A critique on the tsunami–earthquake link

Various causes are known for generation of tsunamis, yet those which originate especially in the Circum-Pacific belt, are invariably associated with earthquakes. Even the 26 December 2004 Indian Ocean tsunami was preceded by a high-intensity earthquake. Perhaps it is because of this intimate association that the 'harbour waves' are described as 'earthquake-generated tsunami' or 'seismic sea wave'. The Circum-Pacific seismicity is also often dubbed as 'tsunamigenic'. Without refuting the tsunami–earthquake link, the usage appears misleading because, scientifically speaking, both earthquake and tsunami are manifestations of sudden dislodgement of rock masses during faulting.

The elastic rebound theory[1] aptly explains how the energy released during disruption (or faulting) of strained rocks radiates from the source of origin as elastic waves. The vibration in the earth's crust caused by the propagating waves shakes the ground, and the phenomenon is known as earthquake. Some elastic waves cannot pass through a liquid medium, while some others get considerably subdued. (A useful information which would confirm the above statement is that many residential buildings in the earthquake-prone Andean South America have swimming pools especially designed as a safety-facility from earthquake hazard).

It would be wrong to say that the earthquake waves can provide energy for generating a tsunami. A point to remember is that no tsunami was generated during severe earthquakes along the San Andreas Fault, a considerable part of which runs along the ocean floor. The reason is that the movement along the fault causing an earthquake was of translational or strike-slip type, and did not displace water in any significant way. And the fact is that unless there is massive displacement of water, no tsunami would occur, even though the faulting might cause a high-intensity earthquake.

The energy source for tsunami generation is the gravity disequilibrium caused by the formation of either a bulge or a depression over the normal sea-level. Waves are generated as the disturbed water level attempts to attain equilibrium. Because there is little energy loss during the propagation of waves over the ocean water, the harbour waves which finally strike the coastal areas assume ferocity.

There cannot be any cause–effect relationship between earthquake and tsunami. At the most, we can think of subduction-related earthquakes as early signals of an incoming tsunami.

All these are well known to the earth scientists; yet terms like 'tsunamigenic' earthquake or 'seismic sea wave' find wide usage[2]. It is better to avoid such usage because common people, especially those living in coastal areas might misread that an intense earthquake as a definite signal of an incoming tsunami. Two tsunami signals were issued in the newspapers and electronic media following the 12 September 2007, earthquake of magnitude 8.4, that struck Bengkulu in southern Sumatra, Indonesia and another also in Indonesia recently, during the last week of August this year. Both the warnings proved false. The sooner we understand the tsunami–earthquake link, the better it is for us.

I thank Ranen Sen and Sumit Ray for some fruitful discussion on this subject.

1. Reid, H. F., Report of the State Investigation Commission, Carnegie Institution of Washington, Washington DC, 1910, vol. 2.
2. Bilham, R., *Nature Geosci.*, 2008, **1**, 211–212.

A. B. ROY

Department of Geology,
Presidency College,
Kolkata 700 073, India
e-mail: abroy_g@yahoo.com

An income-generating scheme for vector management of chikungunya fever in Kerala and Karnataka

India is under the grip of an outbreak of chikungunya fever[1–3] since 2006. The genome of the causative chikungunya virus (CHIKV) closely resembles that from Indian Ocean islands[1,2]. The molecular phylogenetic analysis of the virus revealed its introduction to India from these islands[1] during 2005–06. Subsequently, the virus acquired a crucial mutation in Kerala, enabling it higher efficiency in replication and dissemination in *Aedes albopictus*. This mutation in the virus along with the abundant vector species population acted as a major contributing factor towards a more widespread outbreak[3] of the disease in Central Kerala during 2007. Recently, an epidemic was reported from the northern part of Kerala (Kasaragod District) and adjoining Karnataka (Dakshina Kannada District) in May 2008. Media documented as many as 35,000 and about 16,000 fever cases[4,5], among which at least 6500 cases and 2991 cases being suspected chikungunya fever in these districts respectively. We visited these regions during June–July 2008 for an analysis of the disease outbreak.

Neither vaccines nor drugs are available for CHIKV infection in man, and the integrated vector management strategy remains the only effective control measure of this disease[6]. Here we present a practical solution for control of the vector species, namely *Ae. albopictus* abundant in this region, which could also serve as an income-generating scheme to the local community.

India is the largest producer and consumer of arecanut (*Areca catechu*) in the world. It was grown in about 3.96 lakh hectare area in India[7] during 2006–07. Of these, 1.68 lakh ha is located in South Karnataka and 1.02 lakh ha in North Kerala. These two states contribute 59.75% of arecanut production in India.

During our visit to these regions we found that the fallen leaves of arecanut trees (innumerable in large *A. catechu* plantations in the area), accumulated rain water (due to the SW monsoon), and

Figure 1. Fallen *Areca catechu* leaf acting as breeding source of *Aedes albopictus.*

Figure 2. Disposable plates made using *A. catechu* leaves.

acted as the major breeding habitat for *Ae. albopictus* (Figure 1).

The making of disposable dishes such as plates made out of areca palm leaves (Figure 2) is a well-thriving industry in India, with international export avenues. This small-scale industry could be promoted to provide income to the rural community. Crude estimates reveal that 532 crore palm leaves are shed from the areca plantations in India every year[8].

We propose that the local community collect and process these fallen arecanut palm leaves to make disposable plates, etc. This would generate employment and income to the local rural community. Also, this could be an alternative for plastic cups, plates and other containers, another important source of *Aedes* mosquito breeding. The by-product of this activity would be a drastic reduction of *Ae. albopictus* vector population and thereby chikungunya fever in the regions.

1. Pradeep Kumar, N. *et al., Curr. Sci.*, 2007, **93**, 1412–1416.
2. Arankalle, V. A. *et al., J. Gen. Virol.*, 2007, **88**, 1967–1976.
3. Pradeep Kumar, N. *et al., J. Gen. Virol.*, 2008, **89**, 1945–1948.
4. ThaIndian News, 2008; http://www.thaindian.com/newsportal/health/keralas-kasargod-district-in-the-grip-of-fever_10062542.html
5. *Deccan Herald*, 2008; http://www.deccanherald.com/Content/Aug12008/district2008073182093.asp
6. World Heath Organization, WHO-SEARO, 2008; http://www.searo.who.int/en/Section10/Section2246.htm
7. Vinayak, A. J., 2008; http://www.thehindubusinessline.com/2008/06/26/stories/2008062650791300.htm
8. Newindpress.com, 2007; http://newindpress.com/newsitems.asp?ID=IEO20071006013029

N. PRADEEP KUMAR[1,*]
RAJAN JOSEPH[2]
P. JAMBULINGAM[1]
M. KALYANASUNDARAM[1]

[1]*Vector Control Research Centre (ICMR), Indira Nagar, Puducherry 605 006, India*
[2]*Kerala State Institute of Virology and Infectious Diseases, Alappuzha 688 009, India*
**e-mail: kumarnp@ymail.com*

Rice cultivation is not cause for climate change

There is a discussion in the scientific circles that methane emission from rice cultivation is an important cause for climate change, with methane being one of the greenhouse gases (GHGs)[1–4]. Some argue that during the past 200 years we have witnessed an increase in methane emission. If it were so, I wonder how although rice cultivation has existed since times immemorial, no climate change was ever observed earlier, but only in the past 200 years, and more so in the past 50 years.

There seem to be ulterior motives from some quarters in the West to blame rice cultivation to escape from themselves being targeted for the GHG emission. People in the West do not want to forgo their luxurious lifestyles and hence want to find an alibi to shift the focus onto rice cultivation as the culprit of methane emission, for which some scientists are ready to provide data in their favour. A few also argue that organic carbon available in the rice fields might enhance methane production, and hence organic cultivation would be a problem and chemical fertilizers would mitigate this to some extent. This is again unacceptable for the simple reason that organic cultivation prevailed thousands of years before chemical fertilizers came into existence. Only in the past 50 years usage of chemical fertilizers has seen a boom, and methane emission and climate change also correspond to this period. Hence organic cultivation has nothing to do with methane emissions.

If somebody wants to subscribe to the argument that rice cultivation has indeed been the cause for GHG emissions, then he/she should let people know what happened during the past 10,000 years when rice cultivation was very much present, with rice being the staple food. It would be more agreeable if industrial revolution of the past 200 years and aerosols released from motor vehicles, smoke from different factories, etc. are considered as the causes for GHG emissions and climate change.

Even if methane is generated in the rice fields, the group of bacteria belonging to methylotrophs and methanotrophs would consume the gas in the immediate vicinity, as the same rice fields would serve as reservoirs for propping up of methylotrophs. Since rice fields that have standing crops are almost static units in terms of various parameters, the role of methanotrophs/methylotrophs in mitigating methane produced by methanogens and how they balance the methane table in rice fields should be investigated thoroughly.

One advantage with the argument that methane generated from rice fields leads to climate change is that if it gains more acceptance the same would lead to a shift towards the cultivation of other less water-demanding crops, so that inter-state water disputes in our country could be