Make in India – some suggestions

The guest editorial by Arunan[1] is timely and thought-provoking. However, scientists/science managers/politicians/bureaucrats should also read comments expressed in the long debate on the National Science University (NSU) initiated by Balaram in 1994 (ref. 2). These comments provide more ideas as to what can be done for 'Make in India' to be successful. It is essential that we have a long-term policy which cannot be tampered with even if the governments change. A high-level committee should be created to keep in view the 'Make in India' concept and to decide on priorities in science and technology which shall not be seriously tampered.

Since independence we have been importing many products, both from developed and developing countries. In 2014, we imported US$ 462.9 billion worth of goods from 26 different countries[3]. This has been reduced to US$ 32.3 billion in 2015 (ref. 4). There is further scope for reducing this by import substitution and increasing exports.

'Make in India' can succeed only if we emphasize on quality. Unfortunately, at present there is little attention paid to this. Most commodities produced in India are adulterated. There should be a strict surveillance on quality and for this, there is a need for the development of suitable kits and technology for assessing quality and purity. Simultaneously, laws must be made to punish adulterators and officials negligent of monitoring adulteration. Arunan[1] has also mentioned the need for lab equipment but not chemicals, which are at present mostly imported. Hence expertise and manpower must be developed in these sectors.

We are also short of supporting services and manpower required in the manufacturing sector. For this, vocational training has to be strengthened.

We have many institutions in India, but there is no coordination in their work, nor is there team effort within institutions. This must be streamlined to make their work more useful. 'Clean India' concept also needs some degree of mechanization, suitable science and technology for waste disposal and/or recycling and public awareness.

1. Arunan, E., *Curr. Sci.*, 2015, **109**, 1519–1520.
2. Balaram, P., *Curr. Sci.*, 1994, **67**, 502–503.
3. http://www.worldsrichestcountries.com/top-india-imports.html
4. www.tradeeconomics.com/india/imports

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Chennai flood of 1–5 December 2015: an extreme climatic event?

Chennai received rains throughout November 2015, as expected during the northeast (NE) monsoon every year, perhaps slightly above average. Most of the small and large water reservoirs (known as yeris in Tamil) located west and southwest of the Chennai city were either full or nearly full. These water bodies supply water for agriculture and particularly the large ones (Chembarambakkam, Puzhal, etc.) cater to the city's water demands.

On 1 December 2015, very heavy rainfall reaching up to 49 cm in 24 h fell in parts of Chennai and the surrounding area (Kanchipuram district). Chennai usually receives about 139 cm of rainfall in a year (annual mean rainfall, http://www.imd.gov.in/section/climate/extreme/chennai2.htm) and thus 35% of the annual rain fell in just 24 hours! The rains, though not to this intensity, continued for the following five days. Usually rainfall during the NE monsoon is as a result of formation of a depression in the Bay of Bengal when it moves closer to the southern east coast of India and Sri Lanka. This causes heavy precipitation for about four days in the coastal zone and stops after the depression turns into a cyclone and crosses the coast and moves west- or northwest-ward into interiors of southern peninsular India. Thus the interior parts of Tamil Nadu (TN), Andhra Pradesh (AP) and Karnataka also receive rainfall during this season. The cycle continues several times during the NE monsoon season with rainfall punctuated by cloudy to sunny days. However, during the end of November and the first week of December 2015, the depression stayed centred off the coast of TN for an extended period as the wind speeds were only around 10 km/h. This perhaps had resulted in continuous rainfall through most part of November and early December 2015 in the northern coastal districts of TN, including Chennai, breaking the century-old rainfall record. Thus, this event can be considered as an extreme climatic event.

All the tanks and water bodies surrounding Chennai and in the coastal districts of northern TN were full or nearly full by the end of November 2015. Prompted by the heavy downpour, excess water was released from these water bodies into streams and rivers, such as, the Adyar and Cooum rivers that flow through the Chennai city. Bund of a few tanks breached and suddenly released large volumes of water. These have caused flooding of the flood plains of Adyar and Cooum rivers and low-lying areas of Chennai. These low-lying areas were either marshy lands or rice-cultivated wetlands now converted to mostly residential colonies with schools and colleges. Similarly, the flood plains of rivers are used for residential purposes. During heavy rains water flows as sheet which is known as sheet-flow, whereas during normal rainfall water flow is mostly confined to natural or artificial drainage channels. Once sheet flow is formed, the water tries to find its way towards a stream or river to get drained. As a result of construction of houses, schools, colleges, roads, etc. in the low-lying areas (former marsh and wetlands), the sheet flow of water is prevented from draining, causing flooding and rise of water levels. The increased water flow in Adyar and Cooum rivers also contributed to this. As reported, in several localities flood water level exceeded 5 m in height, severely damaging property of thousands of families.

The extreme climatic events, like the Kashmir floods of September 2014 and Chennai floods of December 2015, are

expected to recur more frequently in this century due to global warming and associated climate changes (https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch10s10-2-3.html). We cannot prevent occurrence of such extreme climatic events, but their severity or extent of adverse impact can be minimized through better preparedness. With reference to the Chennai floods, some of the actions that can minimize the impact of future floods are suggested below.

(1) No new residential/office/industrial structures are to be permitted in the wetlands and flood plains of rivers.

(2) In the low-lying areas which are already occupied by residential colonies and buildings, proper drainage system should be constructed.

(3) The drainage system should consist of street-wise flood water draining channels connected to a drainage canal. The drainage canal is to be connected to existing rivers that drain into the sea (Bay of Bengal).

(4) The course of the existing rivers, Kosasthalayar, Cooum and Adyar, that wade through the city is to be dredged to facilitate free flow of water into the Bay of Bengal.

(5) Dredging and restoration of Buckingham canal and linking it with the rivers and Bay of Bengal will help drain water quickly during heavy downpour and cyclone.

The Buckingham canal runs through Chennai, from Kakinada in AP to Marakanum in TN for a distance of about 420 km; its width ranges from 100 to 40 m, and runs parallel to the Coromandal coast. The Buckingham canal built during the British Raj in the 19th century was used for goods transport till 1965. This canal with a capacity to hold over 100 million cubic metres of water has acted as a buffer against floods and tsunami, and saved thousands of people in the past[1].

Revamping of the three rivers and the Buckingham canal flowing through Chennai will bring enormous other benefits such as restoration of ecosystem, reduction in pollution, control of vector-borne diseases, use for navigation and tourism.

1. Rao, B. R., *Curr. Sci.*, 2004, **89**, 12–13.

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Higher education and Indian science – start with the school education

It is heartening to see a Guest Editorial by Ganesh[1] on the topic of Higher education and Indian science in *Current Science*. In the same issue, Sen[2] writes about the deficits and possible remedies regarding Indian higher education. Both the authors have identified problems that are hindering the growth of Indian science; but the focus on attracting students to a science career right from the school level is missing. Increased resources for R&D are important, but getting and developing the right scientific manpower is the crux of the problem in our system. Young students from our high schools and colleges are slowly being lured away from their genuine interest in science, because of the lack of innovative ways of teaching science. Their natural curiosity about science is not encouraged and supported in the existing school and college system. A personal experience of the present author may prove the point.

After retirement, I decided to offer my services to a well-endowed school nearby. I wanted to interact with students from the eighth and ninth standards to satisfy their curiosity and make them think about and understand the wonders of nature around them. The experiment was to set up an open-ended forum of an 'Ask Club', where the students would ask any question that excites them about the world around them. The forum would try to answer individual questions through discussions amongst the students; and I was to act only as a catalyst to direct the discussions to arrive at an answer. The school authorities were keen for me to use the set science syllabus for each class and 'coach' the students to prepare them for the final examination. When I refused to run such 'coaching' classes, they made it optional for the students to attend the 'Ask Club'. To my surprise, the students of both classes voluntarily agreed to come and attend the sessions and really open up their pent up curiosity by asking questions ranging from 'How to save a fixed amount of electricity consumption in their homes?' to 'Is there life beyond the Earth?' (the SETI problem). They even had questions like 'Why do people believe in horoscopes'? 'How can we prove that Rama, the mythological hero of Ramayana really existed'? 'Was he born in the so-called Ram Janmabhumi'? By letting the students meander from one topic to another, it was exciting to see how they were exploring the method of science. The class was full and students enjoyed every moment. These sessions led me to write a book for the National Book Trust, titled *Science and You*[3]. The students had asked me to 'Write something that is not in our text books'! The book does not have separate chapters on mechanics and optics, but chapters on areas of curiosity shown by the school students. After more than a decade of its publication, the book is still selling roughly 10,000 copies per year, presumably read by the students. This augers well for the curiosity amongst our school students. There is a need for our teachers to satisfy the curious minds with more innovative and interactive teaching to keep up their zest for science. Innovative science education should begin at the schools to ignite the minds of the young. They are then bound to pursue innovative science careers in our universities and national laboratories.

1. Ganesh, K. N., *Curr. Sci.*, 2015, **108**, 2135–2136.
2. Sen, S. K., *Curr. Sci.*, 2015, **108**, 2151–2155.
3. Lavakare, P. J. and Narlikar, J., *Science and You*, National Book Trust, New Delhi, 2000, ISBN: 978-81-237-3657-0.

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