The *jhumias* of Tripura may be frustrated

Peanut shaped Tripura – one of the members of the seven sisters is situated between 22°05′ and 23°32′N lat. and 90°09′ and 92°32′E long., covering an area of 10,491.69 km^2 bounded by Assam in northeast, Mizoram in east and Bangladesh in the remaining sides. In this small state, the *jhumias* of Tripuri, Reang, Jamatia, Noatia, Mog, Lusai, Kuki, Halam, etc. tribal communities practice *jhum* (shifting cultivation) in the steep and very steep slopes on the hilly tracts of the state.

Just before the onset of monsoon, the *jhumias* with hope and desire pray to their most beloved deities for better crop yield. During the onset of monsoon, they drop 2 to 3 seeds of different crops (rice, cotton, gourd, chilli, mesta, maize, etc.) in small holes after cleaning the land. Holes are generally made by dibbling knives made up of iron/bamboo/wood. When there is dry spell for a couple of days, weeks or months, they use *chongas* (one-sided hollow bamboo pots) to collect water from the very distantly located streams or streamlets. As the crops grow, their work becomes more tedious in protecting their sole crops from wild pests like the birds, bores, elephants and other herbivorous animals. To keep an eye on the crops they make small bamboo huts on the tree tops. At night they light fires to protect the crops as well as themselves from wild animals. Once the harvesting is over, they move in search of a new piece of land because they believe that cultivation of crops on a new piece of land will fetch them more yield. In this process, they return to their present land after about 5 to 6 years. Thus, a cycle is formed, in such type of cultivation, giving the name shifting cultivation. Today, growth of population, decrease of forest cover and land have forced the *jhumias* to reduce their *jhum* cycle ultimately resulting in degradation of the state's natural wealth (soil, flora, fauna, etc.) causing serious ecological changes at an alarming rate. For their survival, they are compelled to move from one place to another (within the hills and forests) cultivating crops on a piece of land with utmost frustration.

Since independence several steps have been taken up by the government and other organizations to rehabilitate the *jhumias*. In the state, two resettlement divisions for shifting cultivators were set up under the forest department with Headquarters at Manu (North Tripura district) and Jatanbari (South Tripura district). Subsequently, for successful implementation of different programmes a separate department named 'Tribal Rehabilitation in Plantation and Primitive Group Programme' was created in October 1985. Several efforts from the Central government (through North Eastern Council), State government (agriculture, forest, animal husbandry, tribal welfare) departments, Indian Council of Agricultural Research (ICAR), nongovernmental organizations, etc. are also being made through implementation of various programmes. But, the progress in rehabilitation of the *jhumias* is very slow. In both South and North Tripura districts, the rehabilitated *jhumias* have again reverted to *jhum*. 'Hunger' seems to play the key role behind such incidents. Lack of proper transport and communication, physiographical isolation, adequate technical know-how, marketing facilities along with their distressed economic condition are the prime hindrances for *jhumia* rehabilitation. It is not possible to accomplish such rehabilitation programme single-handedly. Scientists, planners, policy makers, extension workers should join hands and work together. One should also keep in mind that *jhumias* need food, fibre, shelter and a secure future. Thus, care should be taken to see that these programmes continue not for a day or month but for several years; in the process, a bondage will be formed among the urban people, the workers and the *jhumias*.

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Satellite altimetry

Majumdar and Bhattacharyya[1] must be appreciated for giving the basics of satellite gravity/altimetry, which helps in the preparation of bathymetry maps fast and with minimum effort. The three profiles given by them across 90°E Ridge are comparable to a great extent. Using ship-borne bathymetric data collected on-board RV *Samudra Shaudhikama* of Geological Survey of India, within the territorial waters off Tuticorin in the Gulf of Mannar, the bathymetric map was prepared to compare sea-floor morphology with that of the bathymetric data derived by satellite altimetry (www.ngdc/noaa.gov).

The ship-borne data interval is ~0.4′ by ~2.5′. The bathymetric map using the ship-borne data brings out the following information about sea-floor morphology in the area. The area is characterized by an older but pronounced wave-cut terrace (WT_1) between 18 and 30 m water depths and is parallel to the present coast followed by a discontinuous submerged coral ridge (CR_1) within a water depth of 14–18 m, which follows an emerged but discontinuous coral ridge (CR_2) and a younger but less pronounced wave-cut terrace (WT_2), whereas the bathymetric map prepared using the altimetry data pertaining to this area shows marked dissimilarities in sea-floor morphology. WT_1, according to the altimetry data, is not parallel to the present coast and CR_1 is absent. Northeast of Tuticoin, a flat topped plateau having 4 m water depth appears at a place where the actual depth is between 14 and 50 m. Manifestations of CR_2 are absent in this map and WT_2 is not traceable. Whether the plateau reflects any buried mass is not known. Such marked discrepancies were also observed while comparing the profiles drawn from the inner-shelf to the western slope across the Lakshadweep Ridge (S. V. Hegde, pers. commun.). Since these two areas fall on the continental crust, our apprehension is about the algorithm used to convert the gravity data obtained over the continental crust and oceanic crust. Hence, care must be taken while using altimetry data of near-shore areas. A detailed paper on this will be presented at the National Seminar on Quaternary Climatic Changes and Landforms in Tirunelveli.

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Response:

We thank Dinesh *et al.* for appreciating the satellite altimetry-related bathymetry prediction activity as a fast and effective method. We have tested the model in a deeper ocean near the Andaman offshore and received appreciably satisfactory results. The known ship-borne bathymetry technique is old, requires a number of corrections and is highly time-consuming. Even today, a huge area in the Indian offshore remains unexplored by ship-borne bathymetry. In this respect, satellite altimetry delivers a fast and comparatively accurate method for prediction/delineation of bathymetry, particularly over the deeper oceans.

For generation of gravity using altimeter data, one has to first generate the marine geoid (the hypothetical surface nearest to the sea surface, free of any external disturbances, e.g. tides, sea-surface winds, ocean gyres/eddies, etc.) from sea surface heights. The same can be converted to free-air gravity using a simple formulation as given by Chapman[1]. The detailed method gets complicated due to a number of corrections, and other necessary parameter estimations. Geoid undulation (geoid height with respect to the reference ellipsoid) is used as one of the parameters for bathymetry estimation using the concept that the changes in the geoid (static component) are caused by bathymetry anomaly in this region.

We are also pleased to note that a ship-borne bathymetry map was prepared to compare the sea-floor morphology with that of the bathymetric data derived by satellite altimetry within the territorial waters off Tuticorin in the Gulf of Mannar. Now coming to the intricate details that are expected in the case of a few near-shore anomalies, it would have been better if they had given the profiles with the bathymetry anomaly plotted. However, one point here is important in that the prediction of bathymetry becomes invalid in the near-shore region due to the signal processing limitations. By Nyquist theorem, two samples per cycle will completely define a band-limited signal or the sampling rate must be twice the highest frequency component of the signal (Shannon's sampling theorem). So, if the area falls within the limit of two sampling intervals (~30 km), in the present case data resolution ~15 km, it will not be possible to predict the bathymetry. With higher resolution datasets (currently ~3.5 km), this problem will be limited to within 7 km near the coast. However, the technique is valid in the deeper oceans. Details of intricate sea-floor morphology, particularly coral ridge, etc. should get reflected in the predicted bathymetry profiles, provided they are in deeper oceans and sufficiently large in extent.

1. Chapman, M. E., *J. Geophys. Res.*, 1979, **84**, 3793–3801.

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Is phytoremediation the solution for arsenic contamination of groundwater in India and Bangladesh?

Groundwater which is not present in abundance in nature is one of the most important sources of drinking water. The contamination of groundwater with arsenic is a serious problem encountered in northern India and Bangladesh[1]. To understand the magnitude of the arsenic calamity in West Bengal, a detailed study spanning seven years was made in North 24-Parganas, one of the nine arsenic-affected districts[2]. Area and population of North 24-Parganas district are 4093.82 km^2 and 7.3 million, respectively. Nearly forty eight thousand water samples were analysed from hand tube wells of North 24-Parganas which are in use for drinking. 29.2% of the tube wells were found to have arsenic above 50 µg/l, which is beyond the maximum permissible limit of World Health Organization (WHO) while 52.8% had arsenic above 10 µg/l, which is slightly above the WHO recommended value of arsenic in drinking water. Out of the 22 blocks of North 24-Parganas, arsenic has been found in 20 blocks above the maximum permissible limit and so far in 16 blocks people have been identified as suffering from arsenical skin lesions. From the data, it is estimated that about 2.0 million and 1.0 million people are drinking arsenic contaminated water above 10 µg/l and 50 µg/l level, respectively in North 24-Parganas