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Magnitude calibration of north Indian earthquakes

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SUMMARY

This article is concerned primarily with the evaluation of the size and location of northern Indian and southern Tibetan earthquakes during the last 200 yr. It draws attention to the problems of assessing intensity of early and more recent earthquakes in a built environment, which is different from that for which the intensity scale has been constructed and to the way in which isoseismals are drawn.

Through a re-evaluation of intensities and a reassessment of isoseismals, a formula for the estimation of surface wave magnitude using isoseismal radii is derived. This formula is used to estimate the surface wave magnitudes of 16 earthquakes that occurred in the region between 1803 and 1900. This study shows that it is possible to calculate accurate surface wave magnitudes for earthquakes that occurred before the advent of the scale and that there is no need to resort to empirical formulae for the assessment of the size and seismic moment release of pre-20th-century earthquakes. Also derived are formulae for the conversion of M_s to M_0. In total, locations, surface wave magnitudes and M_0 estimates are presented for 43 important events that occurred in the region between 1803 and 1974, eight of which were in the lower crust or were subcrustal. We find that the M_0–M_s scaling for India yields smaller M_s than the global relation and that the methodology used can help to evaluate more realistic slip rates as well as to address other issues related to earthquake hazard in northern India.

Key words: earthquakes, Himalayas, intensity, magnitude, north India.

1 BACKGROUND

The study area includes northern Afghanistan, Pakistan, India and southern Tibet and is shown in Fig. 1. Its systematic study is of considerable importance not only because of its significance in global tectonics, but also because destructive earthquakes occur in the region (see Table B1 in Appendix B). To study this area, more information about earthquakes and more field evidence of recent tectonics are needed. Especially, we need a significantly more extensive sample of seismicity, particularly of the larger events in terms of location and magnitude, covering much more than the period of the few decades of modern seismology, which is minutely brief on the timescale involved in tectonic processes. Obviously the large earthquakes, which are the most informative events, are far less numerous than small earthquakes and as such are not easily counted unless the period of observation is sufficiently long.

Much of what is known about the seismicity of northern India and adjacent regions comes from recent events of the instrumental period. It is very possible, therefore, that its present-day seismicity may not reflect the actual distribution and pattern of earthquakes over a longer period of time and that the present pattern of activity may be the result of scant and incomplete sampling.

Just as instrumental data are needed for the study of modern earthquakes, to give parameters that are important for the assessment of earthquake hazard, appropriate methods must also be developed from macroseismic observations for the study of large events of the early instrumental and pre-instrumental periods. This requires:

(i) reinterpretation of primary macroseismic information of earthquakes in the instrumental period (after 1900) and uniform assessment of intensities;

(ii) calculation of the instrumental surface wave magnitude of events for which macroseismic information is available;

(iii) from (i) and (ii) derivation of a regional magnitude scaling law, which can be used to assess the magnitude of earthquakes in the pre-instrumental period (before 1900); and, finally,

(iv) the general location and magnitude of these early events.

Readily available macroseismic information for northern India is rather poor and easily subject to misinterpretation. It comes from the well-known published works of: Oldham (1899), Middlemiss (1910), Heron (1911), Stuart (1919), Auden & Ghosh (1934), West (1934), Brett (1935), West (1936), Gee (1937), Dunn *et al.* (1939) and Gee (1953).

In this study, we used additional information culled chiefly from published and unpublished local and foreign reports written by the civil authorities, such as government documents from the Indian subcontinent and from Tibet, official correspondence kept at the

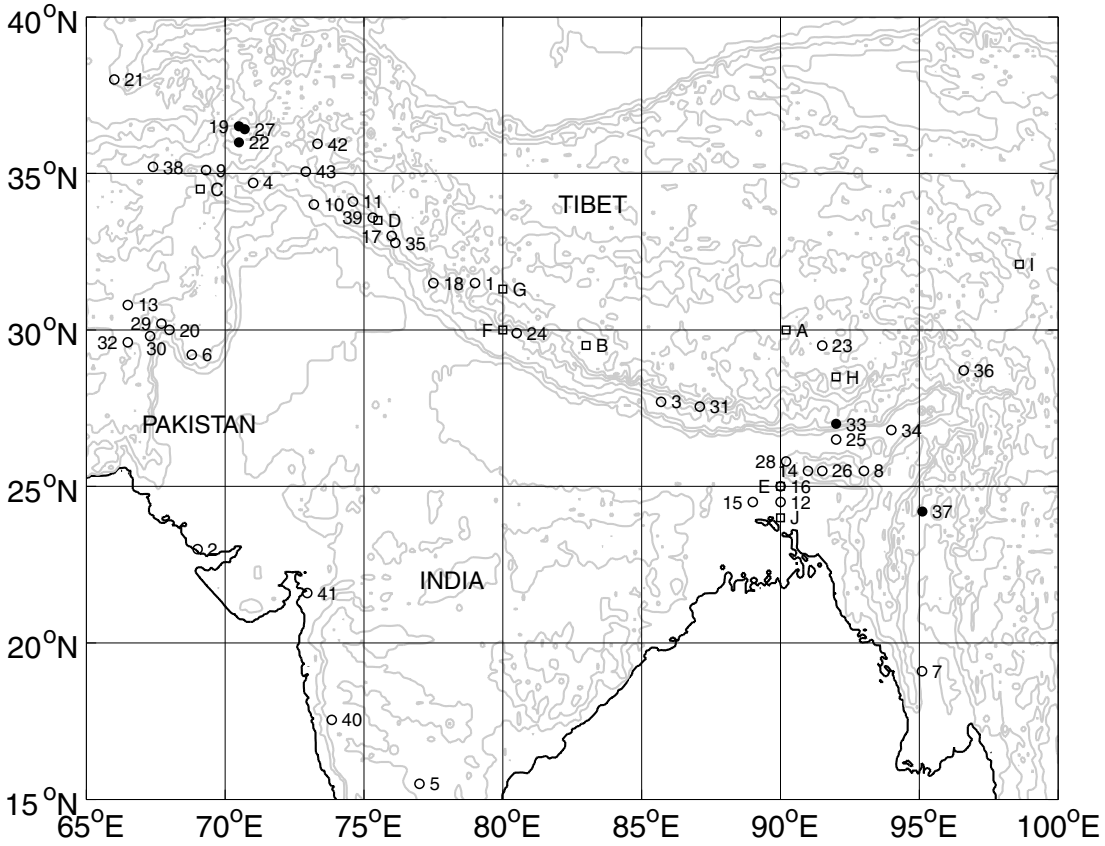


Figure 1. Map of the study area showing location of events listed in Table B1. Open and full circles show crustal and subcrustal events, respectively.

Indian Office in London, diaries of residents and technical reports, supplemented by the local and international press. Examples of the variety and wealth of macroseismic information available in these sources can be found in the recent studies of some of the historical earthquakes in the region, i.e. Chen *et al.* (1982), Lee (1983–7), Bilham (1995), Ambraseys (2000), Ambraseys & Bilham (2000, 2003a,b) and Ambraseys & Jackson (2003).

In the published works, intensities are given in a variety of scales [Oldham's (OL), Rossi-Forel's (RF) and Mercalli's (M)], isoseismals are drawn with different procedures and magnitudes for 20th-century events are few and are not uniformly calculated. For events of the early instrumental period, magnitudes are almost totally lacking.

With the exception of OL, these scales were originally devised for use in Europe where the vulnerability of the building stock is different from what, until recently, was built in the wet valleys of north India and in the arid plains of Pakistan, Afghanistan and south-east India. This diversity of scales with different diagnostic criteria makes it difficult to use scaling laws from other parts of the world or to derive scaling laws for India without resorting to the tedious and lengthy task of reassessing intensities from original material.

This material allowed the re-evaluation of intensities, the assessment of isoseismals and the uniform recalculation of surface wave magnitudes ($5.0 < M_s < 8.2$) of 43 important events that occurred in the region between 1803 and 1974, eight of which were in the lower crust or were subcrustal (Table B1). Sixteen of these events occurred between 1803 and 1900. The large, 1950 August 15 Assam–Tibet earthquake has been excluded pending the translation of Tibetan and Chinese sources of information.

The implications on tectonics of this re-evaluation with additional data will be dealt with in a forth-coming paper.

2 ASSESSMENT OF INTENSITIES

As in other parts of the world, reassessment of intensity of earthquakes in India before the 1950s requires resorting to the original information and reassessing intensity with a common intensity scale and method suitable for the region. The method should be able to sort out those aspects of behaviour of man-made structures and of the ground itself that are important indicators of the level of ground motions in terms of inertial forces and duration of shaking. In rating intensities at a place, the method should also make an allowance for the vulnerability and ageing of man-made structures, as compared with dwellings in those countries for which the scale was originally drawn up.

Before employing an old or modern intensity scale for use in India, it must be borne in mind that until relatively recently the bulk of the building stock was entirely different from that in Europe or in North America. In towns and to a lesser extent throughout the rural areas, better built constructions were of kiln brick, and occasionally of stone, which lay predominantly in lime or clay mortar and was plastered. In villages and towns, in the extensive plains of the Brahmaputra, Indus and Ganges Rivers, brick, mostly sun-baked, was sparingly used only for external walls, quite often only up to the window sill, the rest of the wall consisting of bamboo and lath or adobe, covered with corrugated sheets or thatch.

On the hills, along the eastern Himalayas, in arid parts of the region, local dwellings are quite different and the vulnerability of

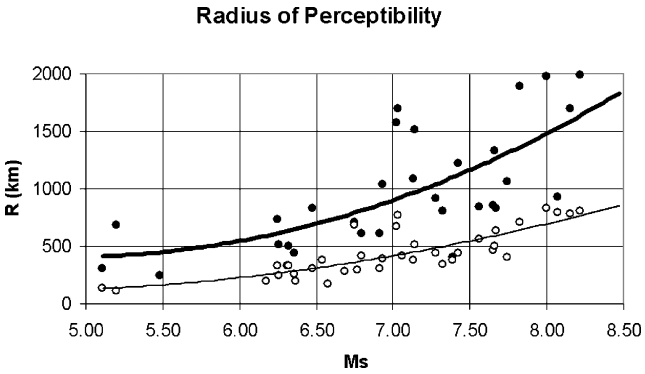


Figure 2. This figure shows the distinct difference between the lowest intensity grades, MSK I and II. Thin trending line shows average distance R (open circles) at which earthquakes of magnitude M_s were felt with an intensity I = III MSK. Thick line shows average distance R (solid circles) at which a shock was barely perceptible, I = II MSK.

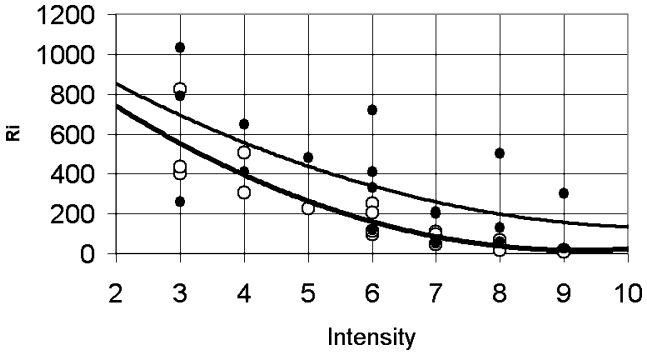


Figure 3. Plot of equivalent isoseismal radii R_I of intensity I assessed in the RF (solid circles) and MSK (open circles) scales for seven Indian earthquakes.

the building stock exposed to the earthquake varies enormously. For the vulnerability of these types of constructions see Ambraseys & Bilham (2003a,b) and Ambraseys & Jackson (2003).

It is also important to distinguish between damage caused by transient earthquake loading and damage caused by indirect, secondary effects, such as foundation spreading, liquefaction, slides, rock falls and aftershocks. This becomes an important consideration for large earthquakes in northern India, the effects of which spread over vast areas of river plains of high liquefaction potential particularly during the monsoon period.

Some of these effects can be assessed using a simplified version of the Medvedev–Sponheuer–Karnik (MSK) scale, by removing structures of type C, damage classification grade 5, criteria associated with the effects on nature, i.e surface faulting, landslides, ground deformations, liquefaction, water-waves, and by simplifying criteria on human response.

It has been observed that in the upper range of the scale, maximum intensity in any earthquake affecting vulnerable structures appears to be effectively the same; that is, the scale saturates at intensities VII–VIII MSK at which point all adobe, rubble stone masonry houses are damaged beyond repair or destroyed and any town or village would thus appear equally, but no more, devastated at so-called higher intensities e.g. Ambraseys (1967) and Ambraseys & Zatopek (1968). This is a serious limitation of intensity scales in that the criteria needed for grading high intensities in the context of this study are lacking and that makes the assignment of intensities greater than VIII MSK very subjective. In our study, with the exceptions of very few cases, no attempt was made to assign intensities greater than VIII (MSK) or to estimate epicentral intensities. Table B2 in Appendix B lists the assessed intensities for the 43 earthquakes investigated here.

In the low range of the intensity scale, it is equally important to differentiate between intensities II and III (MSK) and to include in the data set the sites at which the shock was not felt (I MSK). Fig. 2 shows the difference in site and average distances R at which earthquakes of different magnitude M_s were felt in India.

3 COMPARISON OF INTENSITY SCALES

The only conclusion that can be drawn from the comparison of intensity ratings between different intensity scales is that intensity conversion through a simple empirical formula is not the way to arrive at any conclusion. It is possible, however, to get a rough idea of the general trend of such conversion formulae, but the scatter of data is too great to permit the assumption of any quantitative correlation between two scales.

For a number of earthquakes in India, as a test, we compared published intensity ratings of isoseismals in the RF scale with ratings assigned to the same isoseismals in this work, in the MSK scale. The trending lines in Fig. 3 show that on average, for this particular case, RF intensity estimates are larger than MSK by one to two intensity units with an unacceptably large scatter of the data. This figure also shows that, other things being equal, an isoseismal of 200-km equivalent radius would correspond to intensity V-plus in the MSK, while in the RF scale the corresponding intensity would be VIII RF.

A similar conclusion about the large and unpredictable differences between the two scales was drawn by Shebalin *et al.* (1974) who compared reassessed intensities in the MSK scale with original RF estimates at 830 sites in the Balkans and showed that, in the range VI to VIII, RF intensities are on average 0.5 to 1.5 intensity units greater than in the MSK scale.

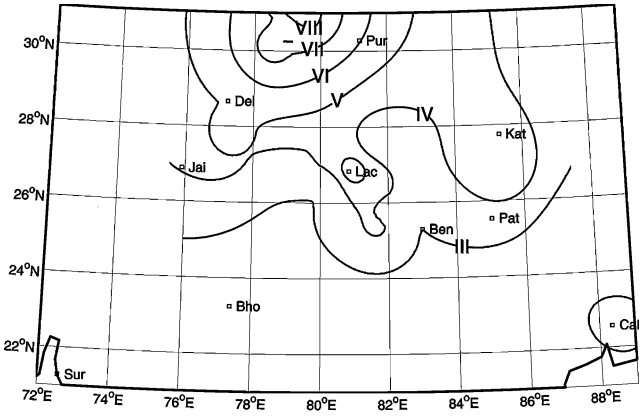
These observations suggest that intensities cannot be converted from one scale to another merely through simple, one-to-one empirical laws.

We have no data to compare in a similar way MM with MSK.

4 INTENSITY DISTRIBUTION

With few exceptions, intensity contours (isoseismals) are drawn by eye using different procedures that may or may not include smoothing through an averaging process. Almost all existing isoseismal maps for earthquakes in India have been drawn by eye around points of maximum intensity observed within a given area, in the process disregarding other points of lower intensities. Some of these isoseismals are purely diagrammatic, as representing what their shape would probably be if we assumed that attenuation was isotropic and that local foundation conditions and buildings were uniform everywhere. This approach introduces a bias towards higher estimates.

These methods of contouring are to some degree as subjective as the assessment of intensity and they do not overcome the difficulty that arises when a few isolated high intensities exist within a background of many sites of much lower intensity and conversely when isolated low intensities exist within a background of not felt. The latter situation has a considerable effect on the determination of the radius of perceptibility (III MSK), which is often grossly overestimated by taking into consideration the furthermost location at which the shock was perceived.



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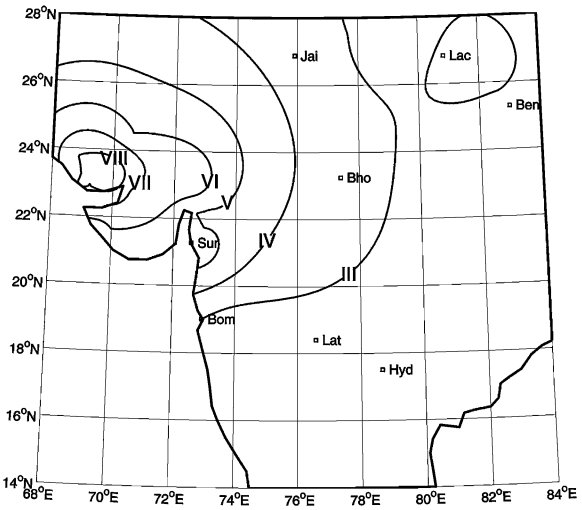

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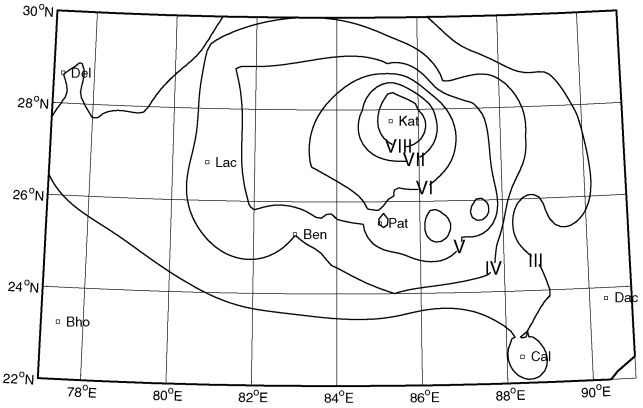

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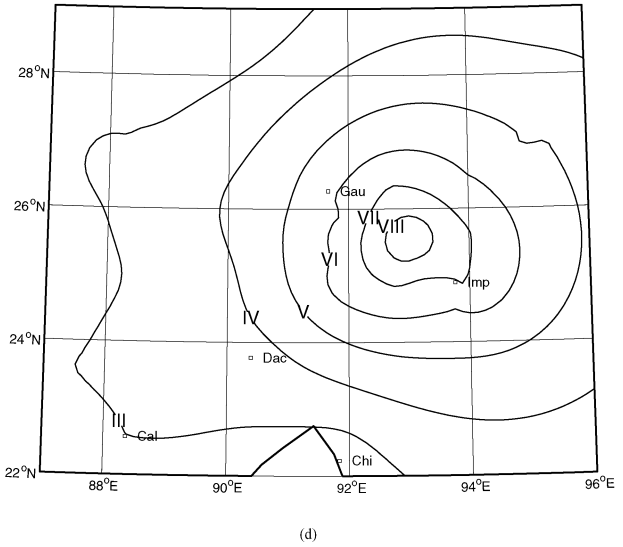


(d)

Figure 4. Isoseismal maps of the earthquakes of: (a) 1803 September 1, 33 intensity points; (b) 1819 June 16, 30 intensity points; (c) 1833 August 26, 61 intensity points; (d) 1869 January 10, 41 intensity points; (e) 1897 June 12, 282 intensity points; (f) 1905 April 4, 523 intensity points; (g) 1918 July 8, 139 intensity points; (h) 1930 July 2, 117 intensity points; (i) 1931 August 27, 98 intensity points; (j) 1934 January 15, 806 intensity points; (k) 1935 May 30, 49 intensity points; (l) 1974 December 28, 65 intensity points.

In order to avoid subjectivity as much as possible in drawing isoseismals, the contouring of intensities was done by kriging (Olea 1999) the intensity data, disregarding the fact that intensity is not a continuous function and taking into account points at which the shock was perceptible (II MSK) and not felt. By this procedure, local variants of intensity between isoseismals become averaged and damped out by the surrounding regional intensity and only those anomalies that become fortified through association gain an encircling contour. In kriging the distances from each gridpoint to each intensity point are calculated and weights based on these distance are computed, by assuming an underlying spatial correlation function, which are then used to estimate the intensity at the gridpoint. Therefore, at gridpoints close to known intensity points the estimated intensity is similar to the near-by measured values, but for gridpoints far from observed intensities the estimated intensity is based on a weighted average of distant intensities. For a description of the method see Appendix A.

Figure 4. (*Continued*.)

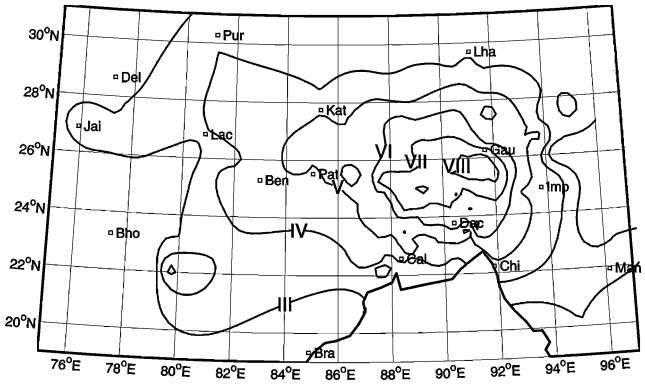
The intensity distribution of all earthquakes for which there are data were contoured using kriging and a selection of their isoseismal maps is shown in Fig. 4.

For the reasons mentioned earlier, no contours are shown for intensities greater than VIII MSK.

From these contours, we can calculate equivalent isoseismal radii R_i for different intensities. For open contours, R_i was approximated as the average radius of the area inside the open isoseismal. The equivalent radii of closed contours were calculated using a computer programme that sums the number of small squares within each contour. This area is then converted to an equivalent radii by assuming a circular contour. All areas of a given intensity, such as small regions of higher intensity within a larger region of lower intensity, are included within the sum and consequently the equivalent radii found may be slightly larger than the radii derived by using only the main contours. Equivalent radii of open contours were calculated by averaging the measured radii at a number of points around the contour. The results from the two methods of calculation were compared for a few earthquakes and similar results were obtained.

Most if not all of the large intensities in Indian earthquakes have been assigned to sites in areas of widespread liquefaction and slope failures, an intensity criterion we did not use to assign intensity.

Table B1 lists the 43 earthquakes since 1800 reappraised in this article for which we could find primary information, but which is not



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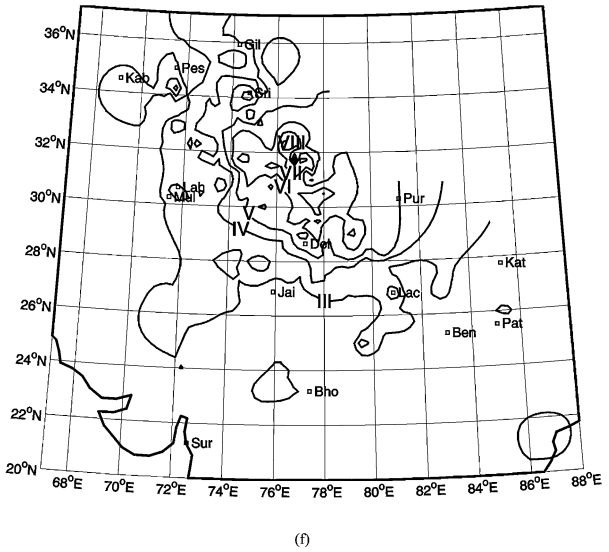

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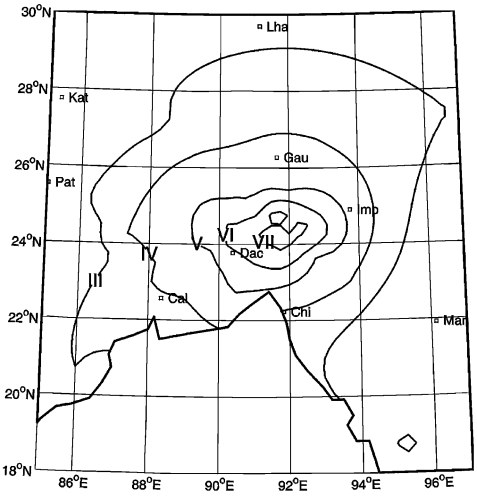
Figure 4. (*Continued*.)



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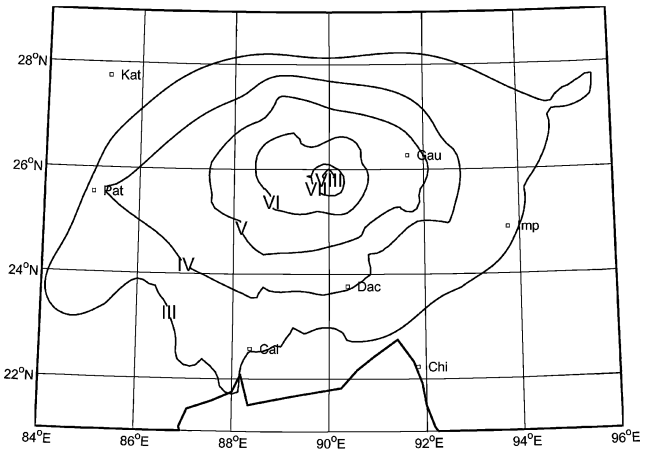


(h)

Figure 4. (*Continued*.)

always sufficient to assess intensities and estimate their distribution. Of these, 26 occurred in the instrumental period for which both magnitudes and site intensities we reappraised.

Depending on the degree of ambiguity, either a site was discarded, or its intensity was taken as $I + 0.5$, a notation that implies a grading between I and $I + 1$, and in a few case of more than one grade.

Despite the large number of site reports, only 3423 provided macroseismic information, not always unambiguously, for 326 of which site information is too poor to allow intensity assessment.

From Fig. 5, which shows the distribution of site intensities, we notice that the number of sites at which the shock was slight (II MSK) or for which we have negative reports (I MSK) is considerable.

Intensities from epicentral sites are relatively few and uncertain, in most cases coming from sites, which are clustered together, providing little and not always a clear indication about the size and shape of the epicentral area. For these reasons and also because intensities at high values saturate, contours of high intensities, defined by kriging, are disregarded.

In contrast, to constrain the outward spreading of the lowest isoseismal of $I =$ III MSK, sites of the lowest intensities $I =$ I and II MSK are retained.

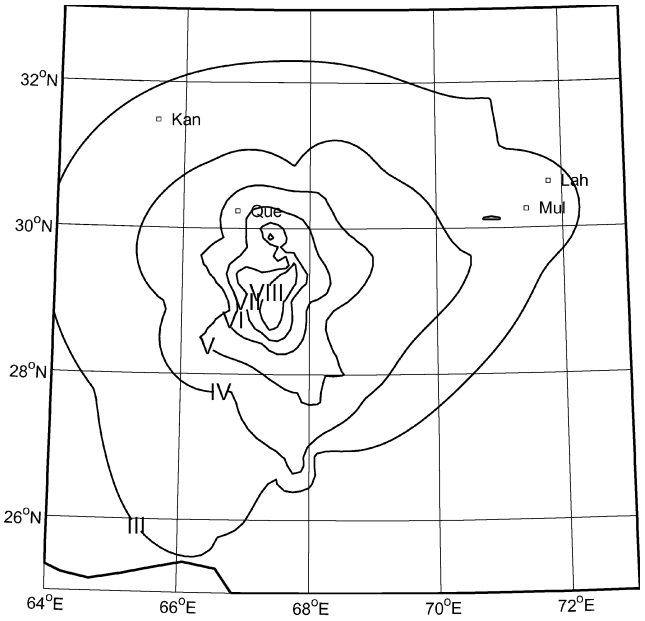
It has been observed that large earthquakes in northern India are felt at larger distances in an east–west direction south of the Himalaya than away from the mountains to the north and south. This preferential distribution is in part the result of the lack of macroseismic information from Tibet and to the enhancing effect that the Ganges and Brahmaputra alluvial valleys have on intensity distribution in these directions rather than the result of any other less obvious cause.

5 SURFACE WAVE MAGNITUDE

For the purpose of uniformity, we calculated the surface wave magnitude of all events, including those in Gutenberg & Richter's catalogue, using the Prague formula (Willmore 1979). For the period 1900 to 1974, amplitude and period data were taken from station bulletins.

Of the 43 earthquakes studied in this article, 15 have been assigned generalized magnitudes by Gutenberg & Richter (1965) and two have M_s values given by by international agencies.

Calculation of M_s of the 27 earthquakes in this study required culling 444 pairs of amplitude and period readings of surface waves from the bulletins of 26 seismographic stations worldwide. Magnitudes from some stations, particularly in the early period, required station corrections by as much as ± 0.3 to ± 0.5 magnitude units, the application of which considerably reduced large differences from the



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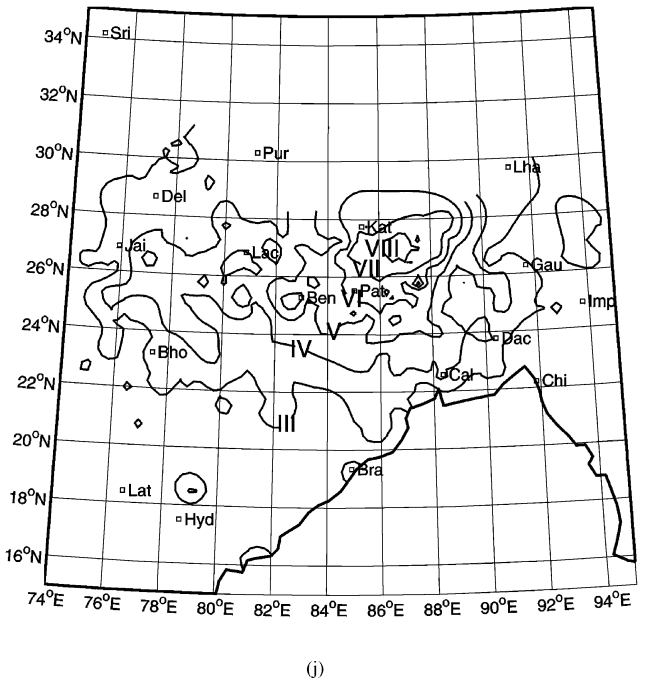


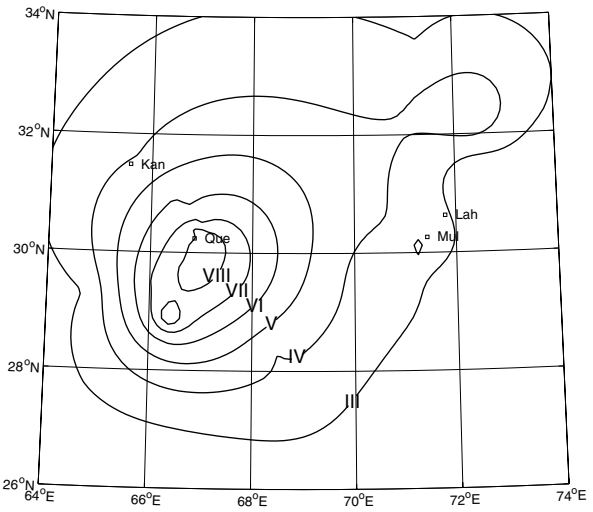
(j)

Figure 4. (*Continued*.)

mean, with the result that no ad hoc exclusion criteria were needed for outliers. The average standard deviation of a station magnitude after correction is ±0.25 and the uncertainty in the mean event magnitude is ±0.10.

For earlier earthquakes, as for instance the earthquake of 1897, M_s was calculated from long wave amplitude readings recorded by early instruments and the method of Abe (1994).

We find that the generalized magnitudes assigned by Gutenberg & Richter (1965) are in good agreement with our estimates, with theirs being over estimated by approximately 0.2 magnitude units.



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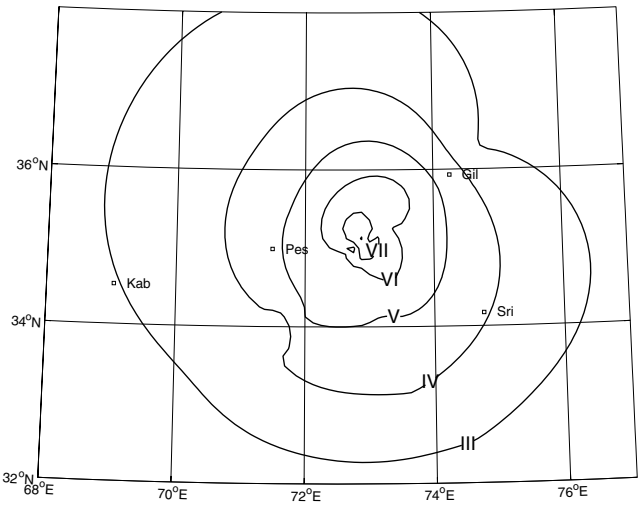

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Figure 4. (*Continued*.)

6 MAGNITUDE–INTENSITY SCALING LAW

Magnitude scaling laws are often derived from intensities, which have been estimated over the years by different authors using different intensity scales, or converted from one scale into another through a simple empirical relation.

The assessment of the magnitude of earthquakes of the pre-instrumental period requires the derivation of a scaling law between data from the instrumental period, such as M_s and isoseismal radii R_I and their corresponding intensities. This law can then be used to estimate the magnitude of historical earthquakes from macroseismic data.

Magnitude–intensity scaling laws can be divided into two categories: those that have been derived from uniformly reduced input data (M_s, I, R_I) and those which are based on non-homogeneous input data.

One of the first attempts to scale M_s from uniformly reduced input data for European and Asiatic earthquakes was made during the compilation of the earthquake catalogue of the former USSR

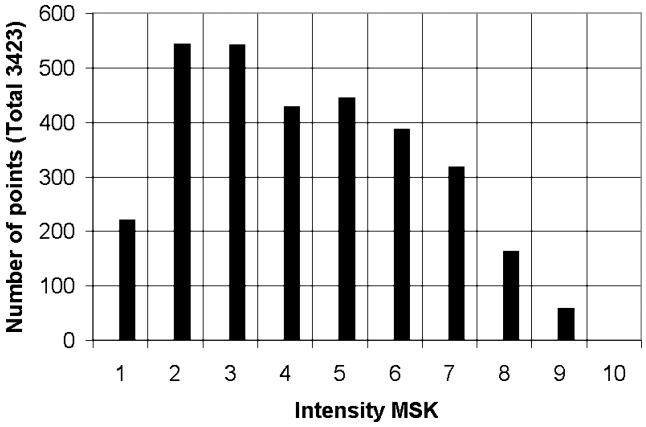


Figure 5. Distribution of the number of site intensities with magnitude M_s. Intensities I and II correspond to not felt and slight, respectively, in the MSK scale.

(Kondorskaya & Shebalin 1977). About the same time, Karnik and Shebalin followed a similar procedure to compile the earthquake catalogue for the Balkans. Because of the enormous amount of work required to calculate M_s and reassess site intensities in the MSK scale for the whole region (Albania, Bulgaria, Greece, Romania, W Turkey and the former Yugoslavia) only large events ($M_s > 6.0$) were reappraised by these authors and included in a final publication (Shebalin *et al.* 1974).

Site intensities of historical and recent earthquakes in the UK were also reassessed in terms of the MM and MSK scales by three separate working groups (Principia Mechanica 1982; Soil Mechanics Ltd 1982; Ambraseys 1985a) and an empirical magnitude scaling law was derived by combining the MSK database with uniformly recalculated M_s values from the Prague formula. This work was extended to include events in western Scandinavia (Ambraseys 1985b), and later in Turkey (Ambraseys 1988) and Switzerland (Ambraseys 2003).

There are other magnitude scaling laws of the second category that put more emphasis on the development of methodologies to analyse intensity data than on the quality of the input data themselves.

Johnston *et al.* (1994), using available isoseismals from earthquakes worldwide, derived scaling laws between $\boldsymbol{M}$ and isoseismal areas for different intensities. These laws are for stable continental regions and are not relevant to the present study.

Bakun & Wentworth (1997) derived for California two scaling laws that are based on published intensities in the MM scale from 11 earthquakes in the range $5.5 \leq \mathbf{M} \leq 6.9$. Intensities I and II MM were increased to III MM, and intensities X and XI MM were reduced to IX MM. In one of these equations (eq. 9 in their paper) the coefficient of the geometric term was set to zero, while in the other equation (eq. 10 in their paper) the coefficient of the anelastic term is set to zero.

For crustal earthquakes, the scaling law for M_s in terms of epicentral distance R_i and observed intensity I_i at a site may be expressed by:

$$M_s = a + bI_i + cR_i + d \log R_i. \qquad (1)$$

A similar law holds for M_s in terms of the radii of isoseismals R_I and their associated intensities I_I.

It must be pointed out that this simple model assumes a point source and it does not take into account the finite volume of the energy source or focal depth. Also, it assumes that the absorption coefficient in the near field is independent of R. For small-magnitude, shallow events these assumptions are reasonable. However, to improve the model for near-field conditions requires knowledge of the size of the source and this is not possible with the data usually available.

We think that macroseismic magnitude scaling laws must be simple and they must be derived from reliable data. A too-sophisticated model carries with it the danger that its weaknesses and assumptions may not be appreciated. Conversely, a too-simple model may be discredited because it exposes the underlying assumptions too clearly. We would prefer a simple model in which the number of variables is justified by the available data.

While there can be no objection to modelling M_s to the highest precision, with so many uncertainties in the input data, whose accuracy for predictive purposes is little known, there is a degree of precision beyond which refinement of eq. (1) becomes pointless.

To avoid some of these complications, particularly in the near field of large earthquakes, eq. (1) was used with intensities usually smaller than VIII MSK, a choice justified also by the fact that high intensities in India saturate at low values.

7 RESULTS

Using eq. (1) and excluding subcrustal earthquakes, from 25 earthquakes and for 99 isoseimals of radius R_I, we find that:

$$M_{s,i} = -0.297 + 0.653(I_I) + 0.0026(R_I) + 1.646 \log(R_I), \qquad (2)$$

with a standard deviation of 0.31. $M_{s,i}$ is the macroseismic M_s derived from isoseismals. Fig. 6 shows eq. (2), which fits the data reasonably well throughout the magnitude range $5.1 \leq M_{s,i} \leq 8.2$.

Subcrustal events ($h > 50$ km) are not only too few to allow the derivation of a scaling law similar to eq. (2), but also M_s is not the appropriate independent scaling variable. As Fig. 6 shows, all subcrustal events plot as outliers, but it is interesting that when plotted against a more appropriate independent variable, such as the long-period body wave magnitude m_B, they tend to approach appreciably eq. (2). The fit would have been improved if focal depths were better known to allow a more accurate estimate of m_B.

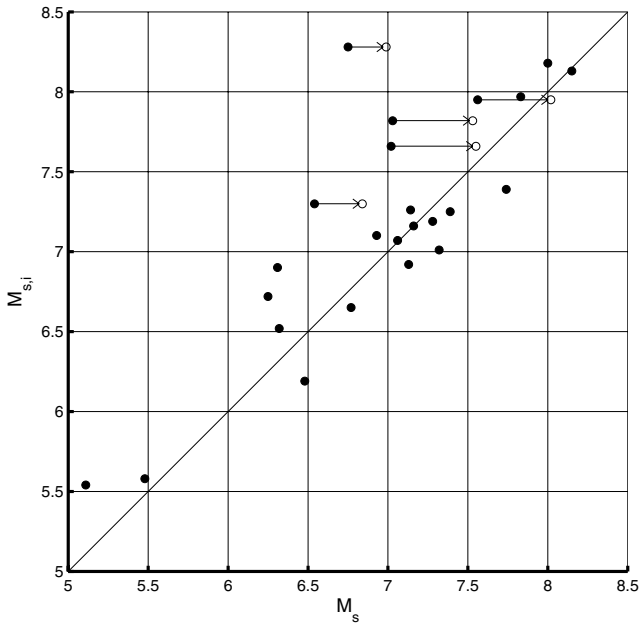


Figure 6. Comparison between observed M_s and predicted $M_{s,i}$ from isoseismals (solid circles) and eq. (2). Open circles show observed m_B values for subcrustal earthquakes versus predicted.

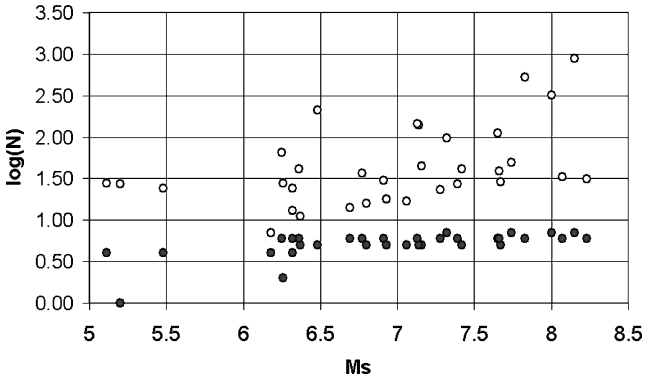


Figure 7. Number of isoseismals N (solid circles) and the corresponding number of site intensities (open circles), plotted against magnitude.

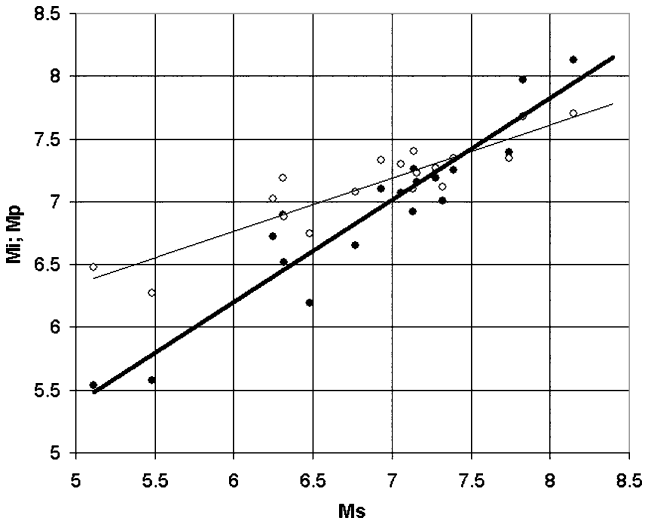


Figure 8. Plot of instrumental M_s versus predicted $M_{s,i}$, calculated from isoseismals (solid circles), and predicted $M_{s,p}$, calculated from intensity points (open circles). Note the systematic overestimation of $M_{s,i}$.

Next we examined the scaling of M_s using individual site distances rather than isoseismal radii. From 2247 intensity points associated with crustal events, we have:

$$M_{s,p} = 2.99 + 0.262(I_i) + 0.0002(R_i) + 1.36\log(R_i), \qquad (3)$$

with a standard deviation of 0.44. $M_{s,p}$ is the macroseismic M_s derived from individual site intensities. This relation is obviously biased not only because of the few earthquakes that contributed the bulk of intensity points shown in Fig. 7, but also by events for which there is a large azimuthal gap in the intensity distribution as a result of the lack of information from sparsely inhabited areas or for earthquakes with off-shore epicentres.

The bias shown in Fig. 8 as a plot of instrumental M_s versus the empirical $M_{s,p}$ and $M_{s,i}$ militates against the use of point intensities in magnitude scaling and in the assessment of the attenuation of intensity with site distance D_i.

7.1 Sensitivity of macroseismic magnitude to uncertainties in derived constants

The question now arises of how accurately the variables in eq. (1) should be known to guarantee an acceptable uncertainty in the estimates of M_s.

We notice in eq. (1) that an error of dI in intensity will cause an error in station magnitude of b(dI), which is independent of the epicentral distance R.

The error in station magnitude dM_s resulting from an error in epicentral distance is $\mathrm{d}M = (c + d/R)\,\mathrm{d}R$ and depends on the value of the coefficients of attenuation and spreading as well as on the value of R.

Taking values of b, c and d from eq. (2), i.e. $b = 0.653$, $c = 0.0026$ and $d = 1.646$, we have that an error in site or isoseismal intensity of 0.5 units will produce an error in magnitude of 0.3, which is the same as the standard deviation of a station magnitude, but which is almost three times larger than the standard error of the mean event magnitude, which is 0.1.

For the same constants, an error in M_s of say 0.3 in station magnitude, would require an accuracy in R better than 18 per cent for small and 10 per cent for large values of R. These values decrease to 6 and 4 per cent respectively if we want event accuracy in M_s better than 0.1 units.

It appears, therefore, that M_s is less sensitive to errors in I than in R and that the error in M_s increases rapidly with decreasing values of R. This means that isoseismals need to be defined more precisely at high than at low intensities, which in practice is more difficult.

Note, however, that when macroseismic magnitudes are calculated using a number of isoseismals and then averaged, the errors in the average event magnitude will probably be lower than the estimates above because individual errors in the values of R or I will be averaged out.

8 COMPARISON OF MAGNITUDE–INTENSITY SCALING LAWS

Considering the quality of input data, these laws can only be approximate at best and a too refined examination of their similarities or differences is not warranted.

First we compared eq. (2) with similar laws from other active tectonic areas such as Turkey, southern Balkans, Middle Asia and the Far East, derived from uniformly reduced input data in terms of M_s. These scaling laws are shown in Fig. 9 and their coefficients are listed in Table B3 of Appendix B.

From Fig. 9 we notice that, within the useful range of distances, differences in predicted M_s are of the order of the standard deviation of a station magnitude determination and that, provided the comparison is made with isoseismal radii rather than with epicentral or focal distances, these laws show almost the same rate of decay with distance. The somewhat larger magnitudes predicted by eq. (2) for intensities IX MSK are clearly the result of the fact that the Indian data set has no constraint on earthquakes smaller than M_s 5.1 and it is biased for smaller earthquakes and has been derived for MSK intensities of less than IX.

Next we compared eq. (2) with scaling laws derived for other regions of active tectonics expressed in terms of moment magnitude M_w. For this comparison M_w replaced M_s in eq. (2) through the global scaling relation of Ekström & Dziewonski (1988). These 11 laws are shown in Fig. 10 and their coefficients are given in Table B3. They differ from those already considered in that they have been derived from non-homogeneous input data, from published site intensities or isoseismals in MM, or converted into MM from other intensity scales. They also differ in that they have been derived from a least-squares fitting, either with intensity or magnitude as the independent variable. For events before the early 1970s, M_w was estimated from other scales through empirical formulae.

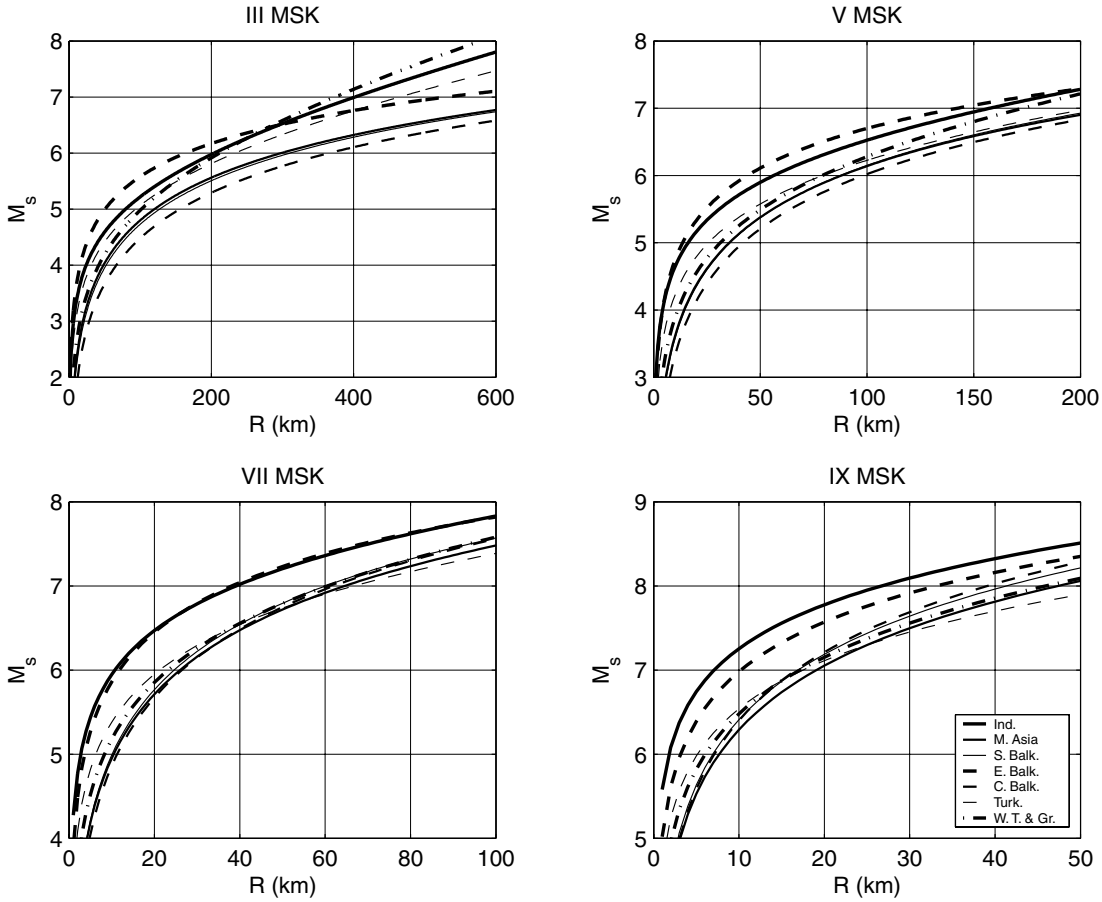


Figure 9. Comparison of eq. (2) with M_s-scaling laws derived for Turkey, southern Balkans, Middle Asia and the Far East, derived from uniformly reduced input data, for intensities III, V, VII and IX MSK. The coefficients or these laws are listed in Table B3 (group I).

These 11 plots in Fig. 10 fall with a zone, somewhat broader than in Fig. 9, which is to be expected because the data are not homogeneous. The broadening of the zone with larger magnitudes and greater distances is the result of lack of constraint on earthquakes of $M_w > 7.0$, which is particularly noticeable in the Californian laws.

Eq. (2), is compared in Fig. 11 with seven similar laws for less seismically active regions. The plots are closely packed, showing differences in predicted M_s values smaller than the standard deviation of a station magnitude regardless of the region for which they have been derived. The divergence of the curves for Switzerland and Iberia is a result of the extrapolation of the dependent variables well beyond the range of their application.

As Figs 9 to 11 show, differences in predicted magnitude from different laws are somewhat larger in the near field. One of the reasons for this is that these scaling laws are modelled as point sources and as such they are not valid in the near field. For small values of R, or for values comparable to the dimensions of the seismic source, epicentral distance R is not any longer the appropriate distance variable. Earthquakes of magnitude, say between 6.0 and 7.5, will have ruptured faults 10 km to more than 100 km in length and the epicentre will indicate nothing more than the general location of the event. Also, for small events the focal depth comes into play and R must be replaced by the focal distance D.

Another reason for these differences is that different laws are constrained by the data within different magnitude ranges and they have different sample bias. For instance, eq. (2) is biased towards large magnitudes, in the range $5.1 \leq M_s \leq 8.2$, while the laws for California (Bakun & Wentworth 1997) are constrained in the range $5.5 \leq \mathbf{M} \leq 6.9$ and cross eq. (2) near **M**6.0, underestimating magnitudes for small values of R and overestimating **M** for large R. Provided more isoseismals are used to assess an event magnitude **M**, spread over a wide range of intensities, these differences in **M** are likely to be smaller than from a single isoseismal. This is because the individual differences in **M** between the two laws, arising from different isoseismal radii, will cancel. However, for magnitudes much smaller or larger than 6.0, differences are significant, which argues against their extrapolation to larger or smaller magnitudes and to regions other than those for which they have been derived.

9 SEISMIC MOMENT AND MOMENT MAGNITUDE

We estimated seismic moments from surface wave magnitudes for all events in Table B1. First we used the global log M_0–M_s relation of Ekström & Dziewonski (1988). We also calculated a regional log M_0–M_s relation based on 180 shallow earthquakes ($h < 50$ km) in our region and 390 within a larger area extending from the west to 20°E. Moments are between 5×10^{22} to 4×10^{28} dyn cm and M_s magnitudes between 3.5 and 8.5. For small events, moments are from *P*/*SH* modelling taken from published sources while the bulk of the data are scalar moments taken from the Harvard CMT catalogue.

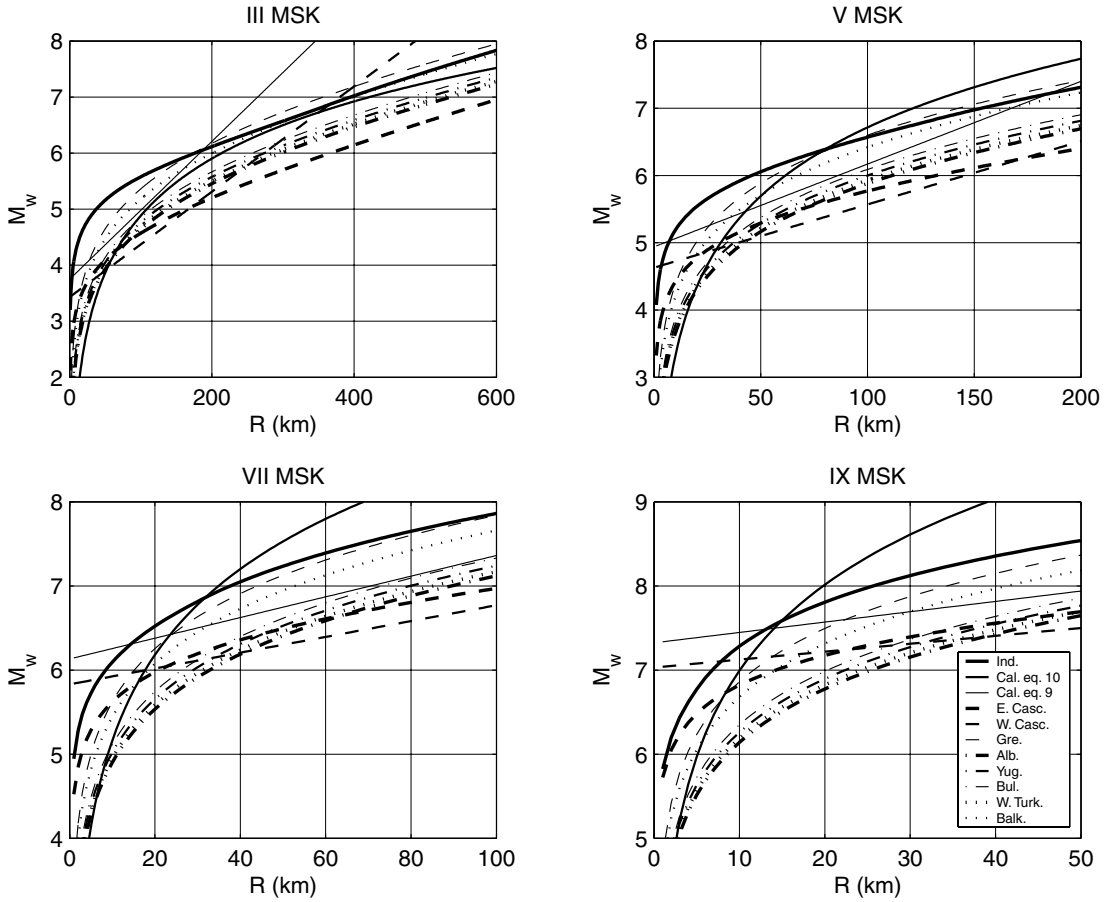


Figure 10. Comparison of eq. (2) with M_W-scaling laws derived for other seismically active areas listed in Table B3 (group II).

Ekström & Dziewonski (1988) derived global average relationships between M_s and log M_0, in which the independent variable is log M_0 based on the assumption that the slope of the regression is 1 for small and 2/3 for large values of M_0, viz.:

$$\log M_0 = 19.24 + M_s \quad \text{for} \quad M_s < 5.3, \tag{4}$$

$$\log M_0 = 30.20 - \sqrt{92.45 - 11.40 M_s} \quad \text{for} \quad 5.3 \leq M_s \leq 6.8, \tag{5}$$

$$\log M_0 = 16.14 + 1.5 M_s \quad \text{for} \quad M_s > 6.8. \tag{6}$$

They point out that there is regional bias in M_0 and global average relationships such as given above may be inappropriate for the estimation of moments in continental regions.

From Figs 12(a) and (b), in which we compare plots of Indian and regional log M_0–M_s data sets, respectively, with global relations derived by Ekström & Dziewonski (1988), it appears that global relations yield M_0 values systematically higher than the observed data for India.

Next, we examined the bilinear-quadratic scaling of log M_0 with M_s for regional bias using the same fitting procedures as Ekström & Dziewonski (1988), for:

(i) the Indian data set with M_s as the independent variable;
(ii) the regional data set with M_s as the independent variable;
(iii) the Indian data set with log M_0 as the independent variable;
(iv) the regional data set with log M_0 as the independent variable.

Also using the above combination of data we sought:

(v) a bi-linear relation in which the slope of the regression is 1 at low M_s and 1.5 at high M_s, and
(vi) repeating (v), allowing the slope at low M_s to be determined by the regression.

As Fig. 13 shows, the results of these regressions, from both data sets, are very similar, the regional relations yielding on average smaller M_0 values for a given M_s and a slope at low magnitudes somewhat smaller than 1 (0.95). However, it is not clear whether this is not the result of sample bias at the low end of M_s.

Finally, we chose the regional laws:

$$\begin{aligned} \log M_0 &= 19.38 + 0.93 M_s \quad \text{for} \quad M_s \leq 5.94 \\ \log M_0 &= 16.03 + 1.50 M_s \quad \text{for} \quad M_s > 5.94 \end{aligned} \tag{7}$$

to derive seismic moments.

Kanamori (1977) defined the seismic moment magnitude M_W as a linear transformation of the logarithm of the seismic moment M_0 given by:

$$\mathbf{M} = M_W = (2/3) \log M_0 - 10.73, \tag{8}$$

in which M_0 is in dyn cm units (10^{-7} Nm) and from which we obtained moment magnitudes following the transformations $M_s \rightarrow \log(M_0) \rightarrow M_w$, the values of which are listed in Table B1 for events back to 1803.

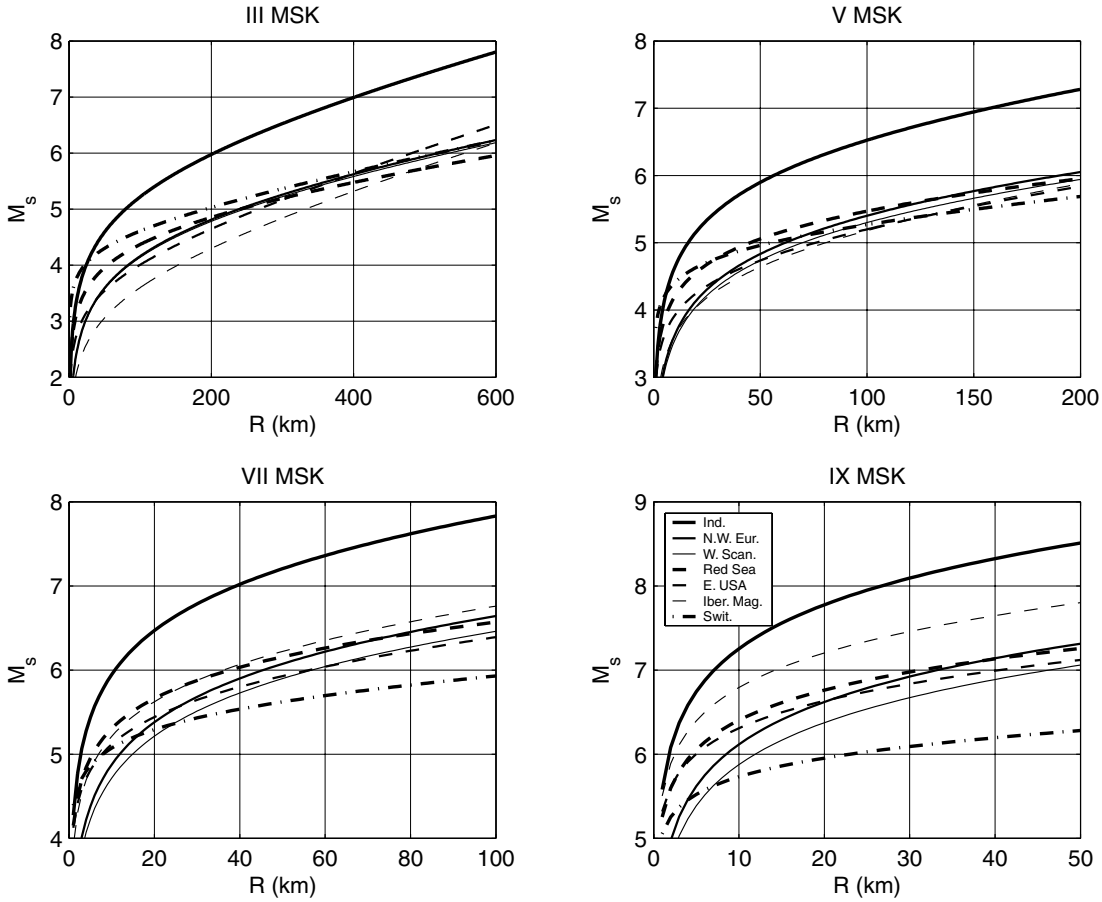


Figure 11. Comparison of eq. (2) with M_s-scaling laws derived in Table B3 (group III).

10 DISCUSSION

We may conclude with a number of observations, which are discussed below.

We do not suggest that the simplified version of the MSK scale we have chosen in this article is a panacea. The MSK scale was chosen because it was devised for a built environment nearer to that in the East rather than to that in the West and also because we are more familiar with its use in the field. Any other scale, suitable for India, if applied uniformly to all, early and modern earthquakes would have been acceptable and suitable for scaling magnitude.

Note that for modern earthquakes and for the built environment for which they have been devised, MSK and MM scales are for all practical purposes consistent over the range of primary interest (IV to IX).

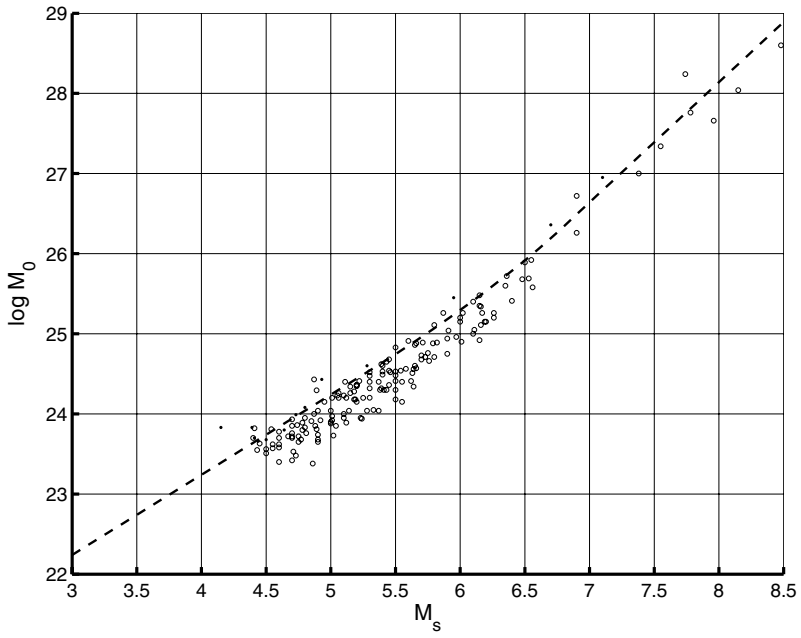
With few exceptions, empirical laws for the assessment of macroseismic magnitude are based on published intensities, which come from a combination of a variety of sources. The majority come from isoseismal maps published by different authors and national agencies, prepared by the same staff usually over a long period of time, or from the data set used to prepare these maps, which is a listing of small towns or settlements all having the same intensity. An examination of how these maps were prepared by a number of agencies shows that invariably the custom was that, if in a small town or settlement the intensity varied through a range of values, the highest value was used for the whole area.

Changes of staff in an agency are often reflected in the way intensities are estimated. Also, isoseismals drawn across national borders by different agencies often show differences that can be attributed to different customs of assessing macroseismic information (Ambraseys & Moinfar 1988).

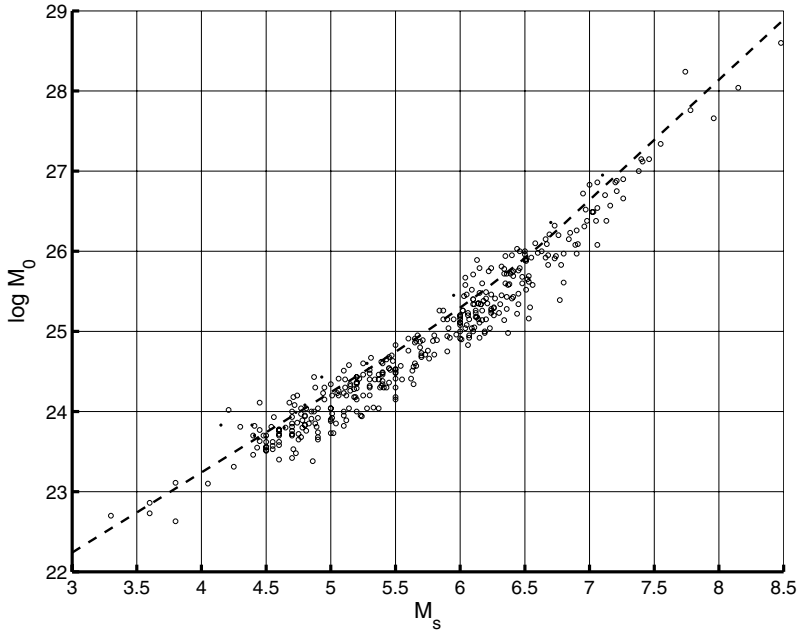
Clearly, a significant amount of averaging and maximizing of intensity values has to be suffered when dealing with a geographical area of any extent: intensity scales descriptions are not precise enough and damage is not consistent enough to do otherwise. Because, physically, there is no justification for any relationship between intensity and ground motion, as confirmed by the tremendous spread in the results of most studies, for instance in the detailed work by Trifunac & Brady (1975b,a), it is immaterial how precisely one treats the intensity values at one's disposal. Reviewing some of the published isoseismal maps for India, it is obvious that their authors allowed non-vibrational effects to influence their assessment of intensities.

This study demonstrates that it is possible to calculate accurate surface wave magnitudes for earthquakes that occurred before the advent of the ISC and there is no need to rely on empirical macroseismic formulae for the assessment of the size of early-20th-century events.

We find that the regional log M_0–M_s relation yields smaller M_0 values for a given M_s than the global relation, with a slope smaller than one derived from small magnitudes. As with the seismicity of the Sea of Marmara, it appears that the global relation gives seismic moments that are too high, while the regional relation derived for India fits better those observed (Ambraseys & Jackson 2000). In the case of northern India, the overestimation in total M_0 is by 13 per cent.



(a)



(b)

Figure 12. Comparison of plots of (a) Indian and (b) regional log M_0–M_s data sets with global relations derived by Ekström & Dziewonski (1988).

The question of how complete is the record of large earthquakes in the region for the last 600 yr is difficult to answer. Since the publication of a previous paper on the seismicity of the region (Ambraseys & Jackson 2003), new references to several more early earthquakes in northern India and Tibet have been retrieved, even some in the 18th century. It is very probable that more records will continue to emerge and the overall picture north of the Himalaya will get clearer in the coming years. So far we believe that we have not missed anything big near the main populated areas since 1400. However, there must be many omissions in the Himalayan massif and also in the swathes of nomadic areas to the northwest. However, we would not think that great earthquakes like that which occurred in 1505 could have been easily overlooked, but oddly enough it was not in the official Tibetan list of earthquakes (Chen *et al.* 1982).

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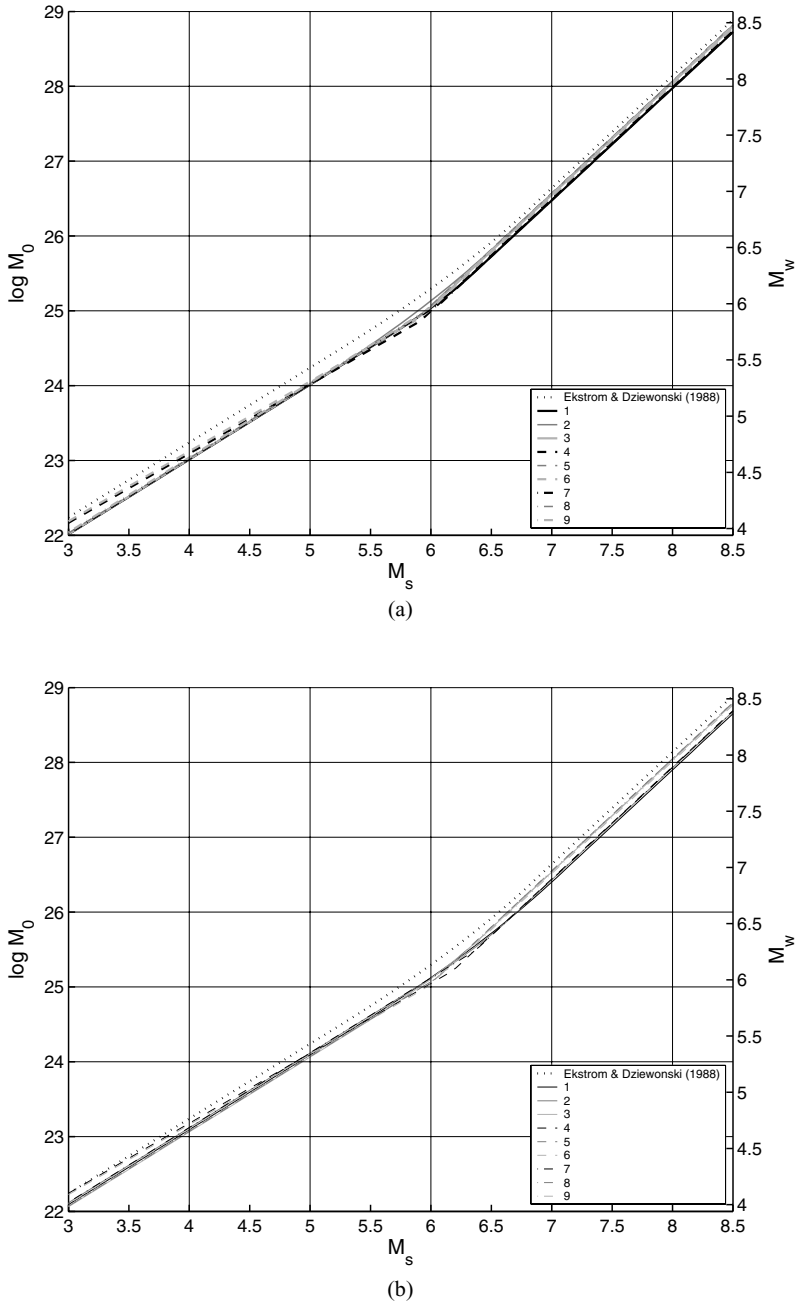

Figure 13. Comparison of log M_0–M_s regressions.

Bilham and an anonymous reviewer for their positive and constructive reviews: their contributions significantly improved this paper.

REFERENCES

Abe, K., 1994. Instrumental magnitudes of historical earthquakes, 1892 to 1898, *Bull. seism. Soc. Am.,* **84,** 415–425.

Ambraseys, N.N., 1967. The earthquakes of 1965–66 in the Peloponnese, Greece, *Bull. seism. Soc. Am.,* **57,** 1025–1046.

Ambraseys, N.N., 1985a. Intensity-attenuation and magnitude-intensity relationships for northwest European earthquakes, *Earthquake Engineering and Structural Dynamics,* **13,** 733–778.

Ambraseys, N.N., 1985b. The seismicity of western Scandinavia, *Earthquake Engineering and Structural Dynamics,* **13,** 361–399.

Ambraseys, N.N., 1988. Engineering seismology, *Earthquake Engineering and Structural Dynamics,* **17,** 1–105.

Ambraseys, N.N., 1992. Soil mechanics and engineering seismology. In: *Proc. 2nd Greek Natl. Conf. on Soil Mechanics, Thessaloniki,* pp. i–xi. Technical Chamber of Greece.

Ambraseys, N.N., 2000. Reappraisal of north-Indian earthquakes at the turn of the 20th century, *Current Science,* **79,** 101–114.

Ambraseys, N.N., 2003. Reappraisal of magnitude of 20th century earthquakes in Switzerland., *Journal of Earthquake Engineering,* **7,** 149–191.

Ambraseys, N.N. & Bilham, R., 2000. A note on the Kangra earthquake of 4 April 1905, *Current Science,* **79,** 45–50.

Ambraseys, N.N. & Bilham, R., 2003a. Earthquakes in Afghanistan, *Seismological Research Letters,* **74**(2), 107–123.

Ambraseys, N.N. & Bilham, R., 2003b. Earthquakes in Baluchistan, *Bull. seism. Soc. Am.* **93,** 1573–1605.

Ambraseys, N.N. & Jackson, D., 2003. A note on early earthquakes in northern India and southern Tibet, *Current Science,* **84,** 570–582.

Ambraseys, N.N. & Jackson, J., 2000. Seismicity of the Sea of Marmara since 1500, *Geophys. J. Int.,* **141,** F1–F6.

Ambraseys, N.N. & Moinfar, A., 1988. Isoseismal maps across national frontiers; the Caldiran earthquake of 24 Nov., 1976, *European Earthquake Engineering,* **3,** 15–21.

Ambraseys, N.N. & Zatopek, A., 1968. The Varto Ustukran (Anatolia) earthquake of 19 August 1966, *Bull. seism. Soc. Am.,* **58,** 47–102.

Ambraseys, N.N., Melville, C. & Adams, R., 1994. *The seismicity of Egypt, Arabia and the Red Sea* Cambridge University Press, Cambridge.

Auden, J.B. & Ghosh, A.N., 1934. Preliminary account of the earthquake of 15th January, 1934, in Bihar and Nepal, *Rec. Geol. Surv. India,* **68(2),** 177–293.

Bakun, W.H. & Wentworth, C.M., 1997. Estimating earthquake location and magnitude from seismic intensity data, *Bull. seism. Soc. Am.,* **87**(6), 1502–1521.

Bakun, W.H., Haugerud, R.A., Hopper, M.G. & Ludwin, R.S., 2002. The December 1872 Washington State earthquake, *Bull. seism. Soc. Am.,* **92**(8), 3239–3258.

Bakun, W.H., Johnston, A.C. & Hopper, M.G., 2003. Estimating locations and magnitudes of earthquakes in eastern North America from Modified Mercalli intensities, *Bull. seism. Soc. Am.,* **93**(1), 190–202.

Bilham, R., 1995. Location and magnitude of the 1833 Nepal earthquake and its relation to the rupture zones of contiguous great Himalayan earthquakes, *Current Science,* **69**, 101–128.

Brett, W.B., 1935. *A report on the Bihar earthquake and on the measures taken in consequence thereof up to the 31st December 1934,* Pub. Superint. Govt. Printing, Patna, p. 99.

Carr, J.R. & Glass, C.E., 1986. An evaluation of the quality of the 1886 Charleston South Carolina intensity data using indicator functions. In:, *Proceedings of the Third U.S. National Conference on Earthquake Engineering,* Vol. 1, pp. 33–42. Earthquake Engineering Research Institute, Charleston, SC, USA.

Carr, J.R. & Glass, C.E., 1989. Use of geostatistics for accurate mapping of earthquake ground motion, *Geophys. J.,* **97**(1), 31–40.

Carr, J.R., Deng, E.D. & Glass, C.E., 1986. An application of disjunctive kriging for earthquake ground motion estimation, *Mathematical Geology,* **18**(2), 197–213.

Chen, J. et al, 1982. *A collection of material on earthquakes in tibet (xizang dizhen shiliao huibian),* Vols 1 and 2, Xizang Renmin Chubanshe, Lhasa.

Chen, W.-P. & Molnar, P., 1977. Seismic moments of major earthquakes and the average rate of slip in central Asia, *J. geophys. Res.,* **82**(20), 2945–2969.

Dunn, J.A., Auden, J.B., Ghosh, A.M. & Wadia, D.N., 1939. The Bihar-Nepal earthquake of 1934, *Mem. Geol. Surv. India,* **73**, 1–391.

Ekström, G. & Dziewonski, A.M., 1988. Evidence of bias in estimations of earthquake size, *Nature,* **332**(March), 319–323.

Engdahl, E.R., van der Hilst, R. & Buland, R., 1998. Global teleseismic earthquake relocation with improved travel times procedures for depth determination, *Bull. seism. Soc. Am.,* **88**, 722–743.

Gee, E.R., 1937. The Dhubri earthquake of the 3rd July 1930. In: *Proc. 24th Indian Sci. Congress* pp. 1–106, includes appendices by M. Krishnan and A. Lister-Jackson. India Science Congress, Delhi, India.

Gee, E.R., 1953. The Assam earthquake of 1950, in *Compilation of Papers on the Assam Earthquake,* Publication no. 1, pp. 101–107, ed. Ramachandra Rao, M.B., Central Board of Geophysics, Calcutta.

Gutenberg, B. & Richter, C., 1965. *Seismicity of the earth and associated phenomena,* Hafner, New York.

Heron, A., 1911. The Baluchistan earthquake of the 21st October 1909, *Rec. Geol. Surv. India,* **41**, 22–35.

Jeffreys, H., 1935. Some deep-focus earthquakes, *Mon. Not. R. astr. Soc., Geophysics Suppl.,* **3,** 317.

Johnston, A.C., Coppersmith, K.J., Kanter, L.R. & Cornell, A., 1994. *The earthquakes of stable continental regions,* Vol. 1, pp. 3.19–3.40, Electric Power Research Institute, Palo Alto.

Kanamori, H., 1977. The energy release in great earthquakes., *J, geophys. Res.,* **82**(20), 2981–2987.

Kondorskaya, N. & Shebalin, N., 1977. *Novii katalog sil'n'ikh zemletriasenii na territorii CCCP Izdatelstvo Nauka*, Moscow, p. 535.

Lee, S., 1983. *Publications of historical material in china,* Vols 1–7, Science Press, Beijing.

Lopez Casado, S., Molina, S., Giner, J. & Delgado, J., 2000. Magnitude-intensity relationships in the Ibero-Magrebhian region, *Natural Hazards,* **22**, 271–297.

Middlemiss, C., 1910. The Kangra earthquake of 4 April 1905., *Mem. Geol. Surv. India,* **38**.

Oldham, R., 1899. Report on the great earthquake of 12th June 1897, *Mem. Geol. Surv. India,* **29**.

Olea, R.A., 1999. *Geostatistics for engineers and earth scientists,* Kluwer Academic Publishers, Dordrecht.

Papazachos, C. & Papaioannou, Ch., 1997. The macroseismic field of the Balkan area, *Journal of Seismology,* **1**, pp. 181–201, see also for discussion, **2,** pp. 359–375.

Principia Mechanica, 1982. *British earthquakes; an analysis of British earthquakes* Tech. report 115/82, Principia Mechanica, London.

Quittmeyer, R. & Jacob, K., 1979. Historical and modern seismicity of Pakistan, Afghanistan, northwestern India and southeastern Iran, *Bull. seism. Soc. Am.,* **69**(3), 773–823.

Shebalin, N., 1968. Metodi ispolozovaniia inzhenerno-seismologicheskikh danniikh pri seismicheskom raionirovanii, in *Seismicheskoie rayonirovaniie SSSR,* pp. 85–111, Nauka, Moscow.

Shebalin, N., Karnik, V. & Hadzievski, D., 1974. *Catalogue of earthquakes* UNDP/UNESCO Survey of the Seismicity of the Balkan Region, Part 1, p. 366. UNDP/UNESCO, Skopje, Yugoslavia.

Soil Mechanics Ltd, 1982. *Re-assessment of UK seismicity data,* Tech. report 7984, Vols 1–3, Soil Mechanics Ltd, London.

Stuart, M., 1919. Preliminary note on the Srimangal earthquake of July 8th, 1918, *Rec. Geol. Surv. India,* **49,** 178–190.

Trifunac, M.D. & Brady, A.G., 1975a. On correlation of seismoscope response with earthquake magnitude and Modified Mercalli intensity, *Bull. seism. Soc. Am.,* **65**, 307–321.

Trifunac, M.D. & Brady, A.G., 1975b. On the correlation of seismic intensity scales with the peaks of recorded stromg ground motion, *Bull. seism. Soc. Am.,* **65**, 139–162.

West, W.D., 1934. The Baluchistan earthquakes of 25th and 27th August 1931, *Mem. Geol. Surv. India,* **67**, 1–82.

West, W.D., 1936. Preliminary geological report on the Baluchistan (Quetta) earthquake of May 31st, 1935, *Rec. Geol. Surv. India,* **69**, 204–241.

Willmore, P., 1979. *Manual of Seismological Observatory Practice,* Tech. report SE-20, World Data Centre A for Earth Geophysics, Boulder, CO.

APPENDIX A: KRIGING TECHNIQUE

Kriging is a technique for estimating a continuous, spatial attribute at an unsampled site, preferably inside the convex hull defined by the location of the data (Olea 1999, p. 7). Kriging is a form of generalized linear regression for the formulation of an optimal estimator in a minimum mean square error sense (Olea 1999, p. 7). Kriging has been used in the past for earthquake ground motion contouring, including intensity data (e.g. Carr & Glass 1986; Carr *et al.* 1986; Carr & Glass 1989). Kriging is identical to spline interpolation for specific semi-variogram models (Carr & Glass 1989).

In this article, the kriging technique known as universal kriging (kriging with a trend model) was adopted because intensity values are not constant across the Earth but feature an underlying decay with distance from the earthquake source. Therefore, the data does not obey the ordinary kriging assumptions. In kriging terms, the underlying function is known as the drift.

The assumptions of universal kriging (Olea 1999, pp. 92–93) are given below.

(i) A sampling is a partial realization of a random function.

(ii) The residuals $Y(\boldsymbol{x}) = Z(\boldsymbol{x}) - E[Z(\boldsymbol{x})]$ honour the intrinsic hypothesis: $E[Y(\boldsymbol{x})]$ is constant and $\mathrm{Var}[Y(\boldsymbol{x}) - Y(\boldsymbol{x}+\boldsymbol{h})] = 2\gamma_Y(\boldsymbol{h})$

for all $\boldsymbol{x}$, $\boldsymbol{x}+\boldsymbol{h}$ in d, where $\boldsymbol{h}$ is a Euclidean distance and $\gamma_Y(\boldsymbol{h})$ is the semi-variogram of the residuals.

(iii) The deterministic and unknown drift can be modelled as a linear combination of analytical functions.

The algorithm to apply universal kriging is:

(i) Calculate each term in matrix P where:

$$\mathbf{P} = \begin{pmatrix} \mathrm{Cov}_Y(\boldsymbol{x}_1,\boldsymbol{x}_1) & \dots & \mathrm{Cov}_Y(\boldsymbol{x}_k,\boldsymbol{x}_1) & 1 & f_1(\boldsymbol{x}_1) & \dots & f_n(\boldsymbol{x}_1) \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \mathrm{Cov}_Y(\boldsymbol{x}_1,\boldsymbol{x}_k) & \dots & \mathrm{Cov}_Y(\boldsymbol{x}_k,\boldsymbol{x}_k) & 1 & f_1(\boldsymbol{x}_k) & \dots & f_n(\boldsymbol{x}_k) \\ 1 & \dots & 1 & 0 & \dots & \dots & 0 \\ f_1(\boldsymbol{x}_1) & \dots & f_1(\boldsymbol{x}_k) & 0 & \dots & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ f_n(\boldsymbol{x}_1) & \dots & f_n(\boldsymbol{x}_k) & 0 & \dots & \dots & 0 \end{pmatrix}, \quad \text{(A1)}$$

where $x_1 \dots x_k$ are the coordinates of the intensity points, $f_1 \dots f_n$ are the functions describing the drift (in this case $f_1 = \log\sqrt{d^2+h^2}$) and $\mathrm{Cov}(\boldsymbol{h}) = \mathrm{Cov}(0) - \gamma(\boldsymbol{h})$.

(ii) Calculate each term in the vector $\boldsymbol{p}$ where:

$$\boldsymbol{p} = \left[\, \mathrm{Cov}_Y(\boldsymbol{x}_0,\boldsymbol{x}_1) \dots \mathrm{Cov}_Y(\boldsymbol{x}_0,\boldsymbol{x}_k) \;\; f_1(\boldsymbol{x}_0) \dots f_n(\boldsymbol{x}_0)^T \,\right], \quad \text{(A2)}$$

where $\boldsymbol{x}_0$ is the point at which to estimate the new intensity value.

(iii) Solve the linear system: $\mathbf{P}\boldsymbol{q} = \boldsymbol{p}$ for the vector $\boldsymbol{q}$ which holds the optimal weights λ_i for the estimator.

(iv) Compute the estimate at $\boldsymbol{x}_0$ using $\hat{Z}_{UK}(\boldsymbol{x}_0) = \boldsymbol{Z}^T\boldsymbol{q}$, where $\boldsymbol{Z}$ holds the intensity values at each of the sample points.

(v) Compute the universal kriging estimation variance at $\boldsymbol{x}_0$ using $\sigma^2{}_{UK}(\boldsymbol{x}_0) = \mathrm{Cov}_Y(0) - \boldsymbol{p}^T\boldsymbol{q}$.

An exponential semi-variogram of the form $\gamma(h) = c_0 + c_1\,(1 - \exp(-3h/a)$, where h is called the lag that equals the distance between two intensity points, was used. $\gamma(a) = c_0 + 0.95c_1$, and therefore a, roughly corresponds to the distance of the zone of influence of one intensity value. Intensity points separated by a distance greater than the range a are not spatially correlated. The values used were $c_0 = 1$, $c_1 = 1$ and $a = 1000$ km.

APPENDIX B: TABLES

Table B1. Significant earthquakes in northern India (15°–36°N, 65°–95°E).

	Y	M	D	OT	N	E	h	R	M_s	σ_1	n_1	M_m	σ_2	n_2	$\log M_0$	M_w	Location	C
A	1411	Sep.	29	0500	30.00	90.20	n	m				7.70		10	27.58	7.66	Danxung	T
B	1505	Jun.	06	0500	29.50	83.00	n	m				8.20		13	28.33	8.16	Lo Mustang	N
C	1505	Jul.	06		34.50	69.10	n	m				7.30		13	26.98	7.26	Kabul	A
D	1555	Sep.		2200	33.50	75.50	n	m				7.60		6	27.43	7.56	Srinagar	I
E	1664				25.00	90.00	n	m				7.80			27.73	7.79	N Bangla	B
F	1720	Jul.	25	1230	30.00	80.00	n	m				7.50			27.28	7.46	N Uttarpradesh	I
G	1751				31.30	80.00	n	m				7.00			26.53	6.96	Guge	T
1	1803	Sep.	01	0130	31.50	79.00	n	m				7.50	0.22	33	27.28	7.46	Uttar–Pradesh	I*
H	1806	Jun.	11		28.50	92.00	n	m				7.70		9	27.58	7.66	Samye	T
2	1819	Jun.	16	1900	23.00	69.00	n	m				8.23	0.18	30	28.38	8.19	Cutchch	I*
3	1833	Aug.	26	1730	27.70	85.70	n	m				7.65	0.26	61	27.51	7.61	Nepal	N*
4	1842	Feb.	19	1120	34.70	71.00	n	m				7.67	0.16	29	27.54	7.63	Kunar	A
I	1842	Sep.	16	0430	32.10	98.60	n	m				7.40			27.13	7.36	Zongguo	T
J	1842	Nov.	11	2138	24.00	90.00	n	m				6.80			26.23	6.76	Bangla	B
5	1843	Apr.	01	0430	15.50	77.00	n	m				6.37	0.39	11	25.59	6.33	Barelly	I
6	1852	Jan.	24	0345	29.20	68.20	n	m				6.69	0.23	14	26.07	6.65	Kahun	P
7	1858	Aug.	24	1530	19.10	95.10	n	m				7.66	0.29	25	27.52	7.62	Arracan	Bu
8	1869	Jan.	10	1700	25.50	93.00	n	m				7.42	0.22	41	27.16	7.38	Cachar/Silchar	I*
9	1874	Oct.	18	0018	35.10	69.30	n?	m				6.58	0.73	8	25.90	6.54	Kuhistan	A
10	1878	Mar.	02	1230	34.00	73.20	n	m				6.80	0.27	16	26.23	6.76	Abbottabad	P
11	1885	May	29	0245	34.10	74.60	n	m				6.36	0.07	37	25.57	6.32	Srinagar	I
12	1885	Jul.	14	0030	24.50	90.00	n	m				6.91	0.28	30	26.40	6.87	Bengal	I
13	1892	Dec.	20	0020	30.80	66.50	n	m				6.18	0.17	7	25.30	6.14	Chaman	P
14	1897	Jun.	12	1106	25.50	91.00	n	I	8.00	0.15	6	8.18	0.32	282	28.14	8.03	Shillong	I*
15	1897	Jun.	13	0730	24.50	89.00	n	m				5.20		10	24.22	5.41	Shillong	I
16	1897	Aug.	02	1540	25.00	90.00	n	m				6.26	0.08	13	25.42	6.22	Shillong	I
17	1905	Apr.	04	0050	33.00	76.00	50	gr	7.83	0.15	6	7.97	0.17	523	27.78	7.79	Kangra	I*
18	1906	Feb.	27	1940	31.50	77.50	n	m	6.45	0.22	5				25.71	6.41	Bashahr	I
19	1909	Jul.	07	2137	36.50	70.50	230	gr	7.56	0.25	8	7.95	0.24	27	27.37	7.52	Hindu–Kush	A
20	1909	Oct.	20	2341	30.00	68.00	n	gr	7.16	0.25	9	7.16	0.12	45	26.77	7.12	Kachhi	P

Table B1. (*Continued*.)

	Y	M	D	OT	N	E	h	R	M_s	σ_1	n_1	M_m	σ_2	n_2	$\log M_0$	M_w	Location	C
21	1911	Jan.	01	1018	38.00	66.00	50	gr	6.93	0.36	10	7.10	0.16	18	26.43	6.89	Mazar-I Sherif	A
22	1911	Jul.	04	1333	36.00	70.50	190	gr	7.03	0.45	12	7.82	0.49	28	26.58	6.99	Hindu–Kush	P
23	1915	Dec.	03	0239	29.50	91.50	n	iss	6.76	0.27	7			29	26.17	6.72	sTanrtse	T
24	1916	Aug.	28	0639	29.90	80.50	n	m	7.26	0.24	8				26.92	7.22	Uttaranchal	I
25	1918	Jul.	08	1022	26.50	92.00	n	iss	7.14	0.34	15	7.26	0.12	139	26.74	7.10	Srimangal	B*
26	1923	Sep.	09	2034	25.50	91.50	n	iss	7.06	0.26	12	7.07	0.14	17	26.62	7.02	Mymesingh	B
27	1929	Feb.	01	1714	36.40	70.70	170	4	6.75	0.35	25	8.26	0.15	24	26.16	6.71	Hindu–Kush	A
28	1930	Jul.	02	2103	25.80	90.20	n	iss	7.13	0.38	16	6.92	0.32	117	26.73	7.09	Dhubri	I*
29	1931	Aug.	24	2135	30.20	67.70	n	iss	6.77	0.25	20	6.65	0.20	37	26.19	6.73	Sharigh	P
30	1931	Aug.	27	1527	29.80	67.30	n	iss	7.32	0.39	20	7.01	0.27	98	27.01	7.28	Mach	P*
31	1934	Jan.	15	0843	27.55	87.09	n	3	8.15	0.29	22	8.13	0.16	806	28.26	8.11	Nepal–Bihar	N*
32	1935	May.	30	2133	29.60	66.50	n	iss	7.74	0.28	22	7.39	0.35	49	27.64	7.70	Quetta	P*
33	1941	Jan.	21	1241	27.00	92.00	100	gr	6.54	0.34	9	7.30	0.28	6	25.84	6.50	Shillong	I
34	1943	Oct.	23	1723	26.80	94.00	n	iss	7.28	0.30	13	7.19	0.16	23	26.95	7.24	N Assam	I
35	1945	Jun.	22	1801	32.78	76.13	n	q	6.31	0.35	11	6.90	0.21	13	25.50	6.27	Chamba	I
36	1950	Aug.	15	1409	28.70	96.60	n	iss	8.48	0.39	21				28.75	8.44	Assam–Tibet	T
37	1954	Mar.	21	2342	24.20	95.10	120	iss	7.02	0.17	12	7.66	0.59	99	26.56	6.98	Manipur	Bu
38	1956	Jun.	09	2313	35.20	67.40	15	R	7.39	0.30	24	7.25	0.29	27	27.12	7.35	Bamyan	A
39	1967	Feb.	20	1518	33.58	75.32	14	eng	5.48			5.58	0.34	24	24.48	5.59	Anantnang	I
40	1967	Dec.	10	2251	17.54	73.84	27	isc	6.48	0.27	31	6.19	0.21	213	25.75	6.44	Koyna	I
41	1970	Mar.	23	0153	21.60	72.96	8	isc	5.11	0.12	3	5.54	0.11	28	24.13	5.36	Broach	I
42	1972	Sep.	03	1648	35.94	73.33	10	1	6.32	0.26	14	6.52	0.14	24	25.51	6.28	Hamrin	P
43	1974	Dec.	28	1211	35.06	72.91	10	1	6.25	0.20	42	6.72	0.08	65	25.41	6.21	Pattan	P*

A to J, refer to events in Ambraseys & Jackson (2003) and Ambraseys & Bilham (2003a) and are added for the sake of completeness. These events are still under investigation and they are presented here merely for the sake of completeness and not to be seized upon to develop long-term seismicity models.
Parameters for entry no. 36 adopted from published material.
N and E, epicenter locations.
R, source.
m, macroseismic.
iss, ISS/ISC.
gr, Gutenberg & Richter (1965).
R, recomputed.
q, Quittmeyer & Jacob (1979).
1, ISC.
3, Chen & Molnar (1977).
4, Jeffreys (1935).
Eng, Engdahl *et al.* (1998).
h, focal depth estimate.
n, crustal.
M_s, for events before 1905 and, with the exception of event no.14, M_s computed from eq. (2); σ_2 is the standard deviation of the event magnitude derived from isoseismals, the construction of which depends on n_2 data points. After 1904, M_s is computed from surface waves and the Prague formula with station corrections; σ_1 is the standard deviation of the event magnitude from n_1 readings.
log M_0, seismic moment (dyn cm) computed from the regional log M_0–M_s relation, eq. (7) and M_s with two decimal figures. For events 42 and 43 CMT moment (dyn cm); M_W, moment magnitude from eq. (8).
C, location: A = Afghanistan, B = Banghladesh, Bu = Burma, I = India, N = Nepal, P = Pakistan, T = Tibet.Au: each note has been started on a new line for clarity and ease of reference: please check that they are separated correctly.

Table B2. Assessed intensities for the 43 earthquakes investigated in this study.

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
1803	degrees	degrees	
Agra	27.17	78.01	3.5
Allahabad	25.46	81.85	4.5
Alighar	27.90	78.07	5
Barahat	30.83	79.97	8
Badrinath	30.74	79.48	8.5
Bahraich	27.57	81.60	3
Balasora Road	21.49	86.94	1
Bombay	18.95	72.83	1
Calcutta	22.57	88.35	4
Cawanpur	26.46	80.33	3
Chunar	25.11	82.89	3
Devaprayag	30.15	78.62	8
Delhi	28.66	77.23	5
Djenee	30.95	78.51	7
English Bazaar	25.01	88.14	1
Farrukhabad	27.39	79.58	4
Gaya	24.80	85.01	3
Gangotri	30.98	78.93	8
Jabalpur	23.16	79.94	2
Joshimath	30.56	79.56	8
KalapaGram	30.53	79.50	7
Karnaprayag	30.26	79.25	7.5
Kashi(Varanasi)	25.31	83.00	3
Lucknow	26.84	80.93	6
Madras	13.08	80.75	1
Mathura	27.49	77.68	6
Meern-ka-Serai	27.00	79.94	4
Mullye	26.75	85.50	5
OjahGhur	30.93	79.00	8
Panha	30.26	79.22	7
Prayag(Alahabad)	25.50	81.90	3
Srinagar	30.22	78.78	7
Sultanpur	26.25	82.07	4
1819			
Ahmedabad	23.03	72.59	7
Amran	22.82	70.56	7
Anjar	23.12	70.02	9
Bhuj	23.25	69.66	9
Broach/Bharuch	21.71	72.97	5
Baroda	22.30	73.19	5
Bombay	18.95	72.83	3
Calcutta	22.57	88.36	2
Cambay	22.31	72.62	5
Chunar	25.11	82.89	2
Coimbatore	11.01	76.97	2
Futteghar	27.37	79.63	2.5
Jaunpur	25.76	82.69	3
Kathmandu	27.70	85.31	2
Kooteenna	21.63	69.98	6
Koteri	23.13	68.93	8
Luckput	23.83	68.78	8
Mandavi	22.83	69.35	8
Minpur	27.23	79.03	2.5
Mirzapur	25.15	82.57	2
Mocha	24.50	70.63	6
Muttra/Mathura	27.49	77.68	3
Nangercha	23.02	69.22	8
Pondichery	11.93	79.83	2
Poona	18.52	73.85	2
Porebunder	21.64	69.61	5.5
Pulicat	13.41	80.31	2
Sultanpur	26.25	82.07	4
Surat	21.20	72.82	6
Thera	23.32	68.92	8
1833			
Agra	27.19	78.04	4
Allahabad	25.45	81.84	5
Arrah	25.56	84.66	5
Bankipur	25.62	85.15	6
Barh	25.47	85.71	5
Benares	25.31	83.01	4
Bhagalpore	25.25	86.98	5
Bhojepur	25.59	84.13	5
Buxar	25.56	83.98	5
Calcutta	22.57	88.36	4
Chanderagore	22.88	88.39	3
Chapra	25.78	84.73	6
Chittagong	22.33	91.82	2
Chupra	25.78	84.73	6
Dacca	23.71	90.41	1
Danapur	25.63	85.05	6
Delhi	28.66	77.23	3
Digarchi	29.29	88.90	3
Dinajpur	25.63	88.65	1
Doti	29.30	80.90	5
Fattigurh	27.37	79.63	3
GandtokS	27.33	88.61	4
Ghazipur	25.59	83.60	5
Gorkha	28.00	84.63	7
Gorukpur	26.76	83.37	6
GyangkarT	28.42	87.76	5
Hathras	27.60	78.05	3
Hazaribagh	24.00	85.37	4
Jabalpur	23.16	79.94	2
JiggyobT	27.97	87.46	5
Kumarkhali	23.91	89.14	3
Kurantandhi	25.54	83.93	4
Kyirong	28.41	85.31	8
Lhasa	29.65	91.13	1
Lohooghat	29.42	80.10	2
Lucknow	26.84	80.93	4.5
Meerut	28.99	77.71	3
Midnapur	22.42	87.32	1
Moghyr	25.38	86.47	7
Mullye	25.90	86.99	5
Murshidabad	24.17	88.27	4
Muzaffarpur	26.12	85.38	6
Nassirabad	23.85	90.90	1
Palpa	27.87	83.54	6
Patan	29.47	80.55	1
Patna	25.61	85.13	7
PunakhaB	27.78	89.90	3
Purneah	25.77	87.48	7
QuxanT	28.10	85.99	8
Rajnahal	25.05	87.84	4
Rangpur	25.74	89.25	4
RhotasHill	24.63	83.83	4
RongxarT	28.08	86.33	7
Singbum	22.77	86.20	1
Sylhet	24.90	91.89	1
Tingri	28.57	86.61	4
Tirhoot	26.40	85.40	6
Udaipur	23.83	89.41	1

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Xingetse	29.30	88.70	1
ZharnT	27.98	85.98	8
ZonggaT	29.00	85.25	5
1842			
Argandeh	34.47	68.92	4.5
Bala-Maidan	34.48	68.78	4.5
Budeeabad	34.78	70.30	8
Chaharbagh	34.52	70.28	8
Delhi	28.66	77.24	2.5
Ferzopore	30.92	74.62	4
Jalalabad	34.43	70.45	8
Jalriz	34.48	68.61	5
Kabul	34.53	69.14	5.5
Kalabagh	32.97	71.55	5.5
Kawulsar	34.10	71.47	7
Kulsea	29.53	77.42	2
Kunar	34.63	70.85	8.5
Laghan	34.60	70.10	8
Ludiana	30.91	75.85	3.5
Multan	30.19	71.19	4
Mussorie	30.46	78.07	2.5
Pashat	34.73	71.02	8.5
Peshawar	34.01	71.55	7
Punji	29.46	77.35	2
Quetta	30.21	67.02	2
Shahanpur	29.97	77.54	2
Shalkur	35.32	75.54	4
Shewan	34.57	70.58	8.5
Simla	31.10	77.16	2
Sind	25.37	68.35	1
Sonub	28.42	77.04	1
Tezeen	34.36	69.57	7
Tigri	34.65	70.21	8
1843			
Bangalore	12.98	77.57	1
Belgaum	15.85	74.50	3
Bellary	15.14	76.92	6
Goa	15.50	73.82	1
Harihar	14.51	75.80	3
Hyderabad	17.39	78.49	1
Kurnul	15.82	76.04	5
Mudhol	16.33	75.28	4
Sangangallu	15.18	76.97	7
Sholapur	17.67	75.90	3
Shorapur	16.52	76.75	4.5
1852			
Bagh	29.03	67.80	5
Bola-Pass-Mach	29.83	67.19	3
Chhatr	28.86	68.33	6
Dadhar	29.48	67.63	5
Gundava	28.62	67.48	5
Kahun	29.31	68.90	8
Kalat	29.03	66.58	2.5
Khangur	27.85	69.40	4
Lehri	29.19	68.20	6
Nufusk=Guchi	29.21	69.26	7
Phulji	29.01	68.34	6
Sehwan	26.43	67.85	3
Shahpur	28.72	68.42	6
Wazirabad	27.87	68.72	4

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
1858			
Akyab	20.13	92.90	6
Allanmyo	19.38	95.22	8
Ava	21.87	95.97	4
Balasora	21.50	86.93	1
Cachar	22.69	90.26	1
Calcutta	22.57	88.36	3
Chera	25.28	91.72	2
Chittagong	22.33	91.82	3
Chotta-Nagpur	23.50	83.50	2
Cuttack	20.45	85.92	1
Darjiling	27.03	88.32	2
Diburghar	27.51	94.91	1
Gowhati	26.19	91.73	1
Hazaribagh	23.98	85.37	3
Henzada	17.60	95.30	6
Kyaukpyu	19.43	93.55	7
Mergui	12.44	98.61	1
Pagan	21.17	94.87	4
Prome	18.80	95.20	8
Rangoon	16.80	96.20	4
Shillong	25.55	91.91	1
Syleth	24.90	91.87	3
Tavoy	14.10	98.22	2
Thanetmyo	19.32	95.19	8
Toungoo	18.94	96.43	5
1869			
Baxa	25.56	83.98	2.5
Bharampur	24.09	88.25	3.5
Bhagalpur	25.25	86.98	2
Bekrar	24.35	88.67	3.5
Bogra	24.85	89.38	3
Calcutta	22.57	88.36	3
Changoori/Bjenguri	24.72	90.62	4.5
Cherapunji	25.28	91.72	6
Chinsurah	23.92	81.03	2
Chittagong	22.33	91.83	2.5
Dacca	23.71	90.41	3.5
Darjiling	27.04	88.26	3
S-dBus	29.00	90.00	2
Dinajpur	25.63	88.64	3.5
Diburgar	27.47	94.85	4.5
Gauhati	26.19	91.75	6
Goalpara	26.18	90.62	4.5
Golaghat	26.51	93.97	6
Hazaribagh	24.00	85.37	2.5
Jaipur	27.26	95.38	5
Jalpaiguri	26.52	88.72	3
Khanoma	25.65	94.03	7
Kursung	26.88	88.28	3.5
Lakhimpur	26.03	90.30	4.5
Madura/Mahura	25.17	93.12	7.5
Manipur/Imphal	24.78	93.95	7
Midnapur	22.42	87.33	2
Moghyr	25.38	86.47	3
Moirang	24.50	93.77	6
Nazira	26.92	94.73	5
Nongpata	25.90	91.88	6
Nowgong	26.35	92.69	7
Pabna	24.00	89.24	3.5
Patna	25.62	85.14	2.5
Purnea	24.56	87.33	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Raniganj	23.61	87.12	3
Shillong	25.56	91.88	6.5
Sibsagar	26.98	94.63	5.5
Silchar/Cachar	24.82	92.78	7
Syleth/Sihret	24.90	91.88	6.5
1874			
Golbahar	35.14	69.30	8
Jabal-Saraj	35.13	69.24	8
Kabul	34.53	69.13	7
Kandahar	31.61	65.70	3
Kohistan	35.10	69.30	8
Lahore	31.56	74.35	3
Samarkand	39.66	66.95	3
Sekandarabad	32.42	65.05	3
1878			
Abbottabad	34.15	73.20	7
Attock	33.77	72.37	6
Bannu	32.99	70.60	4
Ferozapore	30.92	74.61	3
Haripur	34.02	72.92	7
Hazara	34.80	72.30	5.5
Hoti	34.20	72.07	4
Jhelum	32.94	73.72	5
Kohat	33.60	71.44	6
Lahore	31.56	74.35	3.5
Mussorie	30.45	78.07	2
Muree	33.91	73.39	7
Naoshera	34.00	72.00	5
Peshawar	34.01	71.55	6
Rawalpindi	33.60	73.05	6
Simla	31.11	77.17	2.5
1885a			
Bagh	33.98	73.78	5
Baramula	34.21	74.35	7
Chikar	34.15	73.68	5
Chihar	36.38	75.78	2
Chushul	33.59	78.65	1
Dalhousie	32.53	75.98	4
Drang	33.97	74.57	7
Gondikallel	34.17	74.64	7
Garhi	34.22	73.60	5
Gilgit	35.91	74.29	3.5
Gulmarg	34.06	74.39	7.5
Gurais	34.63	74.83	5
Hanle	32.80	79.00	2
Kangra	32.10	76.27	3
Kaosa	34.08	74.66	7
Khaimang	34.97	76.23	4.5
Kohat	33.60	71.44	1
Lahore	31.56	74.35	3
Leh	34.18	77.59	3
Ludhiana	30.90	75.84	1
Magaon/Magam	34.08	74.58	8
Patan	34.17	74.57	8
Peshawar	34.00	71.55	3
Punch	33.84	74.09	5.5
Rampur	34.02	74.93	6
Rawalpindi	33.59	73.05	4
Sabathu	30.99	77.00	2
Shadipur	34.18	74.66	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Shapur	32.28	72.47	1
Sialkot	32.52	74.55	4
Simla	31.10	77.17	2
Sopur	34.29	74.46	7
Srinagar	34.08	74.80	6.5
Sumbal	34.24	74.63	7
Titwal	34.61	72.65	4.5
Tregaon	34.16	74.67	7
Uri	34.09	74.05	6
1885b			
Azimganj	24.23	88.25	5
Barisal	22.70	90.37	4
Bogra	24.85	89.37	7
Calcutta	22.57	88.36	3.5
Chattak	25.03	91.67	4
Chittagong	22.33	91.82	2
Dacca	23.71	90.41	5
Daltongunge	24.01	84.07	2
Darjiling	27.04	88.26	2
Durbhanga	26.15	85.89	2
Faridpur	23.60	89.85	4
Gauhati	26.18	91.75	1
Jamalpur	24.92	89.94	7
Kachahri	23.36	90.34	4.5
Komillah	23.46	91.18	4
Manipur	24.79	93.94	2
Mongyr	25.39	86.47	4
Muktagacha	24.76	90.25	6.5
Mymensingh	24.75	90.40	6
Nattore	24.41	88.99	7
Pabna	24.01	89.24	6
Purneah	25.77	87.47	4
Rumpur	23.68	89.67	5
Sherpur	25.02	90.01	7
Sibsagar	26.98	94.63	2
Silchar	24.82	92.78	1
Siliguri	26.72	88.43	3
Sirajganj	24.46	89.70	8
Sitarampur	23.15	89.23	4.5
Surornkhali	23.72	89.31	5
1892			
Old-Chaman	30.85	66.52	8
Kandahar	31.61	65.70	4.5
Pishin	30.58	66.98	5.5
Quetta	30.21	67.02	5
Shalebagh	30.83	66.58	7
Sibi	29.54	67.88	2.5
Spin-Baldak	31.02	66.40	7
1897a			
Aboo Mt.	24.48	72.78	1
Achalpur	21.25	77.51	2
Agartala	23.83	91.38	6
Agia	26.08	90.62	8
Agra	27.17	78.08	3.5
Ahatguri	26.83	93.86	5
Ahmadabad	23.09	72.59	1
Ajmer	26.44	74.64	2
Akhaura	23.87	91.27	6
Akyab	20.12	92.93	2
Alipura	23.62	89.82	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Alipur-Doar	26.50	89.53	7
Allahabad	25.43	81.92	5
Allanmyo	19.35	95.28	2
Anand	22.53	73.02	3
Atharabari	24.36	90.02	8
Azimganj	24.23	88.30	7
Badarpur	24.88	92.62	6
Bagula	23.32	88.65	5
Baidi	29.10	90.47	4
Balasor	21.50	86.97	4
Balipara	26.83	92.73	6
Bangalore	12.97	77.62	2
Banka	24.55	86.97	5
Bankipur	25.61	85.15	5
Bankura	23.24	87.07	4
Bardwan	23.23	87.87	4
Bareilly	28.36	79.42	3.5
Barisal	22.70	90.37	4
Baroda	22.31	73.19	1
Baxa	26.75	89.58	7
Benares	25.31	83.01	4.5
Berhampur	24.09	88.25	6
Betul	21.92	77.90	1
Bezwada	21.13	86.72	2
Bhakalpur	25.25	86.97	5
Bhamo	24.25	97.27	3
Bhartpur	27.22	77.53	3
BiharSharif	25.20	85.53	5
Bilimora	20.68	73.07	2
Birda	24.58	78.48	3
Bobbili	18.57	83.37	2
Bogribari	26.20	90.20	8
Bombay	18.92	72.90	1
Borjali	26.77	92.75	6
Budge-budg	22.48	88.73	3
Burhanpur	21.32	76.27	2
Buxar	25.57	84.02	5
Calcutta	22.57	88.35	4.5
Chandbali	20.77	86.80	3
Chandpur	23.22	90.66	5.5
Chaphara	27.00	86.28	5
Chapra	25.78	84.78	5.5
Cherrapunji	25.28	91.73	8
Chihindwara	22.05	78.94	1
Chiknagul	24.93	93.05	5
Chittagong	22.35	91.88	5
Coconada	16.95	82.22	2
Colgong	25.26	87.23	5.5
Comillah	23.47	91.22	7
Cona=Tsona	27.98	91.98	5.5
Dabhoda	23.15	72.82	2
Dacca	23.71	90.41	7
Damra	25.90	90.83	8
Damukdea	24.03	89.07	6
Damxoi	28.47	91.55	4.5
Daragon	24.28	91.54	6.5
Darjiling	27.04	88.26	6.5
Darma	28.19	91.20	5.5
Debra	22.40	87.55	4.5
Degyi	28.03	87.67	5.5
Dehegam	23.18	72.85	2
Delhi	28.66	77.23	2.5
Deogarh	24.49	86.69	5
Dhargam	25.12	91.98	8
Dhubri	26.02	89.98	7.5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Diburghar	27.48	94.91	4.5
Dilma	25.87	90.72	9
Dinajpur	25.63	88.64	7
Dongkar	27.57	89.00	5.5
Doqoi	28.83	90.67	4.5
Dumka	24.27	87.25	6
Durgapur	25.14	90.68	7
Faizabad	26.78	82.20	4.5
Faridpur	23.60	89.88	5
Gamba	28.27	88.53	4.5
Gantok	27.32	88.62	6.5
Garbo	28.37	90.83	5.5
Garbyang	30.12	80.85	4
Gauhati	26.18	91.75	8
Gauripur	26.18	90.12	7
Gaya	24.82	85.05	4.5
Ghaziabad	28.67	77.47	2.5
Giridi	24.17	86.28	4.5
Goalpara	26.18	90.62	8
Goalundo	23.83	89.80	6
Godda	24.83	87.21	5.5
Golaghat	26.51	93.97	5
Gomastapur	25.78	88.33	6.5
Gombardangal	22.88	88.80	6
Guripur	24.76	90.56	8
Gwalior	26.22	78.20	3.5
Habiganj	24.38	91.41	6.5
Harirampur	23.62	89.93	6
Haza	26.25	91.58	7.5
Helem	26.83	93.33	5
Henzada	17.63	95.53	2
Hoshangabad	22.75	77.77	2
Howrah	22.58	88.38	5
Hugli	22.90	88.40	5
Isvarganj	24.68	90.58	5
Jabalpur	23.18	79.98	3
Jaidebpur	24.00	90.43	6.5
Jaintiapur	25.13	92.17	8
Jaipur	26.92	75.87	3.5
Jaipur-Hut	25.10	89.07	7
Jalpaguri	26.53	88.77	7
Jamalpur	24.92	89.94	7
Jamalpur	25.32	86.53	7
Jangipur	24.47	88.03	6
Jellinghi	24.13	88.77	6.5
Jessor	23.16	89.21	4
Jhenidah	23.54	89.18	5.5
Jorhat	26.76	94.21	4
Jorra	28.20	92.33	5
Kalewa	23.20	94.30	4
Kalipur	24.06	90.97	7.5
Kalna	23.22	88.37	5.5
Kandi	23.95	88.05	6
Kangkar	27.54	91.90	6.5
Kanpur	26.47	80.33	2.5
Kapasia	24.03	90.13	6.5
Karimganj	24.86	92.36	7
Kasva	23.74	91.15	6.5
Katha	24.17	96.38	3
Kathmandu	27.70	85.31	5
Katwa	23.64	88.23	5.5
Kaunia	25.78	89.48	7
Khana	23.32	87.83	5.5
Khandwa	21.83	76.38	1
Kharagpur	22.35	87.40	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Khulna	22.82	89.62	5
Kindat	23.72	94.47	4
Kishorganj	24.43	90.77	6.5
Kohima	25.07	94.17	5
Kotah	25.17	75.87	2.5
Kotgarh	31.32	77.53	1
Krishnagar	23.40	88.55	6.5
KuchBihar	26.33	89.48	7.5
KyaukPyu	19.37	93.50	1
Kyirong	28.40	85.31	4
Lakang	28.00	91.04	5.5
Lakhimpur	27.24	94.11	3
Lalitpur	24.68	78.47	1
Langrang	27.42	88.85	6
Lemyethna	17.58	95.23	2
Lhasa	29.65	91.13	4
Lilung	28.44	86.63	4.5
Lobpur	24.82	87.85	6
Luckeerserai	25.18	86.15	5
Lucknow	26.87	80.97	4
Lumding	26.78	93.20	5
Luozha	28.08	91.01	5.5
Machilipatnam	16.19	81.14	2
Madhipura	25.93	86.85	5.5
Madhupura	25.85	90.43	7
Madras	13.08	80.27	1
Magura	23.49	89.42	5.5
Magwe	20.14	94.92	3
Maldha	25.03	88.15	8
Mandalay	21.98	96.13	3.5
Mangaldai	26.43	92.04	6
Manipur	24.79	93.94	5
Manu	24.44	91.95	7
Mawlu	24.47	96.22	2.5
Meherpur	23.78	88.64	5
Midnapur	22.42	87.32	5
Mirzapur	25.27	82.63	4.5
Mogok	22.92	96.50	3.5
Mogra	23.83	91.27	8
Mokersa	25.53	90.98	9
Monohordi	23.78	90.67	6
Moweswar	23.98	87.82	5.5
Muktagachha	24.76	90.25	7.5
Munger	25.38	86.47	7.5
Munshiganj	23.49	90.38	6
Murshidabad	24.18	88.32	7
Myelat	20.75	96.75	2
Myitkhina	25.40	97.38	1
Mymising	24.75	90.40	8
Nabinagar	23.88	90.96	6
Nadiya	23.40	88.38	5.5
Nahakaung	24.27	96.23	2
Naihati	22.90	88.47	5
Naini	25.90	81.93	3.5
Nalhati	24.32	87.90	5
Namtang	27.30	88.82	6.5
Narainpur	26.92	93.93	5
Naraniganj	23.62	90.50	6
Narsinagar	23.97	91.10	6
Narsindhi	23.93	90.78	6.5
Nawabganj	23.67	90.17	6
Nilphamari	25.94	88.85	7
Nimach	24.47	74.90	1
Noachali	22.80	91.15	4.5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Nongpoh	25.90	91.93	7.5
Nongstoin	25.52	91.33	8
Nowgong	26.35	92.69	5.5
Pabna	24.01	89.24	6.5
Pali	27.72	89.16	5.5
Panchkura	22.38	87.73	2.5
Parbatipur	25.65	88.97	7.5
Patna	25.61	85.14	4
Pegu	17.43	96.50	2
Piploda	23.62	75.00	2
Purbasthali	23.45	88.40	6
Purniah	25.77	87.47	6
Qonggyaixoi	29.05	91.68	4
Raipura	23.98	90.95	6.5
Rambrai	25.65	91.38	9
Ramgopalpur	24.72	90.55	8
Rangapura	26.81	92.65	5.5
Rangia	26.42	91.63	6
Rangoon	16.78	96.22	1
Rangpur	25.74	89.25	7.5
Raniganj	23.60	87.13	5
Raninagar	24.75	89.03	8
Raoti	23.24	74.83	1
Ratlam	23.35	75.07	1
Rongdi	28.19	87.73	4.5
Ru	19.72	93.87	2
Rupganj	23.80	90.57	6
Rupsi	26.13	89.98	7
Sabhar	24.34	90.00	6.5
Sahibganj	25.23	87.67	8
Saidpur	25.78	88.90	6
Saikupa	23.68	89.30	6
Sakalipur	23.68	87.92	5
Samin	25.68	90.72	9
Saraghat	24.10	89.10	6.5
Saugor.Isl	21.60	88.23	4
Sehore	23.20	77.12	2
Senge	27.47	92.11	6
Sengge	28.07	90.97	6
Seoni	22.09	79.56	5.5
Shaistaganj	24.26	91.45	7.5
Shampur	25.70	89.22	8
Shigatse	29.28	88.89	4
Shigatze	29.27	88.90	4
Shillong	25.57	91.87	9
Sibsagar	26.99	94.63	3.5
Silchar	24.83	92.85	5
Siliguri	26.70	88.50	6
Simla	31.11	77.17	2.5
Sirajganj	24.46	89.70	7
Sonada	26.97	88.32	6.5
Sonamuki	23.30	87.42	5
Srinagar	23.55	90.35	6
Sultanpur	24.80	89.05	6.5
Sunamganj	25.06	91.37	8
Supul	26.12	86.59	5.5
Surat	21.20	72.82	2.5
Susa	27.17	91.50	5.5
Sutna	24.57	80.90	3.5
Sylhet	24.90	91.88	7.5
Tagaung	23.50	96.07	1
Tangail	24.23	89.98	6
Tawang	27.58	91.88	6.5
Tezpur	26.62	92.80	5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Thayetmo	19.32	95.27	1
Tiggaing	23.75	96.18	1
Tindharia	27.78	88.46	5.5
Tinpahar	25.00	87.82	6
Torsa/Darora	23.44	90.92	4
Toungo	18.92	96.52	1
Tura	25.52	90.23	8
Ukiam	25.85	91.42	9
Utripur	26.75	80.17	3.5
Vishnupur	23.08	87.33	4.5
Vizagapatan	17.70	83.33	2
Wokha	26.10	94.32	2
Xiayadong	27.43	88.91	5.5
Yadong	27.48	88.91	5.5
Yandoon	17.05	95.68	2
Yatung	27.42	88.93	6
1897b			
Darjiling	27.04	88.26	2
Hazaribagh	24.00	85.37	2
Maungdaw	20.82	92.37	2
Midnapur	22.42	87.32	2
Sibsagar	26.99	94.63	2
Wuntho	23.90	95.68	2
BiharSharif	25.20	85.53	3
Diburghar	27.48	94.91	3
Manipur	24.79	93.94	3
Paletwa	21.31	92.85	3
1897c			
Bhakalpur	25.25	86.97	2
Darjiling	27.04	88.26	2
Calcutta	22.57	88.35	2
Borjali	26.77	92.75	2
Sibsagar	26.99	94.63	2
Guntok	27.33	88.61	3
Bijni	26.51	90.66	3
Comillah	23.47	91.22	3
Katlichera	24.45	92.57	3
Nowgong	26.35	92.69	3
Jorhat	26.76	94.21	3
Berhampur	24.09	88.25	4
Bordwar	25.91	91.48	4
1905			
Abbotabad	34.14	73.20	4
Abu	24.01	73.74	3
Agra	27.18	78.01	4
Agucha	25.82	74.72	2
Ahmetabad	23.03	72.59	2
Ajmer	26.45	74.64	3
Akola	20.70	77.00	1
Akyab	20.14	92.89	1
Alampur	26.03	78.82	2.5
Alawal	32.22	75.20	7
Aligarh	27.89	78.07	5
Alipura	25.18	79.35	2.5
Allahabad	25.44	81.84	2
Almora	29.60	79.65	6
Alwar	27.56	76.61	4
Ambala	30.37	76.81	7.5
Amraoti	21.65	78.19	1
Amritsa	31.62	74.87	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Amroa	28.90	78.46	5
Arrah	25.56	84.67	1
Astor	35.34	74.86	4
Attock	33.77	72.37	4
Aurangabad	33.03	73.84	4
Azamgarh	26.06	83.19	2
Babugarh	28.71	77.85	4
Bachranwala	30.80	72.37	3
Badaywara	32.98	75.71	5
Bagpat	28.94	77.21	4
Bahraich	27.58	81.59	2
Baijinath	32.05	76.65	7.5
Bajoura	31.85	77.15	8
Bakinpur	25.62	85.15	3
Bakloh	32.47	75.91	6
Balassora	21.49	86.95	4
Ballia	25.76	84.15	3
Banda	25.47	80.33	3
Bandipur	34.42	74.65	5
Banigram	22.12	91.93	2
Banihal	33.42	75.20	5
Banjar	31.63	77.35	7.5
Bannu	32.99	70.60	2
Barabanki	26.92	81.21	3
Baramulla	34.21	74.35	6
Baran	25.09	76.51	2
Baraut	29.10	77.26	5
Bareilly	28.35	79.42	6
Barharampur	24.08	88.49	2
Barisal	24.84	89.37	3
Barkot	30.81	78.20	6.5
Barmer	25.74	71.39	4
Barwar Lake	31.70	77.32	8
Basti	26.79	82.74	4
Batala	31.81	75.21	6
Batinda	30.20	74.94	5
Bawarna	32.05	76.48	8
Beawar	26.09	74.31	3
Beguserai	25.41	86.12	1
Behror	27.88	76.27	3
Benares	25.32	83.01	3
Beri	28.70	76.58	5
Betiah	26.80	84.50	2
Bhamo	24.26	97.23	1
Bharatpur	27.22	77.49	4
Bhiwani	28.79	76.13	4
Bhuin	31.88	77.22	9
Bhuj	23.25	69.66	1
Biaora	23.92	76.90	1
Biharsherif	25.20	85.52	2
Bijawar	25.98	79.85	1
Bijnor	29.37	78.14	6
Bikaner	28.02	73.32	3
Bilaspur	28.40	77.61	6
Bilaspur	31.32	76.77	7.5
Bimtal	29.35	79.57	6
Bissau	28.25	75.08	3
Bogra	24.98	89.38	1
Bolpur	23.66	87.70	1
Bubi Pass	31.95	76.98	6
Budaun	28.04	79.12	5
Budil	33.57	74.30	5
Bulanshahr	28.40	77.85	5
Bundi	25.44	75.64	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Bundkarai	32.05	70.90	3
Bunji	35.66	74.60	3
Burdwan	23.23	87.87	1
Buxar	25.56	83.99	1
Calcutta	22.57	88.36	2.5
Cambay	22.31	72.62	2.5
Campbrllpur	33.87	72.44	4
Cawnpore	26.47	80.33	3
Chakrata	30.70	77.84	7
Chamba	32.56	76.12	7.5
Chanda	26.06	82.31	1
Chandernagar	22.88	88.39	3
Chandpur	22.15	91.92	1
Chaprauli	29.22	77.18	6
Chari	32.22	76.25	9
Charkhama	24.23	90.72	1
Charsadda	34.15	71.74	3
Chatelpur	24.20	91.06	1
Chawai	31.45	77.50	7
Cherat	33.82	71.88	2
Chhatak	25.03	91.67	2
Chilas	35.42	74.09	2
Chineni	33.04	75.29	5
Chini	31.53	78.25	6
Chiniot	31.71	72.99	4.5
Chirawa	28.24	75.64	3
Chitral	36.02	71.75	3
Chunar	25.11	82.89	2
Comilla	23.46	91.18	1
Cossipur	22.62	88.38	1
Cuttack	20.47	85.88	3
Dacca	23.71	90.41	1
Dadhur	29.48	67.64	1
Dagshai	30.88	77.05	7
Dalash	31.38	77.43	6
Dalhousie	32.54	75.98	6
Daltenganj	24.04	84.06	1
Dalu	24.93	92.77	3
Danapur	25.62	85.04	1
Danauda	29.53	76.00	5
Darakhan	31.79	71.11	3
Darbhanga	26.15	85.90	2
Dargai	34.50	71.90	2
Darhal	33.13	73.98	5
Dariwal	31.95	75.32	6
Darjiling	27.04	88.16	2.5
Dattakhel	33.15	70.43	3
Daulatpur	32.07	76.25	9
Dear Gopipur	31.90	76.22	6
Dehlu	31.98	76.80	6
Dehradun	30.36	78.04	7.5
Delhi	28.66	77.23	6
Deoband	29.70	77.67	7
Deoli	26.07	73.83	3
Deoria	26.50	83.78	3
Dera Ghazi Khan	30.05	70.64	3
Deraismailkhan	31.83	70.91	3
Dhakauli	29.05	77.90	5
Dharmsala	32.22	76.32	9
Dhelu	32.00	76.85	8
Dholpur	26.69	77.88	3
Didwana	27.40	74.57	3
Dig	27.47	77.33	4
Dighwara	25.75	84.98	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Dipalpur	30.66	73.66	2
Drang	31.82	77.02	8
Drass	34.42	75.76	5
Drosh	35.55	71.50	3
Dwarahath	29.78	79.43	5
Etah	27.56	78.65	3
Etawa	26.78	79.02	3
Faizpur	21.17	75.85	2
Faridkot	30.66	74.75	6
Faridpur	23.62	89.97	1
Farukhabad	27.39	79.58	3
Fatehabad	23.62	91.05	1
Fatehgarh	27.37	79.63	4
Fatehpur	25.93	80.81	4
Fatehpur	27.99	74.96	5
Fathejang	33.57	72.65	3
Fazilka	30.41	74.02	5
Ferozepor	30.92	74.61	6
Fortlockhart	33.55	70.95	2
Fyemo	34.21	77.32	4
Gadawara	22.92	78.79	2.5
Gandevi	20.82	73.07	2
Gardaspur	30.03	75.40	6.5
Garhi	34.22	73.60	4
Garmuktesar	28.80	77.91	6
Gaya	24.80	85.00	1
Gazipur	25.58	83.60	3
Ghara	32.22	76.28	8
Ghartoli	32.04	76.68	6
Ghaziabad	28.66	77.42	5
Gilgit	35.92	74.29	4
Gonda	27.13	81.96	2
Gopalganj	26.47	84.44	1
Goragali	33.88	73.35	4
Gorakpur	26.76	83.37	2.5
Govindgarh	27.51	76.99	3
Gujranwala	32.15	74.18	6
Gujrat	32.57	74.08	6
Guma	31.97	76.85	7.5
Gupis	36.23	73.44	4
Gurain	34.63	74.83	4
Gurdaspur	32.03	75.41	7
Hafizabad	32.07	73.68	5
Halwara	30.74	75.64	4
Hamirpur	25.96	80.14	3
Hamirpur	31.69	76.52	8
Hansi	29.10	75.96	5
Hapur	28.73	77.78	6
Hardoi	27.42	80.12	3
Haridwar	29.98	78.16	6.5
Haripur	34.01	72.92	4
Haripur	32.00	76.16	7
Hathwa	26.37	84.30	1
Hazaribagh	24.00	85.37	2.5
Hisar	29.15	75.72	5
Hoshiapur	31.52	75.91	7.5
Idak	32.96	70.20	2
Ihalrapatan	28.35	80.55	6
Ilampur	30.38	71.60	5
Indore	22.72	75.86	2.5
Islamabad	34.28	71.58	6
Itarsi	22.62	77.75	2.5
Jabbalpur	23.16	79.94	1
Jagadhri	30.16	77.30	7
Jagraon	30.78	75.46	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Jahajjar	28.60	76.66	5
Jaipur	26.91	75.80	2
Jaisalmer	26.91	70.92	3
Jalalabad	34.44	70.45	2.5
Jalpaiguri	26.52	88.73	3
Jamrud	34.00	71.37	2
Japla	24.68	76.97	1
Jari	31.98	77.20	7.5
Jawalamoukhi	31.87	76.38	8
Jawalapur	29.92	78.11	6
Jessore	23.15	89.21	1
Jhalrapatan	24.55	76.17	3
Jhang	32.35	73.40	4
Jharia	23.75	86.42	1
Jhatingri	31.95	76.87	7.5
Jhelum	32.93	73.72	5
Jhunjhnun	28.12	75.40	5
Jibhi	31.60	77.42	7
Jigni	26.55	78.08	3
Jodhpur	26.28	73.02	4
Jullundur	31.32	75.58	7
Kadaura	25.98	79.85	3
Kadi	23.30	72.32	2
Kairana	29.40	77.20	5
Kaithal	29.79	76.40	5
Kalabagh	32.96	71.55	5
Kalakandar	25.80	81.36	4
Kalat	29.02	66.58	2
Kalka	30.84	76.94	6
Kalpi	26.12	79.75	2
Kalunaur	28.83	76.40	4
Kamalgarh	31.82	76.68	1
Kamalia	30.73	72.64	4
Kamtaul	26.35	85.83	3
Kamthi	21.22	79.20	1
Kandala	29.32	77.27	7
Kandi	23.95	88.05	2
Kangahdogran	31.84	73.62	4
Kangra	32.10	76.27	9
Kapurthala	31.38	75.38	7
Karauli	26.50	77.01	2
Kargil	34.54	76.14	5
Karnal	29.69	76.98	7
Kartarpur	31.44	75.49	7
Kasauli	30.92	76.95	7
Kataula	31.79	76.97	8
Kathmandu	27.71	85.31	2.5
Kathumbar	27.34	77.07	3
Katirhat	22.60	91.80	2
Katni	23.82	80.40	1
Kaul	29.85	76.66	7
Khajuri	32.95	70.32	3
Khanki	32.40	73.98	6
Khanna	30.70	76.21	6
Khar	32.03	78.07	6
Kharr	30.26	70.02	2
Khatauli	29.26	77.73	6.5
Kheri	27.90	80.80	3
Khewra	32.64	73.01	5
Khiderwala	30.95	72.83	3
Khost	30.22	67.58	2
Khotri	27.98	75.80	4
Khulna	22.84	89.55	1
Khushab	32.29	72.35	5
Kishangarh	26.35	74.91	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Kishangarh	27.86	76.71	3
Kisoria	22.08	88.57	1
Kohad	32.08	76.87	8
Kohat	33.60	71.44	3
Kohla	33.85	72.63	4
Kot	31.52	77.48	8
Kota	25.17	75.84	3
Kotgarh	31.32	77.49	8
Kotkapura	30.59	74.80	5
Kotla	27.11	78.49	3
Kotlalodian	32.18	71.07	3
Kotputli	27.70	76.20	3
Kulachi	31.93	70.45	3
Kunch	25.99	79.16	3
Lachi	33.38	71.33	2
Lachmangarh	27.36	76.85	3
Lahore	31.56	74.35	7
Lakeria	26.12	85.90	2.5
Lakhimpur	27.95	80.77	3
Lakhserai	25.18	86.10	1
Lalganj	25.87	85.17	4
Landikotal	34.10	71.15	4
Landour	30.45	78.12	7.5
Landsdowne	29.83	78.68	6.5
Larji	31.72	77.21	8
Leh	34.18	77.58	5
Lucknow	26.84	80.93	5
Luri	31.33	77.48	6.5
Lyallpur	31.41	73.04	3.5
Machlishahr	25.68	82.40	2
Madhipur	24.27	86.63	1
Madnapur	27.87	79.68	3
Maharajganj	26.11	84.50	2
Mainpur	27.22	79.03	4
Mairwa	26.23	84.14	1
Malakand	34.57	71.94	2
Malam	32.10	76.48	9
MalerKotea	30.52	75.88	6
Mandalay	21.97	96.09	1
Mandalgara	25.21	75.10	1
Mandawar	26.15	75.97	3
Mandawar	27.87	76.55	3
Mandi	31.71	76.94	8
Manglaur	29.79	77.88	7.5
Manikarn	32.02	77.35	6
Manshera	34.34	73.19	3
Mardan	34.19	72.04	3
Marhbaluchan	31.78	73.43	4
Mashobra	31.13	77.24	4
Maymyo	22.03	96.47	1
Meerut	28.99	77.70	7
MianMir	31.61	74.30	7.5
Mianwali	32.58	71.54	4
Minbu	20.18	94.88	1
Minimarg	34.80	75.07	4
Miranshah	33.00	70.07	4
Mirzapur	25.15	82.57	2
Mokameh	25.38	85.92	3
Mongir	25.38	86.47	3
Montgomery	30.65	73.10	4
Monywa	22.11	95.14	1
Morabad	28.84	78.77	5
Moradabad	28.84	78.77	6
Morina	26.50	78.01	3
Motihar	26.65	84.91	1

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Mozuffarnazar	29.47	77.70	5.5
Multan	30.20	71.46	3
Mungrabadshahr	25.65	82.19	3
Murree	33.91	73.39	4
Mussoori	30.46	78.08	8.5
Muzaffarabad	34.34	73.48	6
Mymensungh	24.75	90.40	1
Nadaun	31.79	76.35	6
Naddi	32.24	76.31	8
Nadiad	22.69	72.85	1
Naggar	32.12	77.17	6
Nagibabad	29.61	76.33	6
Nagina	29.44	78.43	5
Nagpur	21.15	79.09	1
Nagrota	32.12	76.37	9
Nahan	30.56	77.29	7
Nainital	29.39	79.44	7
Najibabad	29.61	78.34	6
Nakodar	31.12	75.46	5
Nanpara	27.86	81.49	3
Naraya	26.37	86.54	2
Narayanganj	23.62	90.50	1
Narnaul	28.04	76.10	4
Narsingarh	23.70	77.10	3
Nawalgarh	27.85	75.26	5
Nawshahr	31.13	76.12	5
Nilikach	32.12	70.00	1
Nimuch	24.46	74.87	1
Nowgong	25.06	79.45	5
Nowshera	34.01	72.00	3
Nurpur	32.66	72.59	4
Nurpur	32.29	75.88	6
Orai	25.99	79.46	3
Pachbadra	25.92	72.27	3
Pachmari	22.47	78.43	2.5
Paisa	31.96	76.21	7
Pakaur	24.63	87.85	1
Palampur	32.11	76.54	8
Palwal	28.14	77.33	4
Pandaul	26.25	86.08	2.5
Panipat	29.38	76.96	6
Panna	24.72	80.19	3
Paprapola	32.05	76.70	8
Parachinar	33.90	70.09	4
Partabgarr	24.03	74.78	2
Patan	23.85	72.11	3
Pathankot	32.26	75.65	5
Patharkandi	24.62	92.33	2
Pathri	30.10	78.13	6
Patiala	30.32	76.40	5.5
Patkabara	26.66	89.20	2
Pauri	30.16	78.77	7
Peganchowki	29.46	76.50	6
Pendra	22.77	81.96	2.5
Peshawar	34.00	71.55	5
Phillaur	31.02	75.78	6
Pilibhit	28.63	79.81	5
Pinddadun	32.58	73.04	4
Plach	31.12	77.40	4
Pokaran	26.92	71.91	3
Poni	33.08	74.70	5
Poonch	33.84	74.09	5.5
Poprola	32.05	76.70	8
Pundri	29.76	76.81	7
Puri	19.80	85.83	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Purnia	24.52	87.13	1
Pusa	25.98	85.68	3
Quetta	30.21	67.02	2
Rae Bareli	26.23	81.23	2.5
Rahon	31.05	76.12	6
Raipur	21.24	81.64	1
Raiwala	30.02	78.22	6.5
Raiwind	31.25	74.22	4
Rajauri	33.38	74.28	5
Rajgarh	25.34	77.51	2
Rajgarh	24.01	76.73	3
Rajnagar	26.40	86.18	1
Rajpur	30.40	78.10	7.5
Ramban	33.25	75.25	5
Ramgar	27.25	75.18	4
Ramnagar	31.48	73.26	4
Rampur	31.45	77.64	7
Ranchi	23.35	85.33	2.5
Rander	21.22	72.80	3
Raniganj	23.61	87.12	1
Ranikhet	29.64	79.43	5
Ranipur	29.94	78.15	6
Ranital	32.02	76.30	8
Ratangar	28.08	74.62	3
Rawalpindi	33.60	73.04	5
Raya	27.56	77.78	4
Rehlu	32.22	76.27	8
Revelganj	25.79	64.64	2
Riasi	33.08	74.83	5
Rishra	22.07	88.36	2
Rohru	31.21	77.75	5
Rohtak	28.89	76.59	5
Rosa	27.85	79.93	3
Rurki	29.86	77.90	7
Sabathu	30.98	76.98	7
Sada	33.67	70.32	3
Sadra	23.35	72.72	3
Saharanpur	29.96	77.54	7
Sambalpur	20.30	81.04	1
Sambhar	26.90	75.19	2
Sambrial	32.47	79.35	6
Sangla	31.71	73.38	4
Sangri	33.37	74.83	2.5
Sangrur	30.24	75.84	5
Sarail	23.67	90.53	1
Sardanshahr	28.45	74.49	3
Sardhana	29.14	77.61	6.5
Sargoda	32.08	72.67	4
Sarila	25.77	79.68	2.5
Sarsa	22.55	73.07	1
Seoni	22.09	79.55	1
Serahan	31.51	77.80	5
Shahabad	27.64	79.95	3
Shahabad	30.16	76.86	6
Shahargarh	35.02	74.87	3
Shahjanpur	27.88	79.91	4
Shahpur	32.27	72.47	2
Shahpur	32.22	76.14	8.5
Shahrupa	25.62	74.92	3
Shaikohabad	27.11	78.58	4
Sholagar	23.57	90.28	1
Sialkot	32.51	74.56	7
Siapari	32.19	76.22	7
Sibsagar	26.99	94.63	1

Table B2. (*Continued*.)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Sikar	27.61	75.13	3
Sikarndarabad	28.45	77.70	6
Simla	31.10	77.17	6.5
Sirampur	24.13	86.33	1
Sirsa	29.53	75.04	5
Sitamarhi	26.60	85.50	2
Sitapur	27.57	80.69	3
Sitarampur	23.72	86.88	1
Siuri	23.90	87.54	3
Siwan	26.22	84.35	1
Skardu	35.34	75.55	6
Solon	30.91	77.12	6
Sonemarg	34.29	75.29	3
Sonpur	25.71	85.18	1
Srinagar	34.08	74.80	7
Sujangarh	27.69	74.47	3
Sujanpur Tira	31.83	76.50	8
Suket	31.53	76.97	8
Sultanpur	26.26	82.07	2
Sultanpur/Kulu	31.96	77.11	8
Surajgarh	28.31	75.73	3
Surat	21.19	72.82	2
Sutna	24.57	80.83	1
Swar	29.02	79.07	7.5
Sylhet	24.91	91.88	2.5
Tandomasti	27.46	68.66	1
Tank	32.20	70.38	2
Tarakeshwar	21.37	73.05	2.5
Tarn Taran	31.44	74.93	7
Taunsa	30.70	70.65	2
Tehri	30.38	78.48	7
Telokenath	32.23	76.13	7.5
Thal	33.37	70.54	1
Thanser	29.97	76.83	6
Thedaw	21.09	96.06	1
Tikamgarh	24.74	78.83	1
Tilhar	27.96	79.73	3
Titwal	34.61	72.65	3
Tonk	26.17	75.79	3
Tret	33.83	73.28	3
Udaipur	24.57	73.69	1
Udhampur	32.92	75.13	5
Ujjain	23.18	75.78	4
Umbala	30.36	76.80	7
Unao	25.58	78.60	3
Uri	34.08	74.05	5
Urla	31.83	76.94	8
Vadanagar	23.76	72.63	3
Wan	32.21	73.16	3
Wano	32.10	70.42	2
Warcha	32.42	71.98	3
Warshand	33.35	71.50	2
Wazirabad	32.44	74.11	6
1909a			
Alpuri	34.90	72.65	6
Andijan	40.79	72.34	3
Aradu	35.32	71.31	7
Asmar	35.03	71.36	7
Ayvadz	36.98	68.03	6
Basham	34.93	72.87	5
Chitral	36.02	71.75	7
Chust	41.00	71.24	2
Dir	35.20	71.88	7
Drosh	35.55	71.80	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Gilgit	35.92	74.29	5
Kabul	34.53	69.14	7
Karori	34.88	72.76	6
Kattakurgan	39.90	66.25	3
Kerki	37.83	65.20	4
Khojend	40.29	69.63	3
Khorog	37.49	71.55	6
Khowst	33.33	69.92	4
Kirovabad	37.24	69.09	7
Kokand	40.53	70.93	3
Murgab	37.49	61.98	2
Patta-Gisar	37.20	67.28	6
Samarkand	39.66	66.95	4
Swat	34.90	72.49	7
Tashkent	41.31	69.29	2
Termez	37.22	67.27	5
Yangibazar	38.03	67.80	5
1909b			
Arain	28.98	67.70	5
Bagh	29.04	67.82	8
Barsori	28.58	68.00	5
Belpat	28.98	68.00	8
Chachar	29.00	68.11	7
Chhalagari	28.95	67.88	7
Chhatr	28.87	68.33	7
Dadar	29.48	67.64	5
Dadu	26.80	67.81	4
DeraIsm	31.82	70.94	2.5
Dilmorad	28.28	68.58	6
Dosa	29.27	67.90	6
Gandava	28.62	67.47	6
Goranar	28.47	68.78	6
Haji	29.26	67.80	6
Jacobabad	28.27	68.43	5
Jalal-Khan	29.03	67.73	6
Janu	28.97	68.08	8
Jhatpat	28.37	68.33	6
Kalat	29.03	66.59	4.5
Karula	29.05	67.83	8
Khuzdar	27.86	66.19	4
Kokar	28.85	67.81	5
Lalu	29.08	67.75	7
Lehri	29.18	68.20	5
Machhi	28.90	68.38	7
Mahesar	29.18	67.65	6
Mandur	28.72	68.35	8
Mastung	29.79	66.85	5
Mithri	29.37	67.81	4
Multan	30.21	71.47	3
Muradwa	28.78	68.35	7
Nattal	28.74	68.08	6
Nushki	29.53	66.03	4
Pholeji	29.00	68.35	6
Quetta	30.21	67.02	4
Sanni	29.15	67.56	5
Sanri	28.45	68.92	5
Shahpur	28.72	68.41	8
Shari	28.63	68.38	7
Shoran	28.86	67.43	6
Sibi	29.54	67.87	5
Soma	28.80	68.40	8
Tahirlot	28.92	68.33	7
Wazira	28.97	68.17	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
1911a			
Ashkhabad	37.95	58.40	2
Bukhara	39.77	64.42	3
Feyzabad	37.12	70.58	7
Herat	34.14	62.17	1
Kabul	34.53	69.13	6.5
Kalan	35.19	69.23	7
Katakurgan	39.90	66.25	3.5
Kerki	37.83	65.20	4.5
Khanabad	36.68	69.11	7
Kushka	35.31	62.41	2
Mashhad	36.16	59.51	1
Mazar-i-Sherif	36.70	67.10	5.5
Peshawar	34.01	71.54	4
Samarkand	39.66	66.96	2
Shuburgan	36.67	65.74	5
Takhtebazar	35.96	62.91	3.5
Tashkent	41.31	69.30	2
Termez	37.22	67.28	5.5
1911b			
Alladand	34.62	72.03	6
Ashkabad	37.96	58.38	2
Asmar	35.03	71.36	6
Bala/Isham	39.43	54.48	2
Chilas	35.43	74.09	6
Chitral	36.03	71.75	6
Dehra/Ismail	31.83	70.91	4.5
Dir	35.20	71.88	6
Drosh	35.55	71.79	6
Ferghana	40.39	71.78	3.5
Gilgit	35.92	74.29	5
Gupis	36.23	73.44	6
Kabul	34.53	69.13	5.5
Kalam	35.53	72.58	7
Kerki	37.84	65.20	4
Kokand	40.53	70.93	3.5
Kushka	35.31	62.41	2.5
Lahore	31.56	74.35	4
Lawrencepur	33.83	72.50	5
Malakand	34.57	71.93	6
Mastuj	36.28	72.51	6
Sazin	35.54	73.50	7
Simla	31.10	77.17	3
Sirinagar	34.08	74.80	4
Skardu	35.34	75.55	5
Takhtebazar	35.96	62.91	2.5
Tashkent	41.31	69.29	2
Zahedan	29.49	60.86	2
1918			
Agartala	23.83	91.27	7
Agra	27.17	78.08	2
Aijal	23.73	92.75	5
Akhaura	23.88	91.21	7.5
Akyab	20.14	92.89	4
Alinagar	24.32	91.88	7
Allahabad	25.46	81.85	1.5
Amballa	30.37	76.87	1
Asansol	23.69	86.98	3
Asurgank	24.05	90.97	6.5
Badarpur	24.88	92.62	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Balisera Valley	24.25	91.80	8
Bankipur	25.62	85.15	3
Barisal	22.70	90.37	5
Bassein	16.78	94.73	2.5
Bhagalpur	25.25	86.98	3.5
Bhairab	24.06	90.97	6.5
Bharaura	23.34	91.78	6
Bilaspur	22.08	82.15	2.5
Biskra	24.53	90.67	6
Bombay	18.92	72.90	1
Borjuli	26.77	92.75	4
Brahmanbaria	23.97	91.10	7
Burdwan	25.91	91.48	4.5
Calcutta	22.57	88.36	3.5
Cawnpure	26.47	80.40	2
Chamdhara	24.97	89.39	5
Chandichra	23.99	91.55	7
Chandpur-2	24.05	91.54	7.5
Chandpur	22.56	89.02	4
Cherrapunji	25.28	91.72	5.5
Chinsurah	22.90	88.43	4.5
Chittagong	22.33	91.83	4
Comilla	23.45	91.18	6
Cuttack	20.47	85.88	3
Dacca	23.71	90.41	5.5
Daltonganj	24.03	84.12	2
Dargaon	24.28	91.53	8
Darjiling	27.04	88.26	3
Dehara Dun	30.32	78.05	1
Delhi	23.65	77.27	1
Deoghar	24.49	86.69	3
Dinajpur	25.63	88.85	4.5
Doloi	24.22	91.83	7.5
Drug	21.18	81.28	1
Dumka	24.27	87.25	4
Falam	22.91	93.68	4
False Point	15.70	80.82	2
Faridpur	23.60	89.85	5
Fenchuganj	24.68	91.95	7
Fort Hertz	27.37	97.37	3
Gangtok	27.33	88.62	3
Gauhati	26.18	91.80	4.5
Gurigram	24.88	90.63	6
Habiganj	24.38	91.41	7
Henzada	17.66	95.66	2
Jahgchera	24.26	91.94	7
Jamalpur	24.87	90.00	5.5
Kajurichara	24.16	91.72	8
Kalighat	24.26	91.74	7.5
kamaing	25.52	96.71	2.5
Kamaichara	24.28	91.60	7.5
Kanihati	24.37	91.92	7
Kathmandu	26.75	85.33	2
Kindat	16.95	94.75	2
Kishorganj	24.44	90.77	7
Krishnagar	23.40	88.55	4
Kukichera	24.41	92.54	7
Kulaura	24.53	92.05	7
Kurmanchara	24.80	91.59	7.5
Kurseong	26.88	88.28	3
Kyaukpyu	19.42	93.56	3
Kyauktaw	20.84	92.95	3
Lalchand	24.18	91.39	6
Langla	24.48	91.97	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Lashio	22.92	97.77	2.5
Lucknow	26.84	80.93	2
Luskerpore	24.17	91.48	7
Madhabpur	24.23	91.83	7.5
Madras	13.07	80.28	1
Magwe	20.14	94.92	2
Mandalay	21.97	96.09	2
Maulvi Bazar	24.48	91.76	7
Meiktila	20.88	95.87	1
Metgwi	12.18	98.63	1
Midnapur	22.42	87.33	3.5
Minbya	20.33	93.17	2.5
Minpur	24.28	91.57	8
Mogdung	25.30	96.94	2
Monywa	22.11	95.14	2
Moulmein	16.37	97.72	1
Muzaffarpur	26.12	85.38	2
Myitkyna	25.40	96.45	2.5
Mymensingh	24.75	90.40	5.5
Nagpur	21.15	79.12	1
Naini Tal	29.40	79.45	1
Namty	23.02	97.68	1
Narainganj	23.62	90.52	5.5
Netrakona	24.88	90.73	5
Noakhali	22.80	91.15	5
Pabna	24.00	89.28	5
Patrakhala	24.25	91.82	7
Perbung	24.25	93.11	6
Phultala	23.88	89.85	5
Prome	18.82	95.22	3.5
Phulchara	24.28	91.74	8
Puri	19.85	85.88	1
Purnea	25.77	87.52	3.5
Putao	27.34	97.42	3
Rajgat	24.19	91.70	8
Raipur	21.24	81.63	1
Rangamatia	24.57	90.18	6
Rangoon	16.78	96.15	2
Rangpur	25.75	89.30	4.5
Rasidpur	24.30	91.53	7.5
Saylau	23.97	92.58	6.5
Sambalpur	21.47	83.98	2.5
Sandoway	18.46	94.37	2
Shahazi bazaar	24.26	91.37	8
Shaistaganj	24.26	91.45	8
Shamsherganj	24.46	91.63	7
Shilong	25.55	91.93	4.5
Silchar	24.82	92.78	6
Simla	31.10	77.18	1
Sisal-Baria	24.20	91.74	8
Sitgaon	24.29	91.61	8
Srimangal	24.31	91.73	8
Sutna	24.57	80.90	1
Sylhet	24.90	91.88	7
Tilgaon	24.46	91.97	7.5
Taunggyi	20.83	97.08	1
Tavoy	14.09	98.20	1
Thayetmyo	19.32	95.27	2
Tongi	23.89	90.41	6.5
Tura	25.48	90.27	4.5
Umetnagar	24.56	92.61	7
Vizagapatam	17.70	83.33	1
Yamethin	20.32	96.23	1
Yatung	27.42	88.93	3.5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
1923			
Barisal	22.70	90.38	5
Bogra	24.85	89.97	7
Borjuli	26.77	92.75	3.5
Cherrapunji	25.23	91.72	5.5
Chittagong	22.33	91.82	4
Chota/Nagpur	23.45	93.50	4
Gauhati	26.18	91.75	5.5
Jalpaiguri	26.53	88.71	3.5
Manipur	24.80	93.95	3.5
Midnapur	22.42	87.33	2.5
Mymesingh	24.75	90.40	7.5
Narayanganj	23.62	90.50	6
Pabna	24.02	89.22	5
Shillong	25.55	91.93	5
Sibsagar	26.99	94.63	3
Srimangal	24.30	91.73	6.5
Yatung	27.44	88.92	3
1929			
Amritsar	31.62	74.87	3
Abbottabad	34.15	73.20	5
Cherat	33.83	71.88	6
Delhi	28.66	77.23	2.5
Dera-Ism-Khan	31.83	70.91	4
Drosh	35.55	71.80	6.5
Dushambe	38.57	68.78	6.5
Ferozopur	30.92	74.61	4
Gurais	34.63	74.84	5
Hushairpur	31.53	75.91	3
Imratsir	31.63	74.87	3
Kargil	34.54	76.14	4
Kuljab	37.94	69.78	7.5
Lahore	31.56	74.35	4
Multan	30.20	71.46	2
Nurmahal	31.09	75.59	3
Peshawar	34.00	71.55	6.5
Rawalpindi	33.60	73.05	5
Samarkand	39.66	66.94	3
Sialkot	32.52	74.55	4
Skardu	35.34	75.55	5
Sonamarg	34.29	75.29	4.5
Srinagar	34.08	74.81	4.5
Tashkent	41.31	69.29	3.5
1930			
Aijal/Aizawl	23.71	92.72	3
Akyab/Sittwe	20.14	92.90	2.5
Alipore Duar	26.50	89.53	5.5
Araria	26.14	87.51	5
Badarpur	24.89	92.60	4
Balasora	21.49	86.94	2
Balughat	25.23	88.78	6
Bamanghati	22.60	90.15	2
Bamkura	23.23	87.07	3.5
Barhampore	24.09	88.25	4.5
Barisal	22.70	90.37	3
Basihat	22.65	88.87	3
Baura	26.25	89.08	6.5
Bettiah	26.80	84.50	2
Bhagalpur	25.25	86.98	5
Bilaspara	26.23	90.24	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Bogra	24.84	89.37	5.5
Bogribari	26.18	90.17	5.5
Brahmanbaria	23.97	91.10	4
Burdwan	23.24	87.87	3.5
Buxa Fort	26.75	89.58	6
Calcutta	22.57	88.36	3
Chapra	25.77	84.73	2
Cherrapunji	25.28	91.72	5.5
Chindwin	22.60	95.10	1
Chin hills	22.50	93.50	1
Chinsurah	22.89	88.41	3.5
Chittagong	22.33	91.83	2.5
Coch Behar	26.33	89.46	7
Contai	21.78	87.75	3
Dacca	23.70	90.41	4
Dahlbhum	22.57	86.48	2
Dalsingpara	26.82	89.43	6
Darjeeling	27.04	88.26	4.5
Dewangaj	25.15	89.77	5.5
Dhanbad	23.80	86.43	3.5
Dhubri	26.02	89.98	8
Diburghar	27.48	94.91	3
Digboi	27.39	95.62	3
Dinajpur	25.62	88.64	6
Domohani	26.57	88.77	6
Dumka	24.27	87.25	4.5
Faridpur	23.60	89.84	4
Fulbari	25.95	89.55	7
Gaibanda	25.32	89.54	6.5
Gangtok	27.33	88.61	4.5
Gauhati	26.19	91.75	6
Gauripur	26.09	89.96	7
Giridih	24.18	86.30	3
Gitaldala	26.13	89.47	6
Goalpara	26.18	90.62	6
Gyantse	28.90	89.62	1
Gyobingauk	18.22	95.65	2
Haflong	25.18	93.03	3.5
Hoogly	22.90	88.40	3.5
Jainti	26.70	89.93	5.5
Jessore	23.16	89.21	3
Jhargram	22.46	87.00	3.5
Jharia	23.76	86.40	3
Kakina	25.92	89.27	6.5
Kalemyo	23.19	94.07	2.5
Kalimpeng	27.07	88.48	4.5
Katha	24.23	96.50	3
Katihar	25.54	87.57	5
Katmandu	27.71	85.31	2
Khulna	22.85	89.55	3
Kishorganj	24.44	90.77	4
Kohima	25.67	94.11	3
Krishnagar	23.40	88.50	4
Kurigram	25.83	89.69	7
Kushtia	23.93	89.00	4.5
Lalmanrihat	25.91	89.45	7
Lohardaga	23.43	84.69	3.5
Malda	25.03	88.15	5
Mangaldai	26.43	92.04	4.5
Manipur/Imphal	24.79	93.94	3
Mawflang	25.33	91.52	5
Meherpur	23.77	88.64	4
Midnapor	22.42	87.32	3
Minhla	19.97	95.04	2
Monywa	22.11	95.14	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Motihari	26.66	84.91	2.5
Mymesingh	24.86	90.66	5.5
Nalbari	26.56	91.43	5.5
Nator	24.41	88.98	5
Nattalin	18.42	95.55	2
Netrakona	24.89	90.73	5
Niphalmari	25.94	88.85	7
Nowgong	26.35	92.69	4
Pabna	24.01	89.24	4.5
Parulia	22.60	89.02	3
Patna	25.61	85.14	4
Prodyatnagar	25.16	89.77	6
Purnea	25.77	87.48	5
Rajshahi	24.37	88.59	5
Ranchi	23.36	85.33	3
Rangpur	25.73	89.25	6.5
Raniganj	23.61	87.12	3
Sadar	22.15	85.53	1
Sadiya	27.84	95.66	3
Saidpur	25.78	88.89	6
Sapatgram	26.33	90.13	7
Saugor-Isl	21.64	88.08	3
Shillomg	25.57	91.87	5
Sibsagar	26.98	94.63	3
Silghat	26.61	92.93	3.5
Siliguri	26.72	88.43	5.5
Sirajganj	24.45	89.70	5
Sribardi	24.87	90.08	5.5
Suri	23.90	87.54	4
Syleth	24.90	91.88	3.5
Tezpur	26.63	92.80	3.5
Thakurgaon	26.03	88.46	6
Therrawaddy	17.65	95.79	2
Tura	25.52	90.23	7
Yatung	27.43	88.92	5
Zigon	18.34	95.62	2
1931a			
Bagh	29.04	67.81	5
Bellpat	28.98	68.00	4
Bolan	29.90	67.12	5.5
Chaman	30.92	66.44	2
Dadhar	29.48	67.64	5
Dadu	26.73	67.77	1
Dehra/Ismail	31.83	70.91	2.5
Gandava	28.62	67.47	4
Harnai	30.10	67.93	6
Hindubagh	30.82	67.73	4.5
Jacobabad	28.28	68.43	3
Jahl	28.28	67.47	4.5
Jampur	29.64	70.59	1
Johi	26.70	67.61	1
Kalat	29.03	66.58	1
Khost	30.22	67.58	6.5
Kila/Abdula	30.72	66.63	4.5
Kila/Saifulla	30.71	68.37	4.5
Lahri	29.18	68.18	3
Larkana	27.56	68.21	2
Mach	29.87	67.33	5
Mastung	29.80	66.85	3
Nakus	30.15	67.83	7
Pishin	30.57	66.99	5
Quetta	30.21	67.01	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Radhan	27.20	67.95	2.5
Rajanpur	29.10	70.32	2.5
Sangan	29.87	67.65	8
Sanni	29.15	67.57	5
Shahdadpur	25.92	68.61	4
Sharigh	30.20	67.70	8
Shehwan	26.43	67.87	1
Shikarpur	27.96	68.64	3
Shoran	28.87	67.43	4.5
Sibi	29.55	67.88	4
Taunsa	30.70	70.63	1
Ziarat	30.38	67.72	6.5
1931b			
Ab-i-Gum	29.82	67.39	7
Ajmer	26.45	74.64	1
Bagh	29.04	67.81	6
Bahawalpur	29.39	71.67	3
Barkhan	29.91	69.51	5
Belpat	28.98	68.00	6
Bibi-Argi	29.22	67.17	7
Bibi-Nani	29.70	67.38	6
Bikaner	28.02	73.32	1
Bolan	29.90	67.12	7
Bostan	29.00	66.00	4
Chaman	30.92	66.44	4
Chawan	26.00	73.00	1
Churu	28.30	74.97	2
Dadhar	29.48	67.64	8
Dadu	26.73	67.77	5
Dera/Ghazi	30.06	70.64	3
Dera/Ismail	31.83	70.91	3
Dodapur	28.05	68.17	5
Dranjan	29.60	67.42	7
Ferozepore	30.92	74.61	1
Gandava	28.62	67.47	8
Gazkh	28.94	67.01	7
Gokurth	29.53	67.47	7
Goru	27.80	66.83	4
Harnai	30.10	67.93	6
Hindu bagh	30.82	67.75	4
Hirok	29.93	67.21	7
Hyderabad	25.37	68.36	3
Jacobabad	28.28	68.43	5
Jaipur	26.91	75.80	3
Jaisalmer	26.91	70.92	2
Jampur	29.64	70.59	4
Jodhpur	26.28	73.02	3
Johan	29.33	66.96	8
Johi	26.70	67.61	3
Kalat	29.03	66.58	4
Karachi	24.85	67.01	3
Khairpur	27.53	68.75	4
Khari	28.58	67.37	8
Khost	30.22	67.58	6
Kila/Saiful	30.71	68.37	5
Kirta	29.60	67.49	8
Kotra	28.55	67.38	8
Kundalani	29.45	67.50	6
Lahore	31.56	74.35	2
Lahri	29.18	68.18	6.5
Larkana	27.56	68.21	5
Las/Bela	26.23	66.30	3.5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Leiah	30.96	70.93	3
Loralai	30.37	68.60	4
Lunkarabdar	28.49	73.75	2
MachN	29.87	67.33	7
MachO	29.87	67.34	9
Mahmudkot/Multan	30.19	71.02	3
Mastung	29.80	66.85	5
Mehar	27.18	67.82	5
Mianwali	32.59	71.54	1
Multan	30.20	71.46	4
Mushkaf	29.50	67.68	9
Naoshera	29.37	67.58	9
Nasirabad	26.30	74.72	1
Naushahr	26.84	68.13	2.5
Nichara	28.87	66.75	5
Nighari	29.40	67.63	8
Nushki	29.55	66.01	5
Ocepur	29.63	67.63	7
Pali	25.78	73.34	2
Pandran	28.73	66.73	6
Panir	29.67	67.53	7
Peshi	29.72	67.48	7
Pir/Chuttar	28.47	67.28	6
Pishin	30.57	66.99	5
Quetta	30.21	67.01	6
Rajanpur	29.10	70.32	4
Rani	25.37	73.30	2
Ratangarh	28.08	74.62	2
Rindli	29.49	67.63	6
Sanjawi	30.28	68.35	5
Sanni	29.15	67.57	9
SariBollan	29.94	67.17	7
Sarwar	26.07	75.00	2
Sehwan	26.43	67.85	3
Shahdakot	27.84	67.90	5
Shahpur	28.73	68.41	4.5
Sharig	30.20	67.70	6
Shergarh	26.33	72.29	1
Shershah	30.10	71.35	3
Shikarpur	27.96	68.64	5
Shoran	28.87	67.43	9
Sibi	29.55	67.88	6.5
Sirsa	29.53	75.03	1
Spezand	29.98	67.00	6
Sukkur	27.69	68.85	4
Surab	28.49	66.26	5
Udaipur	24.58	73.69	1
Uthal	25.81	66.62	3
Washuk	27.73	64.70	3
1934			
Agra	27.18	78.00	3
Ahraura	25.02	83.03	5
Aijal	23.71	92.72	2
Ajaigarh	24.90	80.26	5
Ajmer	26.44	74.64	4
Ajodhya	26.80	82.20	4.5
Akola	20.70	77.00	3.5
Akot	21.09	77.06	2.5
Akyab/Sittwe	20.14	92.89	2
Aligar	27.89	78.06	3.5
Alipura	25.18	79.32	3.5
Alipur duar	26.50	89.54	4.5
Amarwara	22.30	79.18	3

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Ambala	30.36	76.80	2.5
Amethi	26.16	81.80	4.5
Amla	21.93	78.14	3
Amlekganj	27.28	84.98	6.5
Amraoti	21.65	78.18	2.5
Amta	22.58	88.01	4
Anklesvar	21.63	72.99	2
Arambagh	22.88	87.79	4.5
Araria	26.14	87.51	6.5
Ardhapur	19.29	77.38	2
Arni	20.07	77.95	2
Arrah	25.56	84.67	6
Asansol	23.69	86.98	5
Asifabad	19.37	79.30	2.5
Athgar	20.51	85.51	4
Aurangabad	19.89	75.32	2
Azamgarh	26.07	83.19	6
Azimganj	24.24	88.26	5
Badarpur	24.90	92.60	2.5
Bagaha	27.10	84.09	5
Bagdogra	26.69	88.32	7
Bageswar	29.85	79.75	3
Bagherhat	24.20	90.55	3
Baghmundi	23.18	86.06	3
Bagmati	27.63	85.30	8
Bahadurganj	26.26	87.82	6
Bahawalpur	29.39	71.67	2
Bahraich	27.58	81.59	5
Baihar	22.10	80.55	2
Bakhtiarpur	27.68	85.42	8
Balaghat	22.11	80.55	2
Balapur	20.66	76.77	2.5
Balasore	21.49	86.95	3.5
Balharshah	19.84	79.37	3
Bali	25.83	74.08	2
Balinapat	27.84	85.58	6
Ballia	25.76	84.15	5
Balod	20.73	81.22	2
Baloda bazar	21.66	82.17	3.5
Balrampur	27.43	82.18	3.5
Balurgat	25.23	88.77	4
Banda	25.47	80.33	4
Bandwan	22.88	86.51	5
Bangaon	23.04	88.83	4.5
Bangaon	24.98	87.00	5
Bangaon	25.86	86.54	6
Banka	24.88	86.92	6
Bankura	23.24	87.07	4
Bansberia	22.95	88.41	4
Bansi	27.18	82.93	5
Bapatla	15.90	80.47	2
Baptiahi	26.32	86.73	7.5
Barakpur	22.76	88.38	4
Baran	25.10	76.51	4
Barasat	22.72	88.49	4
Baraunda	25.05	80.65	3.5
Bardoli	21.12	73.11	2
Bargarh	25.14	81.44	4
Barhi	24.34	85.29	4.5
Baripada	21.94	86.73	3.5
Barisal	22.70	90.37	4
Barkhera	22.92	77.67	3.5
Barkuhi	22.22	78.70	3
Barmer	25.74	71.39	1.5
Baruani	22.03	74.90	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Barwaha	22.25	76.04	2.5
Basim	20.10	77.13	2
Basirhat	22.65	88.87	3.5
Basmatnagar	19.32	77.14	2
Basti	26.79	82.74	5
Baswara	23.54	74.44	2
Batala	32.02	75.15	2
Baudgarh	20.86	84.32	3
Bazpur	29.15	79.11	2.5
Begusarai	25.41	86.12	7
Bela	24.96	84.96	5
Bemetara	21.72	81.54	2.5
Benares	25.31	83.01	6.5
Berhampur	24.09	88.25	5.5
Beri	25.90	79.88	5.5
Betrawati	27.98	85.18	7
Bettiah	26.80	84.50	7
Betul	21.92	77.90	3.5
Bezwada	16.51	80.63	1
Bhabua	25.04	83.61	5
Bhadrak	21.06	86.53	2.5
Bhadreswar	22.83	88.36	4
Bhandara	21.17	79.65	3
Bhanpura	24.51	75.75	4
Bharatpur	23.74	81.77	4
Bhatgaon	27.68	85.42	8
Bhawanigar	30.27	76.03	2
Bhawanipatna	19.90	83.17	2.5
Bhikangaon	21.87	75.95	2
Bhimnagar	26.52	86.95	8
Bhimpedi	27.55	85.13	7
Bhojpur	27.17	87.05	9
Bhokardan	20.26	75.76	2
Bhopal	23.24	77.39	4
Bhusawal	21.05	75.78	2.5
Bihar sharif	25.20	85.52	6.5
Bijapur	16.82	75.72	1
Bijawar	24.62	79.49	3.5
Bijnor	29.37	78.06	3
Bikaner	28.01	73.32	2.5
Bilara	26.18	73.71	2.5
Bilaspur	31.32	76.77	1.5
Bilaspur	22.09	82.15	4
Bilgram	27.17	80.03	4
Bina	24.18	78.18	5
Bir	22.05	76.53	3.5
Biratnagar	26.46	87.27	8
Birganj	27.01	84.87	7
Bisauli	28.31	78.94	3
Bishnapur	23.08	87.32	4.5
Bishnupur	22.38	88.28	3.5
Biwharpur	20.76	79.52	2.5
Bobbili	18.58	83.37	3
Boddhanath	27.67	85.39	6.5
Bodhan	18.66	77.89	2
Bodh-Gaya	24.70	84.99	6.5
Bogra	24.84	89.37	3.5
Bolangir	20.72	83.50	3
Bolpur	23.66	87.70	4
Bombay	18.95	72.83	2.5
Bori	20.90	79.00	2
Bramhapuri	20.61	79.86	2
Broach	21.71	72.97	2
Budaun	28.03	79.12	3

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Budhwari	27.10	88.12	7
Bulandshahr	28.40	77.85	4
Bulsar	21.12	72.98	2
Bundi	25.44	75.64	4
Burhanpur	21.31	76.23	2.5
Buthidaung	20.87	92.53	2
Buxar	25.56	83.98	5.5
Calcutta	22.58	88.36	5
Cawnpore	26.46	80.33	5.5
Chainpur	27.27	87.25	7.5
Chakia	26.42	85.06	6
Chakrata	30.70	77.85	3
Chamoli	30.40	79.35	3.5
Champdani	22.80	88.35	4
Chanchura	22.90	88.41	4.5
Chandbali	20.78	86.77	2.5
Chapra	25.77	84.73	7
Charkhari	25.40	79.75	4.5
Charkhi dadri	28.59	76.28	3.5
Chatra	24.20	84.86	4
Chaungu	21.96	95.27	2
Cherrapunji	25.28	91.72	3
Chhindwara	22.06	78.94	2.5
Chicacole	18.29	83.90	2.5
Chichawatni	30.53	72.68	3
Chikalda	21.40	77.31	2
Chirala	15.83	80.36	2
Chitanpali	16.82	78.80	1
Chitbug	27.65	85.18	7
Chitrakot	25.12	80.93	4
Chittagong	22.33	91.82	2
Chopda	21.25	75.30	2
Chunar	25.11	82.88	6.5
Cochin	10.01	76.22	1
Coconada	16.95	82.24	2.5
Colgong	25.27	87.23	7
Comilla	23.45	91.18	3
Contai	21.78	87.76	2
Cuttack	20.47	85.88	4
Dacca	23.71	90.40	4
Dagmara	26.40	86.75	8
Daltoganj	24.04	84.06	5
Damoh	23.84	79.45	4.5
Danta	24.19	72.76	2
Dantan	21.95	87.27	3
Darbhanga	26.15	85.89	7
Darjiling	27.04	88.26	7.5
Daspala	20.34	84.85	2.5
Dataganj	28.04	79.40	4
Datia	25.67	78.45	4.5
Dehra Dun	30.33	78.05	3
Dehri on Son	24.90	84.18	5
Deogarh	21.54	84.74	3
Deoghar	24.49	86.69	6.5
Deopur	27.73	85.60	6
Deori	23.12	78.69	3.5
Deoria	26.18	85.01	6.5
Depalpur	22.85	75.53	2.5
Dera/Ismail	31.82	70.91	1
Desa	24.26	72.18	2
Desuri	25.27	73.56	2.5
Dewas	22.96	76.05	3
Dhamtari	20.70	81.55	2.5
Dhanbad	23.79	86.43	5
Dhankuta	26.95	87.35	9

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Dhar	22.59	75.26	2
Dharamtali	27.75	85.35	7.5
Dharan bazar	26.81	87.27	8
Dharapani	26.88	87.33	8
Dharhara	25.25	86.40	8
Dhenkanal	20.65	85.60	3.5
Dholpur	26.69	77.88	4.5
Dhubri	25.98	90.08	4.5
Dhurwai	25.48	79.05	4.5
Diamond harbour	22.19	88.20	3.5
Diburghar	27.48	94.91	3
Didwana	27.03	74.96	2.5
Digboi	27.39	95.62	2
Dighalbank	26.43	87.83	7
Dighapatia	24.45	89.01	3.5
Dinajpur	25.63	88.64	4
Dinapur	25.64	85.05	7
Dindori	22.93	81.09	3
Dinhata	26.13	89.47	4
Domariaganj	27.21	82.66	5
Drenthang	27.92	87.61	7.5
Drug	21.19	81.28	2.5
Dubrajpur	23.78	87.39	4.5
Dumahan	27.35	87.62	7.5
Dum dum	22.63	88.42	4
Dumka	24.27	87.25	5.5
Dungarpur	21.28	71.73	2.5
Dupguri	26.59	89.01	4
Edalabad	21.06	76.06	2
Ellore	16.70	81.10	2.5
Erandol	20.92	75.33	2
Etah	27.56	78.65	4
Etawah	26.78	79.02	4
Falam	22.91	93.68	2
Faridpur	23.61	89.85	4
Farrukhabad	27.39	79.58	4
Fatehgarh	27.36	79.63	4
Fatehpur	25.93	80.81	4
Fatehpur	27.16	81.20	4.5
Fatwa	25.52	85.30	6
Firozabad	27.15	78.39	2.5
Forbesganj	26.30	87.30	7.5
Fort Herz Putao	27.38	97.43	2
Fyzabad	26.78	82.14	6
Gadarwara	22.92	78.79	3.5
Gaibanda	25.33	89.54	4
Gangtok	27.33	88.62	7
Ganjam	19.38	85.07	3.5
Garchroli	20.20	80.01	2
Garot	24.32	75.65	3
Garrauli	25.08	79.37	3.5
Gauhati	26.19	91.75	3.5
Gaurihar	25.28	80.20	4
Gauripur	26.09	89.96	4.5
Gaya	24.81	85.00	6
Gerkuta	27.95	85.17	7
Ghatal	22.66	87.75	4
Ghazipur	25.59	83.59	6
Ghogha	25.22	87.17	7
Giridih	24.19	86.31	6
Goalpara	26.18	90.62	4
Gobindanj	26.48	84.65	7
Godda	24.83	87.21	6
Godhra	22.77	73.61	2
Gokarna	27.73	85.40	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Gonda	27.13	81.96	5.5
Gondia	21.46	80.20	3.5
Gopalganj	26.47	84.45	6.5
Gorakhpur	26.76	83.37	5.5
Goshaigaon	26.86	94.23	2.5
Goshi	26.12	83.55	5
Goyerkata	26.70	89.03	4
Gujranwala	32.02	74.24	2
Gulbarga	17.33	76.83	1
Guna	24.64	77.31	3.5
Gunnaur	28.24	78.43	3.5
Guntur	16.30	80.45	2
Gunupur	19.08	83.81	2.5
Gurdaspur	32.04	75.40	2
Gurgaon	28.46	77.02	3.5
Gwalior	26.23	78.17	4
Gyangze	28.91	89.62	4
Habiganj	24.38	91.41	3
Haidarganj	26.60	81.35	4.5
Hajipur	25.68	85.20	7
Haka	22.98	94.02	2
Haldwani	29.22	79.53	3
Halol	22.51	73.47	2
Hamirpur	25.95	80.15	5
Hansdhiha	24.60	87.08	5
Hapur	28.73	77.78	3.5
Harda	22.33	77.09	3
Hardoi	27.42	80.16	4.5
Hariharganj	24.55	84.28	6
Haripur	23.65	86.93	4.5
Harisidhi	27.65	85.35	7.5
Hatia	22.46	91.10	2.5
Hatia	26.72	87.25	7.5
Hazaribagh	24.00	85.37	5
Hili	25.28	89.01	3.5
Hilsa	25.32	85.28	6.5
Hindol	20.61	85.20	2.5
Hingoli	19.72	77.14	2
Hissar	29.15	75.72	3
Hoogly	22.90	88.40	4
Hoshangabad	22.75	77.72	3
Hoshiarpur	31.53	75.91	2.5
Hura	23.28	86.64	5
Husainabad	24.53	84.00	6
Hyderabad	17.38	78.48	1
Hyderabad	25.38	68.36	1
Iklehra	22.20	78.68	3
Imphal	24.79	93.94	2.5
Indore	22.72	75.86	2.5
Isagarh	24.83	77.88	4.5
Itarsi	22.48	77.75	3.5
Jagadhri	30.17	77.30	3
Jagdispur	26.70	84.58	6.5
Jahanabad	25.21	84.98	6
Jaipur	26.91	75.81	3.5
Jaisalmer	26.91	70.91	1.5
Jaitaran	26.20	73.93	2
Jajpur	20.85	86.35	3.5
Jalalpur	20.97	72.90	2
Jalapur	26.31	82.74	4
Jaleswar	21.81	87.23	2.5
Jaleswar	26.65	85.80	7.5
Jalgaon	21.05	76.53	2.5
Jalna	19.84	75.89	2
Jalor	25.34	72.61	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Jalpaiguri	26.53	88.72	5
Jambusar	22.05	72.79	2
Jamtara	23.94	86.83	5
Jamui	24.92	86.22	5.5
Jangipur	24.48	88.04	4
Janjgir	22.02	82.57	3
Jaora	23.64	75.12	2
Jasidih	24.51	86.65	6
Jaso	24.50	80.48	4
Jaswantpura	24.80	72.45	2
Jaunpur	25.76	82.69	5
Jaynagar	26.58	86.14	8
Jaypur	18.85	82.57	3
Jessore	23.16	89.21	3.5
Jhabua	22.96	74.82	2
Jhajha	24.77	86.38	6
Jhalda	23.36	85.98	4.5
Jhalrapatan	24.55	76.17	3
Jhansi	25.44	78.56	4
Jhargram	22.45	87.00	3.5
Jhelum	32.93	73.72	1
Jhenida	23.54	89.18	4
Jhumri	24.45	85.55	5
Jigni	25.75	79.42	5.5
Jind	29.30	76.31	3
Jodhpur	26.28	73.02	2.4
Jogbani	26.40	87.26	7.5
Jubbulpur	23.17	79.94	4
Jullundur	31.32	75.58	3.5
Kabul	34.53	69.13	1
Kadaura	25.98	79.85	4.5
Kahnwan	31.90	75.46	2
Kaira-Kheda	22.74	72.68	2
Kakatpur	20.02	86.20	2
Kakuni	27.82	85.25	6.5
Kalamb	19.05	73.05	2.5
Kalanaur	32.02	75.15	2
Kalimpong	27.07	88.48	7
Kalna	23.23	88.36	4.5
Kalol	23.25	72.50	2
Kalpi	26.12	79.76	5
Kanauj	27.06	79.92	4
Kanda ghat	30.99	77.11	2
Kannod	22.66	76.74	2.5
Kantaphor	22.58	76.56	2
Kaputhala	31.37	75.38	2.5
Karachi	24.85	67.01	1
Karauli	26.50	77.03	5.5
Karimnagar	18.44	79.14	4.5
Karinganj	24.86	92.36	3
Karmatar	24.09	86.70	5
Kashipur	29.22	78.95	3.5
Kashipur	23.43	86.67	5
Kasrawad	22.12	75.61	2.5
Katghora	22.51	82.55	3
Katihar	25.54	87.57	5.5
Katmandu	27.71	85.31	8
Katni	23.90	80.59	3.5
Katol	21.27	78.59	2
Kendrapara	20.50	86.43	2.5
Keonnjhargarh	21.62	85.58	3
Khagaria	25.50	86.46	7
Khamiandana	25.02	78.13	4
Khandparagarh	20.27	85.16	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Khandwa	21.82	76.35	2.5
Kharagpur	25.12	86.55	5.5
Khargon	21.82	75.61	2.5
Kharsawan	22.79	85.84	4
Khategaon	22.59	76.91	2.5
Khepurara	21.98	90.21	2.5
Kheri	27.90	80.80	4
Khirkiya	22.17	76.85	2.5
Khokna	27.67	85.27	7
Khulna	22.85	89.55	3.5
Khurda	20.19	85.63	2.5
Kirtipur	27.67	85.29	7
Kishanganj	26.10	87.95	5
Kishanganj	25.68	86.95	5.5
Kishangarh	26.59	74.89	3
Kishorganj	24.43	90.77	3.5
Koch behar	26.32	89.46	5
Kodarma	24.47	85.60	4.5
Kohima	25.67	94.12	2.5
Kohnia	25.39	79.37	4.5
Koilpur	26.68	86.28	8
Kokrajkhar	26.41	90.27	2
Kolhapur	16.69	74.23	1
Korangal	17.10	77.63	1
Korwai	24.12	78.04	4.5
Kotah	25.17	75.84	4.5
Kothi	24.75	80.79	4.5
Krishnangar	23.41	88.51	4.5
Kuhi	21.02	79.37	2.5
Kulaura	24.53	92.05	3
Kunal	26.45	86.80	7
Kurigram	25.83	89.69	4
Kursela	25.45	87.26	5
Kurseong	26.88	88.28	7.5
Kutchlijor	27.62	85.15	7
Kyauktaw	20.84	92.96	2
Lachi/Kerang	28.02	88.75	7.5
Laheria sarai	26.12	85.90	7.5
Lahore	31.56	74.35	2
Lakhimpur	27.24	94.10	3.5
Laksar	29.77	78.05	3
Lakshimpur	22.95	90.80	2.5
Lalmarihat	25.89	89.49	3.5
Latehar	23.74	84.50	4.5
Laukhaung	25.91	98.15	2
Lauriya	26.98	84.40	6
Lawa	26.35	75.57	3.5
Legua Ghat	27.13	87.27	8.5
Lhudiana	30.91	75.85	1
Loharu	28.43	75.80	3.5
Lohat	27.28	86.13	8
Loiseng	22.72	96.87	2
Luckeeserai	25.17	86.10	6
Lucknow	26.84	80.93	5
Machhlishar	25.69	82.41	5.5
Madhubani	26.36	86.06	7.5
Madhupur	24.27	86.63	6
Madras	13.08	80.27	1
Madura	9.92	78.12	1
Magra	22.99	88.38	4.5
Magura	23.50	89.42	3.5
Mahadeopur	18.73	79.99	2.5
Maharaganj	27.13	83.56	4.5
Maharajganj	26.11	84.50	5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Mahasamund	21.11	82.10	3.5
Mahbubnagar	16.75	77.99	1
Maheswar	22.19	75.59	2.5
Mahoba	25.29	79.87	4.5
Maihar	24.27	80.75	4
Mainipur	27.23	79.03	3
Majhowlia	26.82	84.62	6.5
Majri	20.41	78.87	2.5
Makui	25.12	93.57	1
Malakand	34.57	71.72	2
Malda	25.03	88.15	4.5
Malkapura	20.89	76.20	2.5
Mananpur	25.10	86.17	5.5
Manasa	24.46	75.12	3
Mandalay	21.97	96.08	2
Mandar hil	24.82	87.03	5.5
Mandheli	26.60	87.25	8
Mandi	31.70	76.94	2
Mandla	22.59	80.38	4
Mangalai	26.43	92.04	2
Manikpur	25.06	81.09	4
Mankachar	25.53	89.86	4
Mariabu	25.60	82.61	5
Masulipatan	16.19	81.14	4
Matabhanga	26.35	89.22	4
Mau	25.94	83.56	6.5
Maudaha	25.68	80.11	5
Maungdaw	20.82	92.37	2
Meherpur	23.78	88.64	4
Mehidpur	23.48	75.66	4
Merta	26.65	74.04	2
Mhow	22.55	75.76	2
Mianwali	32.59	71.54	1
Midnapur	22.42	87.33	3
Minbya	20.37	93.27	2
Mirganj	26.37	84.33	6
Mirpur	26.69	85.06	8
Mirzapur	25.15	82.57	7
Mirzapur	26.40	86.15	7.5
Modasa	23.46	73.30	2
Moghal serai	25.28	83.12	5
Monywa	22.11	95.14	2
Moradabad	28.83	78.77	4
Morrelganj	22.47	89.85	3
Motipur	28.03	81.36	3.5
Moulmein	16.49	97.63	1
Muhammadgarh	23.65	78.15	3
Muksar	26.67	86.38	8
Mukteswar	29.48	79.65	3.5
Mulag	18.18	79.93	2
Multan	30.19	71.46	1
Mungeli	22.07	81.69	3.5
Murshidabad	24.17	88.27	5.5
Murtazapur	20.73	77.35	2.5
Murwara	23.84	80.40	3.5
Musafirkhana	26.37	81.80	4.5
Muttra	27.49	77.68	4
Muzaffarnagar	29.47	77.70	3
Mymensingh	24.75	90.40	4
Myohaung	20.59	93.19	2
Nabha	30.38	76.15	3.5
Nagar karnul	16.50	78.12	1
Nagarkot	27.70	85.52	5.5
Nagaur	27.20	73.38	2.5
Nagod	24.57	80.58	4

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Nagpur	21.16	79.09	2.5
Naihati	22.90	88.43	4
Naini	25.37	81.86	5.5
Najibabad	29.61	78.33	3
Nakhandol	27.75	85.30	7
Nakodar	31.13	75.47	1.5
Naldun	27.79	85.57	6
Nalhati	24.29	87.83	6
Nander	19.15	77.31	2
Nandura	20.83	76.46	2.5
Nangaon	20.31	74.66	2.5
Naogaon	24.81	88.94	4
Narail	23.17	89.50	3
Narayanganj	23.62	90.50	3
Narayangarh	30.49	77.13	3
Narkher	21.47	78.54	2
Narsigharh	23.70	77.10	2.5
Narsingpur	17.98	75.12	2.5
Nasik	20.00	73.79	2.5
Nator	24.40	88.98	4
Naugachia	25.40	87.10	6
Nawabganj	24.64	88.36	4
Nawabganj	26.93	81.19	5
Nawada	24.87	85.54	5
Nawarkot	27.92	85.16	7
Nayagaon	25.50	75.30	4
Nayagarh	20.13	85.10	2
Nepaltar	26.90	86.53	9
Netrokona	24.88	90.73	4.5
Nilphamari	25.94	88.85	3.5
Nimrana	27.98	76.38	3
Nipania	26.80	86.35	8
Niphad	20.08	74.12	2
Nirmali	26.31	86.57	7.5
Nisarpur	22.10	74.80	2
Niwas	23.05	80.45	3
Nizamabad	18.67	78.10	2.5
Noakhali	22.81	91.10	2.5
Nowarangpur	19.22	82.56	2
Nowgong	25.06	79.44	3.5
Num	27.55	87.28	7.5
Nundhaki	27.32	87.47	6
Nuninhat	24.49	87.13	5
Okhaldunga	27.31	86.50	8
Orai	25.81	79.38	5.5
Pabna	24.00	89.24	4
Pachbhadra	25.92	72.26	1.5
Pachmari	22.47	78.43	3
Paghdhal	22.42	77.35	3
Pahari	26.82	78.07	5
Pairibas	27.07	87.28	7.5
Paithan	19.47	75.39	2
Pakhyong	27.23	88.60	5.5
Palanpur	24.18	72.43	2
Palasner	21.55	75.03	2.5
Paletwa	21.30	92.86	2
Pali	25.78	73.33	2.5
Pal-lahara	21.43	85.19	3.5
Pana	24.72	80.18	4
Pandharkawanda	20.02	78.55	2
Pandhurna	21.60	78.53	2
Panipat	29.38	76.97	3.5
Paoni	20.79	79.64	3.5
Parasia	22.19	78.74	3.5
Parbasar	26.88	74.76	2
Parbhani	19.25	76.77	2
Pargi	17.18	77.87	1
Parha	25.37	80.23	4.5
Parmanipur	27.08	84.77	5
Partagarh	24.03	74.78	2.5
Partapur	24.30	84.63	4.5
Parvatipuran	18.78	83.43	3
Pashupatinath	27.63	85.32	7
Patalia	30.32	76.39	2.5
Patan	23.30	79.70	4.5
Patan	27.68	85.32	8
Patna	25.61	85.14	8
Patnagarh	20.70	83.14	2.5
Patuakhali	22.36	90.24	2.5
Pauktaw	17.20	97.11	2
Pauri	30.16	78.77	3
Pegu	17.33	96.50	1
Peshawar	34.00	71.55	2.5
Petlawad	23.01	74.80	2
Phagu	26.95	88.70	6
Philaur	31.02	75.78	2.5
Phulant	25.52	86.93	6
Phulparas	26.35	86.48	8
Pilibhit	28.63	79.81	4
Piploda	23.35	75.43	3.5
Pipri	24.19	83.01	4.5
Pirojpur	22.57	89.99	3.5
Ponur	16.07	80.56	2
Poona	18.53	73.85	1
Pratapganj	26.30	86.97	8
Pulgaon	20.73	78.32	2.5
Puri	19.80	85.83	2
Purnea	25.78	87.47	9
Purulia	23.33	86.37	4
Pusad	19.90	77.57	2
Quetta	30.21	67.02	1
Raipur	22.80	86.95	4
Raiwala	30.02	78.22	2.5
Rajgarh	22.67	74.94	4
Rajkot	22.30	70.80	1
Rajmahal	25.05	87.84	5.5
Rajnagar	26.40	86.18	7.5
Rajshahi	24.37	88.60	4.5
Rajur	20.11	78.91	2
Rajura	19.78	79.37	2.5
Ramnagar	29.39	79.13	3
Ramnagar	27.17	84.32	4.5
Rampur	21.07	84.35	2
Rampura	24.47	75.44	3.5
Rampur hat	24.18	87.79	6
Ramtek	21.40	79.32	2.5
Ranchi	23.36	85.33	5
Rangamati	22.78	92.05	2
Rangoon	16.78	96.15	1
Rangpo	27.18	88.54	7
Rangpur	25.75	89.25	4
Raniganj	23.60	87.12	5
Raniganj	26.08	87.23	6
Ranka	23.98	83.79	5
Rao/Bareli	26.23	81.23	5.5
Ratlan	23.34	75.04	2
Raupur	21.24	81.64	3.5
Rawer	21.25	76.03	2
Raxaul	26.99	84.85	7

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Rayagudda	19.17	83.41	2
Remuna	21.55	86.88	3
Repale	16.02	80.84	2.5
Rewah	24.53	81.59	3.5
Rhenok	27.18	88.65	5.5
Riga	26.65	85.43	8
Rinchenpong	27.23	88.27	7.5
Rishra	22.71	88.36	4
Risku	26.97	86.03	8
Riwo	28.04	87.70	7
Rohtak	28.89	76.59	3.5
Roorkee	29.86	77.89	3
Rosa	27.85	79.94	3.5
Sadia	27.84	95.66	2
Sadra	23.35	72.72	2
Safidon	29.40	76.66	2.5
Sagrampur	26.48	84.68	7
Saharanpur	29.96	77.54	3
Saharsa	25.87	86.59	6.5
Sahaswan	28.07	78.75	3.5
Sahebganj	25.24	87.63	5.5
Sailana	23.47	74.91	3
Salana	26.45	92.96	3
Salmara	25.07	89.50	3.5
Sambhar	26.92	75.40	3.5
Samdong	27.35	88.50	6.5
Samthar	25.80	79.42	3.5
Sandoway	18.46	94.37	1
Sandwip	22.48	91.43	2.5
Sangil	16.85	74.57	1
Sangrur	30.19	75.85	3
Saomer	21.38	78.92	3
Saraikela	22.68	86.09	3
Sarath	24.23	86.83	5
Sarila	25.77	79.68	4.5
Sasaram	24.95	84.02	5
Satana	20.58	74.20	3
Satkhira	22.71	89.80	3
Satna	24.57	80.83	4
Saugor	23.84	78.75	4.5
Sausar	21.65	78.81	3
Savda	21.15	75.89	2
Sawantwadi	15.90	73.82	1
Sawar	25.75	75.21	2
Sehor	23.20	77.09	3
Seoni	22.45	77.46	3
Seoni	22.10	79.55	3
Serampur	22.74	88.35	4
Shahabad	27.64	79.93	4
Shahjanapur	27.88	79.91	5
Sherpur	25.20	90.01	3.5
Shillong	25.57	91.87	3.5
Sholapur	17.67	75.90	1
Shwebo	22.57	95.70	2
Sibganj	24.89	88.75	3.5
Sibsagar	26.98	94.63	2
Sihora	23.49	80.11	3.5
Sikandra	24.96	86.03	7
Silchar	24.82	92.78	3.5
Siliguri	26.73	88.43	7
Simla	31.10	77.16	2.5
Sindhwari	26.53	87.28	8
Singtam	27.23	88.49	7
Sirohi	24.89	72.85	2
Sironcha	18.85	79.97	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Sirtibas	27.69	85.60	6
Sisagarhi	27.57	85.15	6.5
Siswa bazar	27.15	83.75	4
Sitamarhi	26.60	85.49	7.5
Sitamau	24.01	75.35	3
Sitapur	27.57	80.69	4.5
Siwan	26.22	84.36	5.5
Sohagpur	22.70	78.17	3.5
Sojat	25.92	73.66	2
Sonpur	19.70	81.02	2.5
Sonpur	25.70	85.18	6.5
Srinagar	34.08	74.80	3
Subathu	30.98	76.98	2.5
Sukkur	27.70	68.85	1
Sukna	26.80	88.40	7
Sultanpur	26.26	82.07	5
Sundargarh	31.53	76.90	2
Sundargarh	22.12	84.04	3
Sundarijal	27.75	85.42	6.5
Sunel	24.37	75.97	3
Surat	21.20	72.82	2
Suri	23.90	87.54	4
Surkhali	22.66	89.45	3
Swayambhunath	27.72	85.30	7
Syabru	28.18	85.33	7
Syleth	24.90	91.88	3
Talcher	20.95	85.23	3.3
Tamkuhi	26.68	84.18	5.5
Tamluk	22.30	87.92	3
Tanda	26.55	82.65	4
Tangail	24.25	89.92	4.4
Taplejung	27.35	87.67	8
Tarakesvar	22.88	88.02	3.5
Tarana	23.33	76.04	3
Teghra	25.49	85.94	6.5
Tenali	16.24	80.65	2.5
Tezpur	26.63	92.80	2.5
Thakurgaon	26.03	88.46	5
Thana	19.20	72.97	2
Thankot	27.68	85.18	6.5
Thansing	27.87	85.27	6
Thimi	27.66	85.38	7.5
Tigiria	20.48	85.52	3.5
Tijota	16.84	75.51	1
Tikamgarh	24.74	78.83	4
Timuri	22.36	77.23	3
Tindharia	26.80	88.30	7.5
Tirora	21.17	79.66	2.5
Tiruvottiyur	13.16	80.30	2
Titabar	26.60	94.20	4
Titagar	22.74	88.38	4
Tohri	25.45	79.13	4.5
Tonk	26.17	75.79	2.5
Tribenighat	27.47	83.92	5.5
Trisuli bazar	27.92	85.15	7
Tufanganj	26.32	89.67	4.5
Tundla	27.21	78.23	4
Tura	25.52	90.23	4
Udaigiri	20.75	86.32	3
Udaipur	24.58	73.69	2.5
Udaipur garhi	26.93	86.52	9
Ujjain	23.18	75.78	4
Uluberia	22.46	88.11	4
Umaria	23.53	80.84	3.5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Unao	26.55	80.49	5.5
Uttarpara	22.65	88.35	4.5
Vagra	21.85	72.83	2
Visagapatan	18.11	83.41	2
Waghoda	21.01	75.56	2
Warangal	18.00	79.59	2
Waraseoni	21.76	80.05	3
Wardha	20.74	78.60	2.5
Warora	20.23	79.01	2.5
Wazirabad	32.45	74.02	2
Wun	20.05	78.95	2.5
Wuntho	23.91	95.68	1
Wyndhamganj	24.25	83.38	4.5
Yamethin	20.43	96.14	2
Yatung	27.44	88.92	6.5
Yaval	21.17	75.69	2
Yellandu	17.59	80.33	2
Zirapur	24.02	76.36	3
1935			
Alipur	29.38	70.89	4
Amritsar	31.63	74.87	3
Baleli	30.27	66.93	9
Bahawalpur	29.39	71.68	2
Bostan	30.43	67.01	7
Chagai	29.30	64.70	3
Chaman	30.92	66.44	6
Dehli	28.66	77.23	1
Dera/Ismail	31.82	70.91	4
Dingar	29.90	66.75	8
Jacobabad	28.29	68.43	4
Jaisalmer	26.91	70.91	2
Jampure	29.64	70.59	3
Jatta	31.64	70.80	4
Isakhail	32.67	71.28	4
Kalat	29.03	66.58	8
Kandahar	31.62	65.70	4
Karachi	24.85	67.01	1
khairpur	30.18	71.38	4
Khairpur	32.31	72.40	5
Khanak	29.95	66.71	8
Kuchlagh	30.35	66.95	9
Lahore	31.56	74.35	2
Lalamusa	32.70	73.94	3
Las Bela	26.23	66.30	2
Maghiana	31.27	72.32	2
Mand-i-Haji	29.39	66.62	8
Mangochar	29.35	66.63	8
Mastung	29.80	66.85	9
Multan	30.20	71.45	4
Nauhissar	30.25	66.88	8
Nushki	29.55	66.01	7
Pishin	30.59	66.98	7
Pringabad	29.87	66.87	9
Quetta N	30.22	67.00	8
QuettaS	30.19	67.02	10
Samungli	30.24	66.93	9
Sukkur	27.69	68.85	4
Surab	28.50	66.24	6
Sheik Manda	30.27	66.97	9
Sherkot	33.60	71.28	3
Sibi	29.54	67.87	7
Simla	31.10	77.17	2
Spezand	29.98	67.00	8

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Spin/Baldak	30.77	66.75	6
Sujabad	29.88	71.29	4
Sultanpur	31.22	75.19	3
Tiri	29.88	66.82	9
Washuk	27.73	64.80	3
1941			
Bogra	24.84	89.37	3
Diburghar	27.48	94.91	5
Dhubri	26.02	89.98	4
Gauhati	26.19	91.75	6.5
Silchar	24.82	92.78	5
Shillong	25.57	91.87	7
1943			
Berhampur	24.09	88.25	3
Calcutta	22.57	88.36	2
Chittagong	22.33	91.82	3
Darjiling	27.04	88.26	3.5
Dinajpur	25.62	88.64	3
Diburghar	27.48	94.91	7
Faridpur	23.61	89.85	3.5
Gauhati	26.19	91.75	6
Hazaribagh	23.67	90.45	4
Johrat	26.76	94.21	7
Katmandu	27.70	85.31	2
Lhasa	29.65	91.13	1
Magawng	26.53	97.71	3
Minya	24.33	94.79	4
Muzafferabad	26.12	85.38	2.5
Mymensingh	24.75	90.40	5
Myothit	20.20	95.45	2
Mytikyina	25.38	97.39	3
Patna	25.62	85.13	2.5
Rangpur	25.74	89.26	4.5
Shillong	25.56	91.88	6
Sibsagar	26.98	94.63	8
Silchar	24.82	92.78	5
1945			
Amritsar	31.63	74.87	4
Ariz	33.36	75.82	6
Chamba	32.56	76.12	7
Dalhousie	32.53	75.99	7
Jamu	32.71	74.85	6
Kyelang	32.58	77.03	6
Lahore	31.56	74.35	3
Pandoh	31.67	77.06	4.5
Pathnakot	32.26	75.64	6
Peshawar	34.00	71.54	3
Rawalpindi	33.60	73.05	4
Simla	31.10	77.12	4
Srinagar	34.08	74.79	4
1954			
Akyab	20.14	92.89	4
Alipore	22.53	88.34	3.5
Along	28.16	94.77	3
Astakhal	22.28	89.00	4
Bagalpur	25.25	86.98	3
Baghdogra	26.70	88.32	4.5
Baleshwar	21.49	86.95	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Balia	25.76	84.15	1
Banka	24.88	86.92	3.5
Banki	22.10	84.90	2
Bankura	23.23	87.07	2.5
Barakpur	22.76	88.38	3.5
Barh	25.47	85.71	3
Baripada	21.94	86.73	3.5
Barisal	22.71	90.37	4
Barkagaon	26.42	84.25	3
Basti	26.79	82.75	1
Berhampur	26.30	85.75	3
Bermu Ranch	23.36	85.33	3.5
Bishnupur	23.08	87.33	4
Bogra	24.85	89.36	3.5
Calcutta	22.57	88.36	4
Chaibasa	22.55	85.81	1
Chandua	23.68	84.73	2
Chatapur	24.91	79.59	2
Chatra	26.85	87.17	3
Chittagong	22.33	91.82	4.5
Chunar	25.11	82.88	3
Contai	21.79	87.75	3
Cox Bazar	21.44	91.99	4
Cuttack	20.47	85.88	2
Darjeeling	27.04	88.26	3
Deoghar	24.49	86.69	3.5
Dhanbad	23.80	86.43	2
Diamond Harbour	22.19	88.19	3.5
Digha	25.65	85.08	3.5
Doimukh	27.15	93.75	4
Domariagunj	27.21	82.66	1
Dudi	24.22	83.25	1
Dumka	24.27	87.25	2.5
Fakirangram	26.38	90.13	3.5
Forbesbunj	26.29	87.30	3.5
Gangajalghati	23.42	87.12	4
Gauhati	26.19	91.75	4
Gaya	24.80	85.01	3.5
Giridih	24.18	86.31	2
Godda	24.83	87.21	2.5
Hazaribagh	24.00	85.37	2
Jamtara	23.95	86.83	3
Jamui	24.93	86.22	2
Jhargram	22.45	87.00	2
Kalimpong	27.07	88.48	3
Kalna	23.22	88.37	3
Kaptipoda	21.52	86.53	2
Karanzea	21.77	85.98	2.5
Khaga	25.78	81.11	1
Khagaria	25.50	86.46	3
Khajura	26.05	80.53	2
Khalilabad	26.78	83.08	1
Khatra	23.92	90.70	3
Khirpai	22.70	87.61	3
Khoragpur	22.33	87.32	4
Khulna	22.85	89.55	4.5
Kishangunj	26.11	87.95	3.5
Kuliana	22.07	86.65	3
Kyaukpyu	19.43	93.56	3.5
Laheriserai	26.12	85.90	2
Lhasa	29.65	91.13	3
Mandalay	21.97	96.09	3.5
Mohendrigani	25.30	89.85	4.5
Monghyr	25.38	86.47	3.5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Myaungmya	16.60	94.92	2
Naharokotia	27.28	95.33	4
Pakur	24.64	97.85	4.5
Palamau	23.68	84.24	1
Partapgar	25.90	81.95	1
Patna	24.00	89.24	3
Patna	25.62	85.13	3
Patnagar	20.71	83.14	1
Prome	18.83	95.22	3.5
Purnea	25.77	87.48	3
Purukia	23.33	86.37	2
Putao	27.34	97.42	4
Pyapon	16.29	95.68	2
Raghunathgunj	24.68	81.65	3
Rangun	16.78	96.15	2.5
Robertsganj	24.68	83.07	1
Sandoway	18.46	94.36	3.5
Siliguri	26.72	88.42	2
Sirsa	25.29	82.09	3
Siwan	26.22	84.36	2
Sonai	24.93	89.07	5
Sonamukhi	23.31	87.42	4
Susa	21.22	86.33	2
Tawang	27.58	91.88	3.5
Tezu	27.92	96.17	4
Tharawadi	17.65	95.78	3
Tuting	28.97	94.87	3
1956			
Baghlan	36.14	68.70	7
Bamian	34.82	67.53	8
Behsud	34.38	67.90	6
Chitral	36.02	71.75	3
Dar Shikari	34.88	67.78	7
Dare Anjar	35.36	67.40	8
Doab	35.55	67.81	8
Dowashi	35.62	68.68	7
Derd Deh	34.95	67.97	6.5
Girdeg	35.61	68.68	7
Kabul	34.53	69.13	5
Kahmard	35.33	67.50	8
Kami/Kharqushaq	35.36	67.53	7.5
Kunduz	36.73	68.86	6
Mazar-Sherif	36.71	67.11	4.5
Molotovabad	37.34	68.67	3
Patsigram	35.75	71.20	3
Peshawar	34.00	72.54	1
Puli-khuni	35.95	68.71	6
Qarghan/Takhar	34.40	66.65	7
Saigan	35.17	67.70	8
She Kundi	33.35	68.40	5
Shahristan	34.37	66.77	6.5
Stalinabad	38.57	68.78	2
Takhar	36.73	69.54	5.5
Termaz	37.22	67.27	3.5
Yakwalang	34.73	66.97	7
1967a			
Achhibal	33.68	75.23	5.5
Aishmugam	33.87	75.28	5
Anantnag	33.75	75.19	6
Batagund	33.54	75.25	7
Bijbiara	33.79	75.09	5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Chhatargul	33.77	75.35	6
Desu	33.60	75.39	7
Doru	33.59	75.23	7
Ghazigund	33.63	75.15	6
Hutmara	33.77	75.22	6
Kapurthala	31.38	75.38	2
Khanabad	33.75	75.13	5
Kuther	33.66	75.25	7
Larkipura	33.90	75.01	5
Mattan	33.75	75.20	6
Naugam	33.52	75.19	5.5
Sali	33.80	75.27	6
Sagam	33.36	75.26	5
Sangan	33.82	75.06	4
Shangus	33.69	75.26	7
Shrinagar	34.08	74.80	2
Sop	33.60	75.29	7
Vameg	33.55	75.25	7
Verinag	33.56	75.22	6
1967b			
Ahmetnagar	19.10	74.75	3
Akola	20.67	77.03	2
Alatur	16.97	73.88	5
Amba	16.97	73.78	5
Ambola	17.22	73.75	7.5
Amravati	20.93	77.80	2
Anavala	17.70	73.90	5
Angapur	17.58	74.13	5
Antravali	17.20	73.60	6
Antavadi	17.37	74.22	5
Apshinga	17.55	74.08	5
Apti	17.77	73.77	5
Arale	17.75	74.05	5
Arla	17.10	73.90	6
Arvi	17.50	74.23	5
Asangaon	17.60	73.90	6
Atit	17.52	74.07	5
Bangalore	12.92	77.67	2
Basin	20.08	77.17	2
Baja	17.38	73.78	8
Belkar	16.98	73.63	5
Belgaum	15.87	74.52	4
Belavda	17.33	73.93	6
Bhandara	21.15	79.70	2
Bijapur	16.83	75.72	3
Bombay	18.93	72.83	4
Boposi	17.57	73.88	6
Broach	21.68	73.02	2
Bulsar	20.60	72.93	3
Chandel	17.13	73.72	6
Chandoli	17.13	73.87	6
Chandoli	16.97	73.82	5
Chandoli	17.25	73.73	7.5
Chandrapur	19.95	79.35	2
Chaphal	17.38	74.02	6
Charan	17.05	73.97	5
Charavna	17.65	73.67	5
Charegaon	17.37	74.07	5
Chikhli	17.48	73.30	5
Chinchner	17.65	74.08	5
Chiplun	17.53	73.52	5
Chitradurga	14.23	76.43	2

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Chorambe	17.82	73.82	5
Coorg	12.33	76.17	2
Dangs	20.83	73.37	3
Davangiri	14.47	75.93	3
Devhara	17.10	73.85	6
Devrukh	17.07	73.62	6
Dhamnand	17.60	73.60	6
Dhamni	17.18	73.97	6.5
Dhankala	17.12	73.77	6
Dharwar	15.45	75.08	3
Dhond	18.47	74.62	4
Dhulia	20.97	74.78	2
Divsi	17.28	73.98	6.5
Donachiwadi	17.37	73.00	9
Gava	17.23	73.75	7
Ghot	17.43	73.93	6.5
Gondia	21.47	80.48	2
Goshtavdi	17.37	73.73	8
Govara	17.35	73.73	8
Gudha	17.23	73.98	6
Guhagar	17.48	73.20	5
Gulbarga	17.33	76.83	3
Hamgaon	17.85	73.87	5
Hassan	13.02	76.17	2
Hedli	17.22	73.62	6.5
Helgaon	17.45	74.17	5
Helwak	17.38	73.73	8
Hubli	15.33	75.17	3
Hyderabad	17.33	78.50	2
Igatpuri	19.70	73.58	4
Jadugala	17.25	73.95	6.5
Jalgaon	21.08	75.67	3
Jath	17.05	75.22	4
Javli	17.22	73.73	7
Kadoli	17.35	73.75	9
Kandla	23.00	70.22	2
Kalavda	17.17	74.10	5
Kale	17.20	74.09	5
Kaloti	17.45	73.97	6
Kanera	17.73	73.92	5
Karanguli	17.08	73.93	5
Karanjeri	16.98	73.60	5
Karbathla	17.20	73.63	6.5
Karde	17.15	73.85	6
Karegaon	17.75	73.93	5
Kari	17.63	73.92	5
Karve	17.25	74.22	5
Kas	17.72	73.80	5
Kati	17.48	73.82	7.5
Keral	17.45	73.88	6.5
Kesa	17.27	74.15	5
Khed	17.57	73.40	5
Khodumra	17.18	73.62	6
Khopi	17.68	73.57	5
Kola	15.25	74.07	5
Kolar	13.15	78.18	2
Kolewadi	17.23	74.05	5
Kolhapur	16.73	74.23	4
Koparada	17.33	74.18	5
Koregaon	17.68	74.17	5
Koynagar	17.38	73.75	8.5
Kusrud	17.30	73.90	6.5
Kutra	17.20	73.97	6
Lanja	16.87	73.55	5
Lasurna	17.70	74.13	5

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Lativ	17.22	73.77	7
Latur	18.40	76.58	3
Lumnakhol	17.68	73.88	5
Mahabaleshwara	17.93	73.65	5
Mahuli	17.70	74.05	5
Mahuva	20.87	73.42	3
Makhjan	17.27	73.50	6
Malghar	17.48	73.47	5
Mandya	12.55	76.88	2
Mandur	17.47	73.88	6.5
Mangalore	12.87	74.88	3
Marli	17.30	73.95	6.5
Marmagao	15.42	73.85	5
Marul	17.30	74..02	6
Masulipatan	16.15	81.20	2
Mhasoli	17.17	74.03	5
Miraj	16.82	74.63	4
Mulanagar	19.33	74.37	3
Murud	17.53	73.92	6
Mysore	12.30	76.70	2
Nagpur	21.15	79.15	2
Nalgonda	17.05	79.33	2
Nanded	19.15	77.33	2
Nanegaon	17.42	74.00	6
Nanegaon	17.43	73.98	6
Nanel	17.37	73.77	8
Nanij	16.97	73.53	5
Nasik	20.00	73.83	3
Navaja	17.45	73.73	7.5
Navari	17.20	73.65	7.5
Nerla	17.08	74.23	5
Nile	16.95	73.90	5
Nipani	18.98	73.12	4
Nivla	17.23	73.77	7
Nivla	17.12	73.82	6.5
Nizamabad	18.67	78.17	2
Ootacamund	11.53	76.70	2
Osmanabad	18.17	76.05	3
Pachwar	17.85	73.97	5
Pal	17.48	74.03	5
Panchgani	17.92	73.80	5
Panjim	15.48	73.83	5
Panumbra	17.07	73.95	5
Parali	17.67	73.92	5
Parbhani	19.13	76.83	2
Pasurla	17.00	73.88	5
Patan	17.37	73.90	6.5
Pethlond	17.20	73.78	6
Phaltan	17.98	74.43	4
Phansavna	17.20	73.57	6
Pishvi	16.85	74.02	5
Poona	18.53	73.52	4
Pophali	17.45	73.63	6.5
Ramapur	17.47	73.42	5
Randhiv	17.23	73.72	7.5
Ratnagiri	16.98	73.28	5
Risvand	17.38	74.22	5
Salva	17.28	73.88	7
Sadavaghapur	17.43	73.93	6
Sakharpa	16.98	73.70	5
Sakhri	17.42	73.90	6
Sakurdi	17.32	74.08	5
Sanbur	17.27	73.92	6.5
Sangameshwar	17.18	73.57	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Sangaraddipet	17.65	78.08	2
Sangli	16.97	74.57	4
Satara	17.68	74.00	5
Savanur	14.97	75.47	3
Savda	17.17	74.02	5
Shirshi	17.05	74.07	5
Sholapur	17.67	75.92	3
Sonavda	17.30	73.93	6
Songaon	17.82	73.90	5
Srisailam	16.12	78.90	2
Supane	17.27	74.12	5
Surat	21.15	72.90	3
Tambva	17.13	73.87	6
Tanhamala	17.40	73.26	5
Tapola	17.73	73.77	5
Tarla	17.50	73.98	6
Tasgaon	17.63	74.12	5
Telbid	17.33	74.10	5
Thana	19.20	72.98	4
Tunkur	13.28	77.12	2
Udgiri	17.08	73.83	6
Unhara	17.62	73.32	5
Urul	17.37	74.03	6
Vagheri	17.37	74.23	5
Vajroshi	17.47	73.97	6.5
Vakurda	17.02	74.05	5
Varda	17.37	74.12	5
Varul	16.97	73.87	5
Veti	17.22	73.78	7
Viha	17.33	74.05	5
Vijaywada	16.57	80.63	2
Vond	17.17	74.12	5
Wai	17.95	73.90	5
Warda	20.75	78.60	2
Wathar	17.52	74.20	5
Yelapur	17.07	74.02	5
Yelgaon	17.12	74.03	5
Yelgari	19.17	76.95	2
Yenpa	17.10	74.03	5
Yeotmal	20.35	78.23	2
Yerphal	17.37	73.95	6
Yevti	17.16	74.03	5
1970			
Ahmedabab	23.03	72.59	3
Anand	22.56	72.96	3
Ankleshwar	21.63	72.98	7
Baroda	22.31	73.19	4
Bhainsili	21.72	72.78	6
Bhanagar	21.77	72.14	4
Bombay	18.95	72.83	2
Broach	21.71	72.97	7
Dhamrod	21.52	72.98	5
Dhanturia	21.65	72.86	7
Govalibet	21.70	73.11	7
Hansot	21.58	72.81	6
Hinglot	21.71	72.86	6
Kalyan	19.25	73.15	1
Kantharia	21.73	72.95	7
Kosamdi	21.58	73.04	6
Limet	21.67	73.21	5.5
Nabpur	21.79	73.03	6
Natiad	22.70	72.85	2
Rayma	21.54	72.82	6

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Sajad	21.62	72.90	7
Sakarpur/Bhata	21.65	72.93	7
Sukeltirth	21.75	73.12	6
Surat	21.20	72.82	4
Thana	19.19	72.95	1
Umad	21.75	72.96	6
Vagra	21.85	72.83	5
Vahalu	21.76	72.87	6
1972			
Abbotabad	34.15	73.20	4
Bataret	35.92	73.32	8
Balti	36.10	73.30	8
Dam	36.20	73.73	6
Gilgit	35.92	74.29	5
Gupis	36.23	73.44	6.5
Hamran	36.07	73.07	7
Hangrus	35.98	73.47	8
Haripour	34.02	72.92	4
Islamabad	33.72	73.07	3
Jaklot	35.67	73.40	6.5
Jehlum	32.93	73.70	3
Kabul	34.53	69.13	2
Khorog	37.49	71.55	3
Lahore	31.56	74.35	2
Mankial	35.32	72.61	5.5
Nowshera	34.01	72.00	3
Nutsuf	35.80	73.68	7
Peshawar	34.00	71.55	3
Punial	34.88	72.80	4.5
Rawalpindi	33.60	73.05	3
Sazin	35.53	73.50	6
Tarbela	34.08	72.69	3
Ushkur	36.04	73.39	8
1974			
Abbotabad	34.15	73.20	5
Alpuri	34.90	72.64	6
Andijan	40.81	72.30	2
Balakot	34.55	73.35	6
Balikanai	35.04	72.77	5
Banil	35.14	72.97	5
Bannu	32.99	70.60	3
Barasin	35.53	73.30	7
Beishan	34.94	72.87	7
Buteal	34.96	72.86	7
Chakal	34.90	72.89	8
Chitral	36.03	71.75	4.5
Close Bandar	35.08	72.96	8
Dobair Bazar	35.07	72.87	8

Table B2. (*Continued.*)

Place name	Latitude (°N)	Longitude (°E)	MSK intensity
Dobair Kalay	35.13	72.89	8
Drosh	35.55	71.80	5
Dushambe	38.84	68.95	2.5
Gabar	35.12	72.86	8
Gaya	35.18	72.90	8
Genshai	35.08	72.75	7.5
Gilgit	35.92	74.29	4.5
Hingal Bara	34.02	72.91	5
Holywood	35.10	72.96	8
Hunza	36.27	74.68	3
Jajal	35.04	72.93	8
Jalkot	35.25	73.28	6
Kabul	34.53	69.13	3
Kamila	35.26	73.21	6.5
Kangra	32.10	76.27	2
Karori	34.88	72.77	6.5
Kayal	35.21	73.04	7.5
Keru	35.20	73.13	7
Kohat	33.59	71.59	4
Kolai	35.06	72.97	7.5
Kulyab	37.91	89.78	3
Lahore	31.56	74.35	2
Lahori	34.97	72.86	7
Leuti	35.21	73.16	6
Lew	35.15	73.07	7.5
Madraza	35.26	73.06	7
Maidan	35.24	72.84	8
Mangla	33.15	73.64	4
Multan	30.20	71.46	1
Nirai	35.20	72.87	8
Palas	35.09	73.01	7
Pattan	35.10	73.00	8
Peshawar	34.01	71.54	3
Purva	35.28	73.17	6
Ranial	34.91	72.80	7
Rawalpindi	33.60	73.05	4.5
Risalpur	34.07	71.99	5
Ronalia	35.08	72.84	8
Saidu	34.75	72.34	6
Samarkand	39.66	66.95	2
Sarai	35.08	72.99	8
Seo	35.32	73.25	6
Shang	34.87	72.90	7
Serakot	35.05	73.03	7.5
Shorgara	35.02	72.85	8
Sialkot	32.52	74.55	3
Srinagar	34.08	74.80	4
Tarbela	34.75	72.35	5.5
Thakot	34.75	72.91	6
Upai	34.89	72.81	6.5
Warsak	34.17	71.42	4

Table B3. Attenuation laws.

Region	M	m	I	In	Is	Ft	a	b	c	d	dM	dI	Neq	Nrd	Ref.	Group
N India	M_s	1	MSK	1	2	1	−0.30	0.65	0.0026	1.65	5.0–8.3	I–IX	23	122	14	
Middle Asia	M_s	1	MSK	1	1	1	−2.27	0.67	0.0000	2.53	-	-	20	46	1	
S Balkans	M_s	1	MSK	1	1	1	−2.56	0.71	0.0000	2.58	4.5–7.0	V–VII	-	133	2	
E Balkans	M_s	1	MSK	1	1	1	−0.02	0.56	0.0000	1.96	3.5–6.0	IV–IX	-	144	2	I
C Balkans	M_s	1	MSK	2	1	1	−3.23	0.77	0.0000	2.70	3.5–7.0	III–IX	-	555	2	
Turkey	M_s	1	MSK	1	1	1	−0.53	0.58	0.0020	1.83	4.7–7.8	II–VIII	135	562	5	
W Turkey–Greece	M_s	1	MSK	1	2	1	−1.54	0.65	0.0029	2.14	5.0–8.1	II–X	41	154	6	
California (eq. 10)	**M**	2	MM	2	2	2	−4.65	0.92	0.0000	3.39	5.5–6.1	III–IX	11	-	8	
California (eq. 9)	**M**	2	MM	2	2	2	1.96	0.60	0.0123	0.00	5.5–6.9	III–IX	11	-	8	
E Cascades (USA)	**M**	3	MM	2	2	2	0.32	0.60	0.0031	1.07	-	-	-	-	11	
W Cascades (USA)	**M**	2	MM	2	2	2	1.63	0.60	0.0094	0.00	-	-	-	-	10	
Greece	**M**	3	MM	2	3	2	−0.78	0.62	0.0020	2.04	-	-	177	-	9	
Albania	**M**	3	MM	2	3	2	−1.50	0.62	0.0020	2.04	-	-	14	-	9	II
Yugoslavia	**M**	3	MM	2	3	2	−1.38	0.62	0.0020	2.04	-	-	47	-	9	
Bulgaria	**M**	3	MM	2	3	2	−1.29	0.62	0.0020	2.04	-	-	19	-	9	
W Turkey	**M**	3	MM	2	3	2	-1.45	0.62	0.0020	2.04	-	-	27	-	9	
Balkans	**M**	3	MM	2	3	2	−0.96	0.62	0.0020	2.04	-	-	284	-	9	
NW Europe	M_s	1	MSK	1	1	1	−1.10	0.62	0.0016	1.62	3.5–6.1	II–VII	151	300	3	
W Scandinavia	M_s	1	MSK	1	1	1	−0.96	0.58	0.0016	1.60	3.0–6.5	II–VIII	134	-	4	
Red Sea	M_s	1	MSK	1	1	1	0.30	0.55	0.0014	1.14	4.2–6.5	II–V	34	83	7	III
Ibero–Maghreb	M_s	2	MSK	1	3	1	−1.61	0.79	0.0032	1.26	3.3–6.9	II–X	93	-	12	
Switzerland	M_s	1	MSK	1	1	1	2.08	0.33	0.0022	0.66	3.5–6.2	III–VIII	95	246	13	

$M = a + bI + cR + d \log R$.
M, magnitude scale used.
m, magnitude: 1, calculated; 2, adopted; 3, converted.
I, intensity scale used.
In, intensities: 1, assessed; 2, adopted; 3, converted.
Is, isoseismals: 1, drawn by eye; 2, kriging; 3, adopted.
Ft: 1, R, $I \rightarrow M$; 2, M_s, $R \rightarrow I$.
dM, magnitude range of data set.
dI, intensity range of data set.
Neq, number of earthquake used.
References: [1] Shebalin (1968); [2] Shebalin *et al.* (1974); [3] Ambraseys (1985a); [4] Ambraseys (1985b); [5] Ambraseys (1988); [6] Ambraseys (1992); [7] (Ambraseys *et al.* 1994, p.117); [8] Bakun & Wentworth (1997); [9] Papazachos & Papaioannou (1997); [10] Bakun *et al.* (2002); [11] Bakun *et al.* (2003); [12] Lopez Casado *et al.* (2000); [13] Ambraseys (2003); [14] this article.

Table B4. Comparison of log M_0–M_s relations derived using method of Ekström & Dziewonski (1988) for the Middle East and north Indian areas with equation derived by Ekström & Dziewonski (1988).

	a	b	k	Reference
Global	24.50	26.40	−10.76	Ekström & Dziewonski (1988)
Middle East	25.02	25.96	−10.62	This study
N India	24.68	25.50	−10.65	This study

where:

$$M_s = k - (a+b)/6 + c \log M_0 \quad \text{for} \quad \log M_0 < a$$

$$M_s = k - (a+b)/6 + \log M_0 - (\log M_0 - a)^2/6(b-a) \quad \text{for} \quad a \le \log M_0 \le b$$

$$M_s = k + (2/3) \log M_0 \quad \text{for} \quad \log M_0 > b$$