Table 1. Ranking of top institutions in materials science and engineering research using data from Essential Science Indicators updated as of 1 July 2013 to cover a 10-year plus four-month period, 1 January 2003–30 April 2013

Field	Rank	Institutions	*P*	*C*	*i*	*X*
Materials Science	1	Chinese Acad Sci	18,079	1,77,299	9.81	1739303.19
	2	Max Planck Society	3,650	74,385	20.38	1515966.30
	3	MIT	1,997	52,615	26.35	1386405.25
	4	Univ Calif Santa Barbara	1,050	36,080	34.36	1239708.80
	5	Univ Calif Berkeley	1,451	42,167	29.06	1225373.02
	6	Univ Washington	925	32,170	34.78	1118872.60
	7	Natl Univ Singapore	2,782	51,598	18.55	957142.90
	8	Georgia Inst Technol	2,073	42,166	20.34	857656.44
	9	Northwestern Univ	1,619	36,036	22.26	802161.36
	10	Harvard Univ	967	27,445	28.38	778889.10
	…	…	…	…	…	…
	63	Indian Inst Technol	5,633	35,764	6.35	227101.40
	…	…	…	…	…	…
	87	Indian Inst Sci	1,524	14,135	9.27	131031.45
	…	…	…	…	…	…
	100	Univ Sci & Technol Beijing	4,229	14,333	3.39	48588.87
Engineering	1	MIT	5,055	52,503	10.39	545506.17
	2	Stanford Univ	3,641	41,307	11.34	468421.38
	3	Chinese Acad Sci	11,521	70,541	6.12	431710.92
	4	Univ Calif Berkeley	4,697	44,020	9.37	412467.40
	5	Univ Illinois	5,813	48,524	8.35	405175.40
	6	Nanyang Technol Univ	6,773	45,996	6.79	312312.84
	7	Univ Michigan	5,011	39,550	7.89	312049.50
	8	Natl Univ Singapore	5,568	41,414	7.44	308120.16
	9	Georgia Inst Technol	5,783	41,949	7.25	304130.25
	10	Univ London Imperial Coll Sci Technol & Med	4,346	35,616	8.20	292051.20
	11	Indian Inst Technol	9,301	50,729	5.45	276473.05
	…	…	…	…	…	…
	100	Huazhong Univ Sci & Technol	3,326	14,245	4.28	60968.60

field, the value of *X* for each institution is computed and rankings done accordingly. Table 1 shows an abstracted list of how the leading institutions from India have performed in each category. While the IITs (identified by Essential Science Indicators as a single institution) are ranked at no. 11 in engineering, it is a poor 63 in the materials science list. IISc appears at no. 87 in this list, but does not figure in the top 100 in the engineering list.

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GANGAN PRATHAP

CSIR-National Institute of Science Communication and Information Resources,
New Delhi 110 012, India
e-mail: gp@niscair.res.in

Lusi mud volcano, Indonesia

Mud volcanoes are geological structures characterized by emission of argillaceous material on the land surface or under water. Usually, there is sufficient water and gas, which makes the sediment semi-liquid and forces it up through the crustal openings as an outflowing mass of mud on the surface[1]. The formation of mud volcanoes is typically associated with geological settings where high sedimentation rates occur, for example, in compressional tectonic belts, submarine slopes and inverted back-arc basins[2,3].

One of the best present-day examples of mud volcanoes is the Lusi eruption in Sidoarjo, Indonesia. It began erupting 150 m from the Banjar Panji-1 gas exploration well at 5 a.m. on the 29 May 2006, two days after the Yogyakarta earthquake (5:54 a.m., 27 May 2006). It is still actively erupting gas, water and boiling mud. The mud volcano has caused flooding in several villages and has displaced 13,000 families along with a loss of 13 lives[4].

The cause of this particular eruption is not well understood. Thus it has fuelled the debate about the understanding of such phenomena and potentially, the role of earthquakes in initiating mud eruptions, because it occurred soon after an earthquake. However, a number of studies have demonstrated that mud volcano eruptions are generally not necessarily associated with earthquakes[2–5] and that the Lusi eruption was initiated by drilling that was ongoing at a nearby oil-well site, located 150 m away from the eruption site[2–6]. Nonetheless, it is believed that earthquakes are significantly responsible for causing mud volcano eruptions[7], as also suggested by a recent study published in *Nature Geoscience*[8].

This research has used the numerical wave propagation experiments to demonstrate that the Yogyakarta earthquake produced sufficient seismic energy waves, which could have initiated the Lusi eruption. This possibly occurred because of the high impedance and parabolic-shaped, high-velocity layer in the rock surrounding the site of the Lusi eruption, which potentially could have reflected, amplified and focused incoming seismic energy from the Yogyakarta earthquake. These results have thus suggested that Lusi is a natural disaster classified as a tectonic-scale hydrothermal system[8].

The Lusi mud eruption provides a good opportunity to understand and explore a number of processes linked to the occurrence of mud eruptions, for example, deep-rooted volcanic hydrogeology and degasing, role of seismic energy to trigger an eruption, and reassessment of geothermal disasters[8,9].

Thus, with this research and what is known in the past, two hypotheses are broadly suggested for the Lusi eruption: (a) it was prompted by drilling at a gas exploration well, which was demonstrated by observing fluctuations in pressure[2–4] and (b) the M 6.3 Yogyakarta earthquake, which occurred ~250 km away from the eruption site, could have initiated the eruption[8]. This is primarily possible because of the fault slip associated with the earthquake, which could have mobilized the mud[8].

However, a number of questions still remain unclear, for example, why the Lusi mud eruption occurred two days after the earthquake and why waves from previous earthquakes did not trigger a similar mud eruption. Thus, it seems possible that both drilling and the earthquake could have initiated the Lusi eruption[9]. Therefore, in future, Lusi and other similar eruptions around the world will serve as key locations for researchers to study and understand mud eruption processes in more detail.

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A. A. SHAH

Curtin University,
Sarawak Malaysia, CDT 250,
98009 Miri Sarawak, Malaysia
e-mail: afroz.shah@curtin.edu.my

Peak water and demand side management

Freshwater resources are fundamental for maintaining human health, agricultural production, economic activity and critical ecosystem functions. As populations and economies grow, new constraints on water resources are appearing, raising questions about limits to water availability.

Peak water is the point at which the renewable supply of freshwater is outstripped by the demand. The term ‘peak water’ has been introduced by Gleick and Palaniappan[1] as a concept to help understand growing constraints on the availability, quality and use of freshwater resources. They presented a detailed assessment and definition of three concepts of ‘peak water’: peak renewable water, peak nonrenewable water and peak ecological water. These concepts can help hydrologists, water managers, policy makers and the public to understand and manage different water systems more effectively and sustainably[1].

Management measures on the demand side are those which reduce the demand for groundwater and/or facilitate more efficient use of water. The Planning Commission’s Expert Committee group on groundwater observed that more than 55% of all irrigation water needs in India is met from groundwater and more than 80% of all rural water supplies is groundwater-dependent. The current rate of global population growth will put a strain on the Earth’s natural resources, with another 2.3 billion people likely to be born in the next 40 years[2]. India is the world’s largest user of groundwater with an estimated 20 million wells. With the increase in population dependent on agriculture, the land : man ratio has declined from over 0.4 ha/person in 1900 to less than 0.1 ha/person in 2000 (ref. 3). In Punjab, Haryana, Rajasthan and Gujarat there is rapid decline in water levels[4]. Thus, demand side management of groundwater is the need of the hour.

Presently, water-use efficiency in agriculture is very low. To check the rising demand of irrigation, water-use efficiency has to be enhanced. This can be done by land-levelling, field-bunding, drip irrigation, sprinkler irrigation, mulching, etc. Groundwater regulation and control, water pricing and water audit can also help increase water-use efficiency.

The Punjab State Farmers Commission has proposed a new policy to decrease area under paddy by 40% in the next 5–7 years from the current 2.8 m ha to 1.6 m ha. The alternative crops suggested are basmati variety of rice, maize, cotton, sugarcane, sunflower, pulses, soybean and vegetables. Cultivation of paddy in Punjab increased from 3.9 lakh ha in 1970–71 to 28.2 lakh ha in 2011 due to assured pricing that gave farmers good returns. However, contrary to popular belief, the state’s canal system irrigates only 27% of the area and the remaining 73% is fed by groundwater from ever-deepening tubewells. Most of the blocks in Punjab come under over-exploited category. It is not certain how much of it is being recharged. The intensity of irrigation is saturated[5]. In Punjab and other states of India before it reaches its peak