

Contents

Certificate	v
Acknowledgements	vii
Abstract	ix
1 Introduction	1
1.1 Overview and motivation	3
1.2 Evolution of the Himalaya	5
1.3 Tectonic or longitudinal classification	7
1.3.1 Higher Himalaya	8
1.3.2 Lesser Himalaya	9
1.3.3 Siwalik Himalaya	10
1.3.4 Indo-Gangetic Plains	10
1.4 Latitudinal divisions	11
1.4.1 Northwest Himalaya	11
1.4.2 Central Himalaya	13
1.4.3 Northeast Himalaya	14
1.5 Megathrust system of the Himalaya	16
1.5.1 Main Central Thrust	17
1.5.2 Main Boundary Thrust	17
1.5.3 Main Frontal Thrust	18
1.5.4 Main Himalayan Thrust	19
1.5.5 Out of sequence faults	19
1.6 Seismicity along the Himalaya	21
1.6.1 Paleo and medieval earthquakes	22
1.6.2 Pre-instrumental earthquakes	22

1.6.3	Instrumental earthquakes	23
1.7	Seismic gaps along the Himalayan arc	24
1.8	Thesis objective	25
1.9	Scope of the thesis	25
1.10	Structure of the thesis	26
2	Seismic Hazard along the Himalayan Arc: A Review from Geological and Geodetic Studies	29
2.1	Introduction	30
2.2	Seismic hazard along the Himalayan arc: An overview	30
2.3	Seismic hazard along the northwest Himalaya	35
2.3.1	Geological studies along the northwest Himalaya	35
2.3.2	Geodetic studies along the northwest Himalaya	38
2.4	Seismic hazard along the central Himalaya	44
2.4.1	Geological studies along the central Himalaya	45
2.4.2	Geodetic studies along the central Himalaya	47
2.5	Seismic hazard along the northeast Himalaya	51
2.5.1	Geological studies along the northeast Himalaya	52
2.5.2	Geodetic studies along the northeast Himalaya	53
2.6	Comparison of geologic and geodetic rates along the Himalayan arc . . .	56
2.7	Summary	60
3	GPS-Based Velocity and Strain Rate Field along the Himalayan Arc	63
3.1	Introduction	65
3.2	GPS overview	65
3.3	GPS network and data collection	69
3.4	GPS data processing	76
3.5	GPS time series and velocity field	81
3.6	Strain rate field along the Himalayan arc	101
3.6.1	Dilatation strain rate	103
3.6.2	Maximum shear strain rate	105
3.6.3	Rotation rate	106
3.7	Summary	107

4 Spatial Distribution of Fault Kinematics along the Himalayan Arc	109
4.1 Introduction	111
4.2 Dataset and study area	112
4.3 Methodology	114
4.4 Modeling results	117
4.4.1 Modeling results along the northwest Himalaya	120
4.4.2 Modeling results along the central Himalaya	127
4.4.3 Modeling results along the northeast Himalaya	132
4.5 Discussion	134
4.5.1 Along-strike slip rate distribution of the Himalayan megathrust system	134
4.5.2 Comparison of splay fault model and single fault model	136
4.5.3 Implication of seismic hazard along the Himalayan arc	146
4.6 Summary	148
5 Spatial Distribution of Earthquake Potential along the Himalayan Arc	151
5.1 Introduction	153
5.2 Study region and dataset	154
5.3 Methodology	155
5.3.1 Are the GPS-derived deformation signals comparable to the seismic signals?	156
5.3.2 Seismogenic source segmentation for the present analysis	157
5.3.3 Computation of seismic moment rate	159
5.3.4 Computation of geodetic moment rate	159
5.3.5 Computation of earthquake potential	160
5.4 Results and discussion	161
5.4.1 Moment rate ratio along the Himalayan arc	161
5.4.2 Earthquake potential along the northwest Himalaya (Sec-1 to Sec-13)	164
5.4.3 Earthquake potential along the central Himalaya (Sec-14 to Sec-22)	164
5.4.4 Earthquake potential along the northeast Himalaya (Sec-23 and Sec-24)	165
5.5 Sensitivity analysis	165
5.6 Summary	182

6 Contemporary Earthquake Hazards along the Himalayan Arc: A Statistical Perspective through Natural Times	185
6.1 Introduction	187
6.2 Study area and dataset	189
6.2.1 Northwest Himalaya	190
6.2.2 Central Himalaya	191
6.2.3 Northeast Himalaya	193
6.3 Formulation of earthquake nowcasting method	193
6.4 Results	200
6.4.1 EPS at several cities along the northwest Himalaya	201
6.4.2 EPS at several cities along the central Himalaya	202
6.4.3 EPS at several cities along the northeast Himalaya	203
6.5 Sensitivity analysis	206
6.6 Discussion	210
6.6.1 Validation of EPS in the northwest Himalaya	210
6.6.2 Validation of EPS in the central Himalaya	211
6.6.3 Validation of EPS in the northeast Himalaya	212
6.6.4 Regions of high seismic hazard from the combination of EPS and moment deficits	212
6.7 Summary	212
7 Conclusions and Future Work	215
7.1 Summary of work done	216
7.1.1 Regional GPS network and surface velocity field	216
7.1.2 Geodetic strain rate field	216
7.1.3 Slip rate distribution of the Himalayan megathrust system	217
7.1.4 Spatial distribution of earthquake potential	217
7.1.5 Earthquake potential score of populous Himalayan cities	217
7.2 Major findings of the study	218
7.3 Contributions through this research	219
7.4 Future scope of the present research work	220

A Supplementary information for Chapter 4	223
List of Publications	272
Presented Works	274
Brief Biography of the Candidate	276
Brief Biography of the Supervisor	277