisenberg uncertainty theorem during quantification. For small- and medium-scale measurements, the tolerance of accuracy level could be from Angstrom to a few millimetres. For large measurements such as roads of a few kilometres length, heavy and massive concreting, or displacement of water by a large cargo or passenger ship, quantification could be large. For mega-scale measurements such as astronomical distances in millions of light years, the error or tolerance could be as high as up to 50%. Such measurements are made at an interval of six months of the elliptic orbit of the earth.

I have been working in the fields of earthquake and allied sciences, including earthquake forecasting. I would like to recollect an incidence in 2001. There are documented historical reports that about 3–4 weeks before the occurrence of a large (magnitude > 7.5) earthquake, the groundwater sprouted. This was observed prior to the Great Kutch earthquake of 16 June 1819, Kangra earthquake of 4 April 1905 and Quetta earthquake of 30 May 1935.

During the first week of January 2001, there were reports that a large number of dry wells and nullahs in Kutch (Gujarat), Rajasthan and Sindh Province of Pakistan were suddenly flooded with water oozing out and at some locations water was sprouting in the form of springs. I had e-mailed the Gujarat Government that the sudden appearance of water is positively indicative of the occurrence of a large-magnitude earthquake within 2–3 weeks. Incidentally my email did not receive the desired priority and an earthquake occurred on 26 January 2001. However, my e-mail was subsequently acknowledged.

When I discussed the appearance of water as a reliable seismic precursor at a conference, I was told to quantify the oozing water. This is an impossible task. Another reliable seismic precursor often ridiculed or laughed at is the abnormal animal behaviour. One of the reasons is that it cannot be quantified. However, this has been observed and reported after all large earthquakes such as the Uttarkashi earthquake of 1991, Latur earthquake of 1993, Bhuj earthquake of 2001, Sumatran earthquake and tsunami of 2004 and Kashmir earthquake of 2005. The oldest record of abnormal animal behaviour before an earthquake is available for the Kangra earthquake of 4 April 1905 (ref. 2). At that time India and Pakistan were under British rule. The Lahore Zoo was a famous landmark of the then Punjab. The distance between Lahore and Kangra is about 180 km. The then British Zoo Superintendent at Lahore Zoo was awakened during the wee hours of 4 April 1905 by the shrilling noise of zoo animals. He went around the zoo with food and water, but no animal was ready for it. All the animals were hostile and aggressive.

Though abnormal animal behaviour has been observed and recorded before all medium to large earthquakes, it is not accepted because it cannot be quantified. Quantification of water oozing from the ground, and abnormal animal behaviour before a large magnitude earthquake cannot be quantified, but these are highly reliable and should be used by the authorities for mitigation measures.

Quantification of any parameter in scientific research is definitely required, but if the parameter cannot be quantified, its basic properties and reliability should not be disregarded.

1. Satyamurthy, N., *Curr. Sci.*, 2017, **113**(1), 7–8.
2. Bapat, A., *Curr. Sci*., 2008, **95**(3), 318–319.

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