result in a situation of 'no food, but starvation death'.

The free-ranging dogs require not only food, but also love and care. Along with a few other dog lovers, this author gets the free-ranging female dogs periodically spayed. The 'Blue-Cross' in Chennai is quite proactive in this regard. This approach helps in maintaining the population of free-ranging dogs within manageable numbers and budget for feeding, vaccination against rabies, etc. What is basically needed is a change in the human attitude towards not only free-ranging dogs, but also all other animals. It must also be noted that the ever-increasing human–animal conflicts are due to human encroachment into their habitat. Humans multiplying in numbers beyond the 'carrying capacity' of the planet and also adopting unsustainable lifestyle are responsible for 'habitat destruction' and species extinction.

Finally, we should understand that no other animal species has caused degradation of the environment, species extinction and exceeding the planetary boundaries with regard to climate change, nitrogen cycle, hydrological cycle, etc. as humans have. Learning from animals to live in harmony with nature can save the planet and humanity which are now at the cross-roads.

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Food production to feed the growing population needs both water and energy

Water–energy nexus in relation to population is elegantly brought out in the editorial by Srinivasan[1]. The message that water is needed for energy production and energy in turn, is needed for providing water is loud and clear. As the population increases freshwater is rapidly becoming a limiting factor for human activities. I would like to further add the complexity of food production into the water–energy relationship. Food production which essentially involves conversion of solar energy into carbohydrates, proteins and lipids[2], consumed as food, by humans and animals, is intimately linked to the availability of water and energy. At the same time, though socially reprehensible in food-deficit countries, food can be converted into biofuels (energy).

The demand for food, water and energy increases with population growth and rising income. Though currently India is self-sufficient in cereal production and is an exporter of rice, pulses and oilseeds or edible oils are imported. At the same time, India accounts for one quarter of the world's hungry population. Global hunger index[3] shows that in 2010–12, 17.5% of the population in India was undernourished, 40.2% of children under the age of five were underweight in 2008–12 and under-five mortality rate was 6.1% in 2011.

In this context, it is pertinent to recall that export of rice and horticultural products, though good for the economy, amounts to export of virtual water as well as energy used for production. One kilogram of rice requires 3000–5000 litres of water for production. It is estimated that export of 10 million tonnes of rice amounts to the export of 30–50 billion cubic metre of water[4]. Both energy and water used for production are subsidized by the Government.

Increasing water, energy and food demands of the growing population, and their shortages call for inter-disciplinary science-based estimates of sustainable human population that the land area of the country can support. Earlier, I had called for carrying capacity (CC) estimates for the country based on food, water and energy[5]. Subsequently collective views of several crop and animal scientists were brought out as a Policy Paper[6] of the National Academy of Agricultural Sciences, and as a special section in *Current Science*[7].

Ecologists define sustainable CC of an ecosystem as the number of humans and animals that can be sustained based on primary productivity of plants, with the available resources without damaging the resource base. Since crop productivity (food production from unit area) is highly dependent on inputs of water and energy, it is pertinent to estimate the numbers that can be sustained with the available resources of water and energy. There are increasing demands for energy and water resources from other sectors.

CC is not a fixed number and essentially depends on acceptable environmental impact. The latter is the product of population number, consumption levels, the technology used as given by the IPAT[8] equation. All manmade items – elevators, buses, trains, aircraft, roads, bridges, etc. are designed for a specified CC. The consequences of exceeding the CC are disastrous – elevators do not move, aircraft fail to take off, bridges collapse, people fall off from trains and buses and movement of vehicles slows down on roads. Presently, we live in ecosystems subject to large human interventions and hence, it is relevant to know the numbers and consumption levels that can be sustained based on land area, food, water and energy available and that could be made available within acceptable environmental impact. Exceeding the sustainable levels would lead to disasters and even collapse. Of course, technological innovations and reduced consumption can enhance CC. In the past, adoption of new farming technologies, the so-called Green Revolution, has made it possible to essentially feed the present population of 1.2 billion compared to 340 million at the time of independence in 1947. An anonymous referee had suggested that the concept of 'ecological footprints' (EF) is more relevant for food production systems as land for growing crops is becoming a shrinking resource. The green revolution technology with increased use of chemical fertilizers, pesticides and water has high EF and hence is considered unsustainable. Reduction in EF of food production has been recommended for global sustainability[9]. EF inversely correlate to CC.

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Culture, science and music in the theatre of education

I was motivated to write this note after reading 'Taking science to the public'[1]. This correspondence documents work in progress and hopefully serves as one more attempt to address science communication in the theatre of education.

I was struck by the amount of casual conversation in our culture dominated by inaccurate references (by scientific standards) and analogies from cinema (arguably theatre) and music. These 'non scientific' references seemed to raise a twinkle in students, particularly when I attempted to draw a serious scientific analogy drawn from a stream of thought (discipline or branch) to a hard concept in a given stream of thought (discipline or branch) in class or during personal or group conversations since 2006. The audience during these conversations composed a large variety, from high school students to freshmen, sophomore, juniors, seniors and graduate students. A casual remark (over coffee) to a few colleagues suggesting that actors play the role (of faculty) with scripts (scientific concepts by scientists and/or faculty) may elicit a favourable response drew an expression that could be called 'serious disagreement'. I set to test this tenet more seriously.

The early experiments in the theatre of education involved asking students to do one (of four) problem set in the form of a skit in class or using a piece of music as one of the solution methods, as an option. This drew a small crowd to enquire about the approach. Sufficiently armed with the knowledge of full credit (marks) for trying, with a technical report if the team felt they did poorly (backup), 6–10% of a given class took this route. The attempts were amateur by standards of theatre and its serious demands were remarkable for the originality. Communication in English was a problem in these attempts. This was overlooked (for credit) but addressed as room for improvement (in private). The feedback from the peers in class was usually positive in terms of audience participation that involved mocking, laughter and applause, quantities that indicated healthy conversation. I do distinctly remember a group of four that bravely attempted a poem amidst trying audience participation (boos and jeers).

A *Youtube* video was filmed and displayed by students with script from faculty and another in-class poster session made its way to *Youtube*. A more recent search on *Youtube* and *Google* failed to find these.

While these early experiments might convey progress, they failed in the tenet that science (and its concepts) was communicated using theatre or video. I sought avenues armed with experience.

A casual conversation with a friend on social media led to an experiment with one assignment (of four) required with one quote on social media platform of the student's choice in English. The students were encouraged to seek help from peers and friends for the quote. This highlighted the problem of communication in English and the confidence level on a public social media platform. This first social media attempt 'failed' in science communication.

A more 'serious' approach on social media ran documenting a paragraph and/or 100 characters for each lecture in class for 2 years. These served to remind the class on the date, time, location and content of each in-class lecture. The lecture was supplemented by a discussion (on a discussion board) and information technology tools[2] to assess learning outcomes. Full credit was assigned while using the information technology tools with a criterion to try till the student got the answer 'right'. 'Quantified' response improvement by the use of these tools was very low over a more traditional lecture-based assessment method, measured using data with me since 2006. These experiments continue with music (and more), sacrificing attempts at rigorous quantification.

I have deliberately decided to write this note without quantification. Doing this rigorously would require more efforts[3,4]. I have experienced many attempts to communicate science as an active audience, as described in ref. 5. I think the approaches[5,6] and arguments[6,7] in communicating science are useful to think in the context of our culture[1]. It is clear to me that media has a role to play and perhaps there is more serious work required[1,5–7] in conveying science to the public. This may not happen, in my opinion, till we engage our students more in the theatre of education and get it right, perhaps using music, theatre and more.

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