

Painting the smokestack black

The United Nations' index to measure the wellbeing of nations has been shown to be flawed, says s ananthanarayanan

PROFESSOR Chuluun Togtokh from Mongolia, in evaluating the level of human development, has worked in the cost to the environment and finds that when this is done the icons of success in human wellbeing, according to the United Nations' existing index for the same measure, slip many places, to countries with more green and sustainable methods of living. He argues that the present *Human Development Index*, which is sponsored by the UN, has the effect of idolising some of the most environmentally rapacious societies.

Replacing the index with one that considers environment-friendly technologies would help project "greener" countries and place a value on being responsible in the use of energy. Togtokh is a professor of ecosystem and sustainability sciences at the National University of Mongolia in Ulaanbaatar and vice-chairman of Mongolia's Global Change National Committee. His findings have been projected by the International Geosphere-Biosphere Programme of the Swedish Academy of Sciences and his article has appeared in the current issue of *Nature*.

Human Development Index

The HDI is the outcome of a most earnest effort, with origins in a report of the UNDP, "to shift the focus of development economics from national income accounting to people-centered policies." Much of the credit for its formulation goes to Pakistani economist Mahbub ul Haq and India's Nobel laureate, Amartya Sen. The latter had opposed the idea of expressing the complexity of the human condition in a single index, but Haq argued that this was necessary to turn the gaze of planners from economic indicators to those of human felicity.

The formula worked out considers three factors as the indicators of welfare: health, education and prosperity. The indicator for health is the life expectancy at birth; for education, the years of schooling; and, for prosperity, the per capita national income, normalised against the dollar by purchasing power. Complex mathematics has gone into arriving at the correct average to be considered and the final formula is formidable and scholarly, as can be seen in Figure 1.

Based on this fine measure, formalised this very month (November) 20 years ago, the UN has graded countries as more and less people-friendly and has published the findings, to set up for countries lower in the ranking the examples of the highest ones to follow and emulate. Apart from the validity of the method of ranking being open to question, there remains the uncertainty of the figures being

The Human Development Index depends on the measures of health, education and income and is worked out like this:

Health Index (HI) = $\frac{\text{Life Expectancy} - 20}{63.2}$

Education Index (EI) is based on the mean and expected years of schooling and = $\frac{\text{Square root of (Mean years of schooling INTO expected years of schooling Index)}}{0.951}$

The 'mean years' and 'expected years' indices are also worked out with impressive precision:

Mean years Index = $\frac{\text{Years a 25-year-old person has spent in school}}{13.2}$ and

Expected years Index = $\frac{\text{Years a five-year-old can expect to spend in school in his/her life}}{20.6}$

The Income index (INC.I) = $\frac{\text{Natural logarithm of the GNP (adjusted for purchasing power) per capita}}{\text{Natural logarithm of (another number) - natural logarithm of 163}}$

With the help of these three indices, the

Fig-1 Human Development Index = The cube root of (HI x EI x INC.I)

Country	HDI ranking (2011)	HSDI ranking (2011)	Carbon Emission (Tonnes/capita-2008)
Norway	1	1	9.5
Australia	2	26	17.9
USA	4	28	18.1
Canada	6	24	16.5
Sweden	10	2	5.4
Japan	12	13	9.8
UK	28	22	8.9
India	134	131	1.4
Pakistan	145	143	0.9
Nepal	157	154	0.1

Fig-2

adopted. But this has been the yardstick and nations the world over have been labelled low-human-developed or backward, and the most sign — to go towards higher ranking — has been used by industry, politics and advertising.

Carbon footprint

With the clearly large incomes of countries like the USA, which have become large energy users, and compulsory school education and good nutrition that they enjoy, the formula is guaranteed to show these countries as the most oriented to "human development". Professor Togtokh questions the validity, in the present day context, at any rate, of the factors that are being considered. No doubt, the index has the merit of simplicity and apparently measures what is important to humans. But the result is that with only these goals taken as criteria, the other practices and means used by countries that score high get left out and the "gas guzzling" developed nations have been "celebrated".

While the world and the UN go to all ends to speak for "sustainable development", the use of the HDI as a measure of development, which holds up the developed countries as "advanced", raises grave questions about the real commitment to sustainability. The per capita CO₂ consumption in the developed countries is of the order of 15 to 50 tonnes (in 2008). France is an exception, but this is because it generates over 85 per cent of its electricity needs from nuclear plants. In comparison, the per capita consumption (2008) in India was 1.4 tonnes and only a tenth of a tonne in Pakistan and some African countries.

With the burning of fossil fuels and industrialisation rapidly polluting the earth's resources and environment, the standard of living in the developed world is clearly at the cost of others and the future of the earth — hardly the way for the rest of the world to go. But the HDI shows the largest offenders as the most people-friendly and the world persists in the apparent belief that resources will last



Professor Chuluun Togtokh.

forever and the earth will somehow survive "development".

Professor Togtokh reworked the HDI by taking one more factor into consideration — the per capita carbon footprint. He notes that the per capita carbon emissions are "a simple, available and quantifiable indicator", which is seen to be positively and strongly correlated with income, and not at all with health and education. There is a question of what income really does have to do with "wellbeing" — if it is a means to real value, then the indicators of that value should speak and income may best not be considered. But Professor Togtokh has also taken into account the negative effect of carbon emissions to make the formula a little more complete, and he has reworked the index as a *Human Sustainable Development Index* and found new gradings.

The effect is that with this adjustment alone, some of the giants of development fall in the ranking — while others, equally affluent and with high living standards, rise in the ranking, thanks to their more green and carbon emission-

Ground reality

For the first time animal diversity in the soil has been mapped, writes salonie chawla

ANIMALS that live in the soil play an important role in the ecosystem but little is known about their correlation with organisms above the ground. A study of soils from 11 areas around the world shows that unlike most species above the ground, soil animals have restricted distributions.

A team of ecologists from the USA and UK collected soil samples from 11 sites, including tropical forest in Costa Rica, arid grasslands in Kenya, warm temperate forests in New Zealand, the tundra and boreal regions of Alaska and Sweden and the shrub steppes of Argentina to conduct a comprehensive molecular analysis of the global distribution of soil animals like nematodes and microarthropods.



Researchers Ed Ayres and Diana Wall measure soil respiration in Kenya.

Through testing and sequencing of the genetic material, they found that 96 per cent of the population of soil animals was restricted to a single location. This means each ecosystem is unique, with its own soil fauna. Conserving soil fauna at one location would not help in its distribution to other locations, said Jim Garey, lead researcher from the University of South Florida in the USA.

When asked the reason for restricted distribution of soil fauna, the researchers said it could be related to nutrients. If soil nutrients are tied up in plants that are above ground, they are less available to soil fauna. A greater diversity of plants and animals above the ground results in high levels of inorganic nitrogen and low pH in the soil. High soil nitrogen favours growth of bacteria instead of fungi. Studies have shown that soil animals are more diverse in fungi-dominated soil and less diverse in bacteria-dominated soil, Garey explained.

It has been accepted that a wider range of species can be found above ground at the equator than at the poles. The study proves this does not apply to species living underground. "It was not true for the latitudes we studied," said Garey.

The study was published in *Proceedings of the National Academy of Sciences* on 17 October.

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Light-speed claims rejected

Icarus physicists' study upholds Einstein's theory of relativity, steve connor reports

A STUDY showing that sub-atomic particles can travel faster than the speed of light — thereby overturning more than 100 years of theoretical physics established by Albert Einstein — must be wrong, according to a rival team of physicists. In September, scientists involved in the international Opera experiment said that a beam of neutrinos had arrived 60 billionths of a second faster than light would have travelled from the underground particle physics laboratory at Cern in Geneva to the Gran Sasso facility in Italy.

Over the weekend, the Opera scientists said they had repeated the experiment with minor modifications to the length of the particle beam to take into account a possible source of error.

They said they found the same result — neutrinos that could travel faster than light. Under Einstein's theory of relativity, nothing can travel faster than the speed of light. Otherwise, it would be possible to travel through time.

Now a second group of scientists, part of the Icarus collaboration, has reanalysed the same beam and concluded that the particles could not have travelled faster than light speed without exhibiting a fall in energy levels, which was not detected.

The reanalysis of the same neutrino beam by the Icarus group of physicists is the first serious study to question the "faster-than-light" findings that have astonished and confounded scientists in equal measure. Physicists involved in the Icarus



Dr Tommaso Dorigo (left) said the Icarus study is "very simple yet definitive" in refuting the almost heretical notion that sub-atomic particles can travel faster than light.

collaboration have posted the new interpretation of Opera's results on a scientific website stating that the neutrinos would have lost discernible amounts of energy had they travelled faster than the "universal constant" of light speed — about 186,282 miles per second.

As this was not the case, the particles could not have travelled faster than light, the Icarus team said. "Our results therefore refute a superluminal (faster than light speed) interpretation of the Opera result."

Tommaso Dorigo, a high-energy physicist at Cern who was not part of the Icarus group, said the Icarus study was "very simple yet definitive" in refuting the almost heretical notion that sub-atomic particles can travel faster than light. "The Icarus result says that the difference between the speed of neutrinos and the speed of light cannot be as large as that seen by Opera, and is certainly smaller than that by three orders of magnitude and compatible with zero," he said on his blog.

A definitive answer to the question of whether the Opera results hold water may have to wait until next year when scientists involved in the Minos consortium will carry out similar tests with American particle accelerators in Illinois.

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'Neutrinos still faster than light'

The confidence is showing, writes tom rowley

SCIENTISTS are becoming more confident that they will be able to contradict Einstein's assertion that nothing can travel faster than light, after carrying out another test. Italian physicists first made the startling claim in September but have now repeated an adapted version of their experiment, which produced the same result.

The test suggests that sub-atomic particles called neutrinos can break the barrier. If such tests can be repeated, they would challenge one of the fundamental assumptions of modern physics. On 7 November scientists submitted their latest findings to the *Journal of High Energy Physics* for consideration. They said that they had waited until now to submit the paper to take into account suggestions from other scientists and carry out a new test. They beamed neutrinos through 730 km of rock from the Cern nuclear research facility in Switzerland to Gran Sasso, Italy.

A light beam would take 2.4 milliseconds to travel the distance — but both experiments have shown a neutrino can beat it there by 60 billionths of a second.

In 1905, Albert Einstein stated in his theory of special relativity that nothing could travel faster than a light beam in a vacuum — 168,282 miles per second. According to the theory, it would take an infinite amount of energy to exceed light speed.

The tests were carried out by the Oscillation Project with Emulsion Tracking Apparatus. Fernando Ferroni, president of the Italian Institute for Nuclear Physics, said, "A measurement so delicate and carrying a profound implication on physics requires an extraordinary level of scrutiny. The Opera experiment, thanks to a specially adapted Cern beam, has made an important test of consistency of its result."

"The positive outcome of the test makes us more confident in the result, although a final word can only be said by analogous measurements performed elsewhere in the world." Physicists in Japan will now try to repeat the experiment, with the help of scientists from Liverpool University. Professor Thomas Bowcock,



head of the university's particle physics team, said, "Should neutrinos travel faster than light, it would overthrow our ideas of the structure of space and time."

"Physicists are therefore treating the results of the experiment with caution and looking to test them again through our separate experiments to be certain of what these results are telling us. The University of Liverpool team is working in Japan, which can measure neutrino velocities over a slightly shorter distance (230 km) from Tokai to Kamiokande on the T2K (Tokai to Kamiokande) experiment."

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