

Introduction to Seismic b-Value

- The seismic **b-value** (Fig. 1) is a parameter in the **Gutenberg-Richter** law, representing the relationship between the frequency and magnitude of earthquakes in a region.
- Formula: $\log N(M) = a - bM$
- $N(M)$: Number of earthquakes with magnitude M or greater
- a : Seismic activity rate
- b : Slope of the line, indicating the relative occurrence of small vs. large earthquakes
- Typical b-value: Around 1.0 for most tectonic regions.

Importance of b-Value in Seismology

- Indicates seismic activity and stress level in a region.
- Lower b-value (<1.0): Suggests higher stress, more large earthquakes.
- Higher b-value (>1.0): Indicates lower stress, more small earthquakes.
- Useful in seismic hazard assessment and understanding tectonic processes.

Factors Affecting b-Value

- Tectonic Setting: Different regions have different typical b-values.
- Stress Conditions: Higher stress often lowers the b-value.
- Fault Zone Properties: Fault heterogeneity and material properties affect the b-value.
- Temporal Variations: The b-value can change over time due to evolving stress or aftershock sequences.

Applications and Case Studies

- Monitoring Seismicity: The b-value changes are crucial in identifying areas of increased earthquake risk.
- Emphasize the role of the b-value in predicting seismic hazards and understanding earthquake dynamics.
- Example Case Study: The b-value estimation over Indo-Burma ranges of northeast India.

1. Find out the seismicity of the particular area (Fig. 1(a))
2. Estimate the b-value (Fig. 1(b))

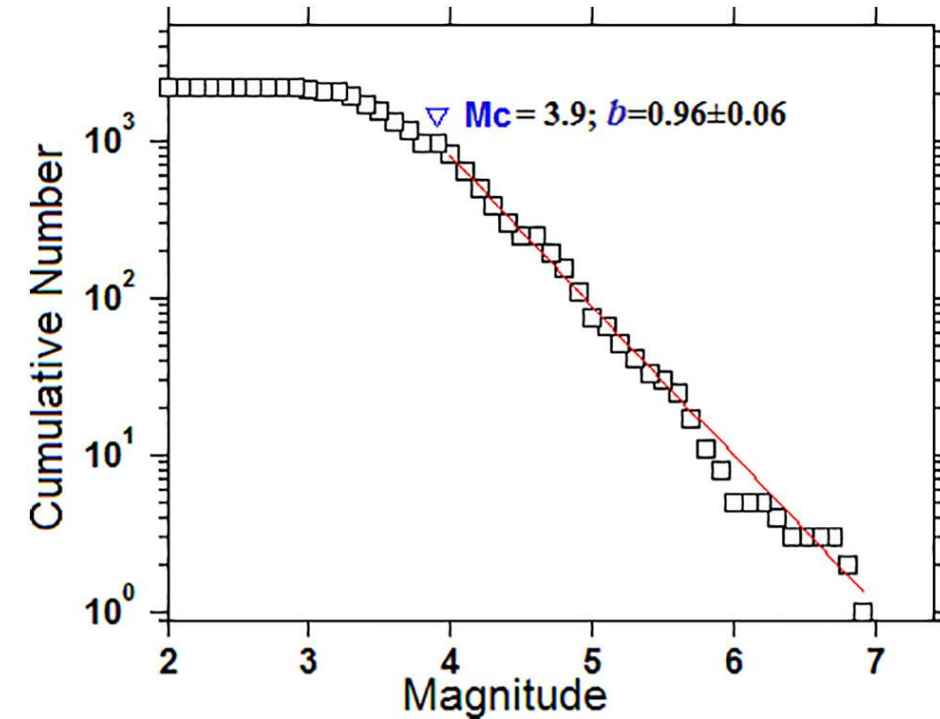
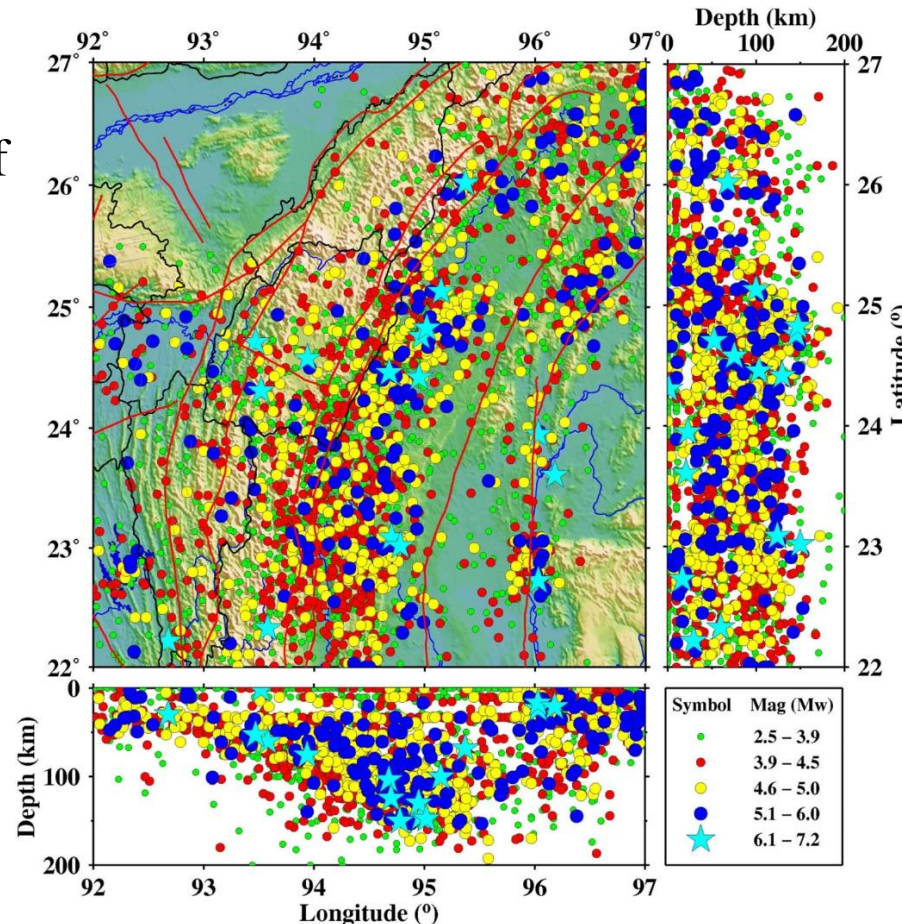


Figure 1: (a) Seismicity map of NE India, (b) Estimation of b-value (Bora et al. 2018)

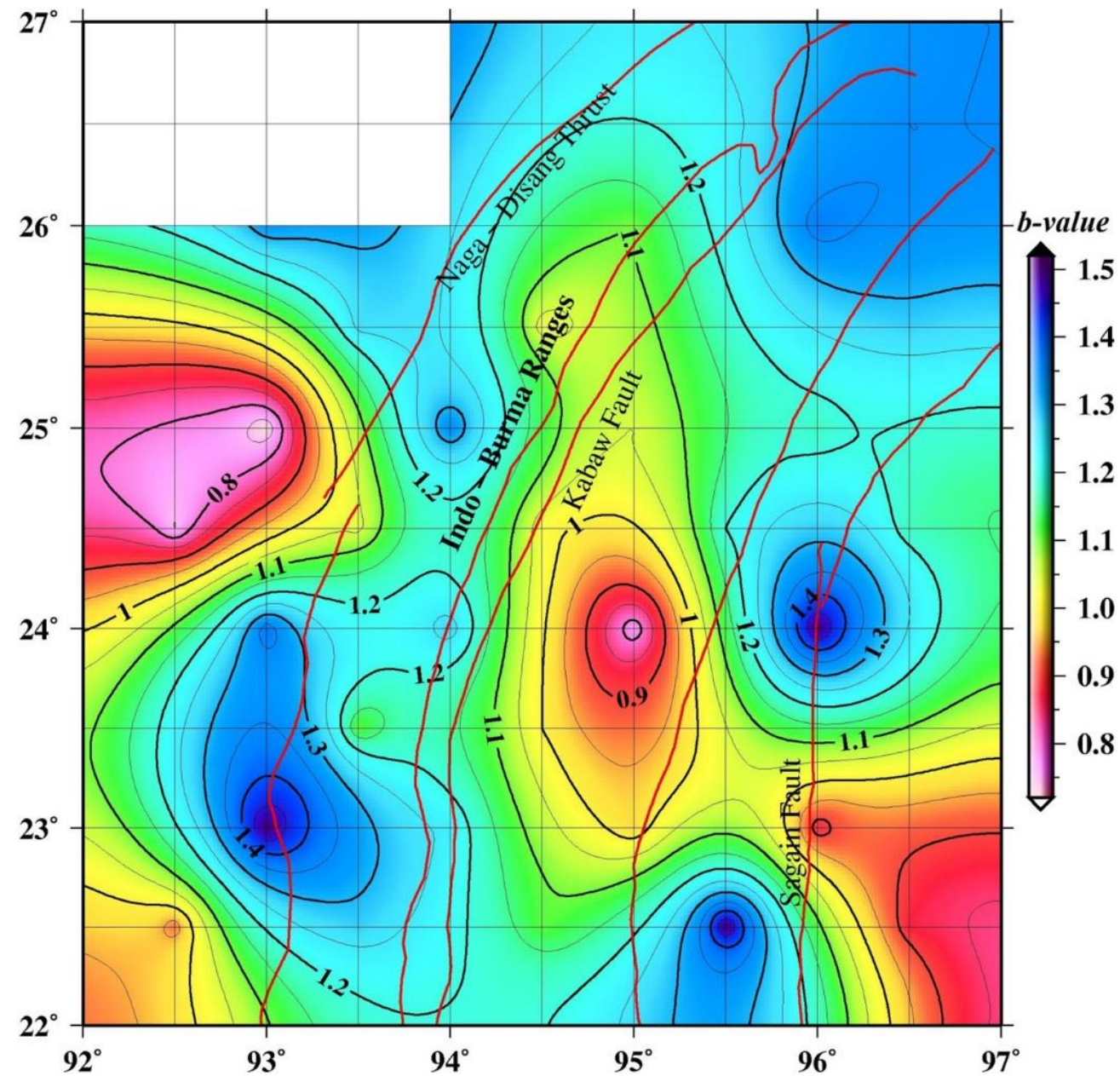


Figure 2: Contour plot showing the b-values of different regions of NE India (Bora et al. 2018)

Steps to Calculate the b-Value from an Earthquake Catalog

➤ Data Collection

(a) Access the ISC (<https://www.isc.ac.uk/iscbulletin/search/catalogue/>) or USGS (<https://earthquake.usgs.gov/earthquakes/search/>) earthquake catalog.

(b) Download earthquake data for the desired region and time period (Fig. 3).

(c) Ensure data includes earthquake magnitudes (e.g., Mw or mb).

➤ Data Preparation

(a) Select a magnitude range with complete data ($M \geq M_c$).

(b) Filter out magnitudes below the completeness level to avoid bias.

➤ Cumulative Frequency Distribution

(a) Plot $\log(N(M))$ versus M to visualize the distribution.

➤ b-Value Estimation

(a) Apply the Gutenberg-Richter Law: $\log N(M) = a - bM$

(b) Fit a linear regression to estimate the slope b (the b-value).

The screenshot displays the ISC earthquake catalog search interface. At the top, there are two radio buttons for 'Output format': 'CSV formatted catalogue' (selected) and 'QuakeML (XML stream)'. Below this is a section titled 'Choose search region:' with four radio button options: 'Rectangular search' (selected), 'Circular search', 'Global search', and 'Flinn-Engdahl region (only one option needed)'. The 'Rectangular search' option includes input fields for 'Bottom latitude (-90 to 90):', 'Top latitude (-90 to 90):', 'Left longitude (-180 to 180):', and 'Right longitude (-180 to 180):'. The 'Circular search' option includes input fields for 'Central latitude (-90 to 90):', 'Central longitude (-180 to 180):', and a 'Search radius:' field with a unit dropdown set to 'degrees'. The 'Flinn-Engdahl region' option includes input fields for 'Seismic region number (1 to 50):' and 'Geographic region number (1 to 757):'. Below the search region section is a 'Select time period:' section with input fields for 'Start date:' (year, month, day) and 'Time (HH:MM:SS):', and 'End date:' (year, month, day) and 'Time (HH:MM:SS):'. The 'Additional search parameters:' section includes input fields for 'Min depth (km):', 'Max depth (km):', 'Min magnitude:', and 'Max magnitude:'. It also has checkboxes for 'Include events with unknown depths:' and 'Include events with unknown magnitudes:'. There is a 'Magnitude type' dropdown menu (set to 'Any MB') and a 'Magnitude author:' dropdown menu (set to 'ISC'). At the bottom, there is an 'Output options:' section with a checkbox for 'Output links in the output.' (checked). A button labeled 'Output event catalogue' is located at the bottom right.

Figure 3. Input parameters screen for downloading earthquake data from the ISC catalog.