Multi Hazard Risk Assessment for the State of Jammu and Kashmir

Data Inventory Report

November 2018

Prepared and Submitted by:
RMSI Private Limited, INDIA

For the attention of:

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Layout set to print on both side

Acknowledgements

RMSI project team acknowledges the support and guidance provided by the PMU, JFTRP, particularly CEO Dr. Raghav Langer, former CEO Er. Vinod Sharma, Director Disaster Management Shri. Shri Aamir Ali Director Planning and Coordination, and Shri. Iftikhar A. Hakim in data collection activities from various departments of the State.

We would also like to take this opportunity to acknowledge the support from the Divisional Commissioners (Kashmir and Jammu regions), Additional Deputy Commissioner Leh, and heads of various Line Departments in providing available data for the study.

We also extend our sincere thanks to the World Bank team for all the support and guidance provided to ensure that the project will benefit the state in the true spirit of its conception. We also acknowledge the support extended by the young and energetic disaster management professionals of the State Disaster Management Authority in data collection from various line departments.

Executive Summary

The Government of Jammu and Kashmir (GoJ&K) has entrusted RMSI to carry out this analytical study of conducting Multi Hazard Risk Assessment for the state and for developing an early warning system for hydro meteorological hazards. The objective of this assignment is to carry out hazard risk assessment using probabilistic and deterministic approaches and assess the risks, that will enable GoJ&K in formulating risk reduction plans and strategies. The expected outcomes of the study include analytical results in the form of reports, capacity building of state officials, a state-level Disaster Risk Database (DRDB), and an Integrated Operating Forecasting System (IOFS), which will help the state provide early warnings on impending hydro-meteorological disasters to Disaster Risk Managers and Agencies and the community at large.

The assignment is subdivided into seven components, with several activities that will be carried out in-parallel.

The first step of the assignment is to conduct an extensive desk research to understand the data availability, information available on hazard and risk assessment in the State, existing DSS and EWS, if any, already operational in the State, and the training and capacity building needs of the stakeholders.

The hazards considered for the study include earthquake, flood - including flash floods, drought, avalanche, GLOF, landslide, forest fire, urban fire, and industrial hazards. For key hazards – earthquake and flood, we plan to carry out probabilistic and deterministic modeling and for rest of the hazards, depending on the availability of historical event data, we will decide whether we should adopt a probabilistic or deterministic approach for assessing risks arising from the hazards in question.

For probabilistic hazard modeling, a stochastic scenario based approach will be adopted. Within the stochastic event set, we will also develop near-worst scenarios for all hydro-meteorological hazards based on climate change assessment. The impact of all the stochastic events will be estimated using the hazard models developed.

Exposure database development will be mainly based on data available with various State departments. However, critical data gaps will be filled using different methods using GIS and remote sensing techniques. The main elements of the exposure database will include demographics, buildings, infrastructure, critical facilities, utilities, agriculture and horticulture, cultural heritage sites, and ecological assets.

Vulnerability assessment will involve quantifying the damage susceptibility (physical, social, and economic) with respect to different parameters of each hazard. An analytical approach complemented by engineering analyses, along with expert judgment based on international experience and damage data of historical events, will be used for developing vulnerability functions. Sample survey of structures and households will supplement the data for physical and social vulnerability analysis.

Risk assessment shall be based on the hazard, exposure and vulnerability assessments carried out in the steps above. The spatial resolution of exposure data and some of the bio-physical data are critical to quantify risks at a micro-level. Risk analysis will be carried out in two broad categories: Direct Economic Losses and Social Impacts such as loss to livelihood etc. Direct economic loss will be calculated for every deterministic scenario as well as stochastic event and for all types of assets at risk, e.g., residential, commercial, and industrial buildings, essential facilities, infrastructure, agriculture/horticulture etc. Social impacts will quantify the susceptibility of the population to casualty and injuries, loss of livelihood, and essential needs like shelter, food, rescue/evacuation, etc. in the event of a disaster. Finally, risk metrics will be derived for all categories of assets including population. Using risk metrics, vulnerable hotspots will be identified and mapped.

A web-GIS based Disaster Risk Data Base (DRDB) will be developed customizing the World Bank's Geonode platform and extending it to support all the functionality needed for Disaster Risk Management/Reduction and Preparedness Planning. The DRDB will include various data sets used for analysis (hazard, exposure, and vulnerability) and analytical results - risk assessment maps. The database will provide a framework for decision support in evacuation planning, assessing shelter needs, etc.

The web-based IOFS will be developed in HEC RTS with provisions for taking real time input data like observed and forecasted rainfall, temperature, etc. from sources like IMD, JAXA, etc., to generate real-time analysis of an impending hydro-meteorological event. IOFS is expected to provide improved lead-time so that adequate precautions can be taken to avoid casualties and reduce damage.

Training and capacity building is a key component of the assignment. The training and capacity building activities will essentially emphasize on continuous interactions with the experts, hands-on exercise, etc. to ensure that all datasets and knowledge base generated as part of the study is transferred successfully to the user departments. As part of maintenance and support of the DRDB and IOFS, RMSI will provide 12 months' maintenance support.

The project outcome will help understand location-specific vulnerabilities and associated risks, and allow GoJ&K to undertake advanced mitigation and response planning in terms of deciding evacuation routes, ideal shelter locations, and preparing appropriate emergency preparedness plans.

This data inventory and data review report, the second deliverable of this assignment, provides the status of the data collected so far, identification of data gaps, strategies for filling the data gaps and methods to be undertaken in improving data resolution and quality.

The report provides the status of data collected during the last three months since its inception. The team has deployed its members at Kashmir, Jammu and Ladakh regions to collect secondary data from various line departments in the state. RMSI will also be using its in-house database library to enhance database required for the risk assessment and DRDB.

Table 1 provides the summary of data collected in terms of coverage, format, resolution, and vintage. It is important to assess all these aspects separately to make an appropriate plan for action to develop a high quality database, which will go as input data for the risk assessment exercise.

Table 1: Summary status of thematic data collected

Thematic data	Coverage	Format	Resolution	Vintage
Earthquake hazard				
Flood hazard				
Drought hazard				
Landslide hazard				
Avalanches				
GLOF				
Climate change analysis				
Forest fire				
Urban fire				
Industrial hazard				
Administrative boundaries				
Demography				
Building cluster/footprints				
Educational facility				
Health facility				
Fire station				
Police station				
Government buildings				
Cultural heritage/ religious places				
Road network				
Bridges				
Tunnels				
Airports				
Railway				
Potable water facilities				
Waste Water facilities				
Electricity infrastructure				
Telecomunication infrastructure				
Oil and Gas Infrastructure				
Agriculture				
Horticulture				
Livestock				

Availability index				
100%	75%	50%	25%	0%

It is explicit from Table 1 that we have reasonably good amount of data on hazards in terms of – coverage, format, resolution and vintage. Urban fire and industrial hazards are the two hazards which have relatively less amount of data. However, no industrial hazard events have been recorded in the state in the recent past. Any fire incidence in industries will be captured and analyzed along with urban fire hazard. There is some limitation in the spatial modeling of

urban fire hazards as the fire incidence events are available at fire station level and not at event location level.

As regards exposure data development, there is a serious dearth of geo-referenced data for several exposure assets. Particularly, data related to the utility sector - waste water and potable water facilities, telecommunication, and gas infrastructure. We have received transmission network and asset (substation) data of 30 towns in GIS format, which were surveyed under R-APDRP project. We also received town locations of all towers under BSNL. We are expecting to receive the asset details of BSNL from the department. The network data related to waste water and potable water is one of the key utility sector data missing and this will need to be made available for at least the key urban areas. We are planning to consult with engineers of respective departments, along with a detailed road map and construct at least the waste water and potable water facilities for the urban areas where the density of these assets is high. Other options for deriving data on potable water facilities include using village level aggregate data on drinking water connections and extrapolating the drinking water network along the road network. Information on other assets related to transport infrastructure and building clusters will be captured from high resolution satellite imagery and attribute information will be collected from respective departments for integration into the database.

Data for vulnerability assessment mainly comes from physical and social surveys, which we are anticipating to complete in the coming months. As part of the field reconnaissance survey, we have documented typical building types in the state and also compiled the building types from Census data based on wall and roof materials. While RMSI has structural damage functions developed for most of the typical structures in India, we will be revisiting these damage functions based on structures and historical damages in the state.

Data related economics, cost of construction of various assets are yet to be collected, which is required for risk assessment. We plan to collect this information early next year after the submission of the hazard assessment report.

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Abbreviations Used

ANSS	Advanced National Seismic System
ASC	Amateur Seismic Centre
BTS	Base Transceiver Station
CMIP5	Coupled Model Inter-comparison Project Phase 5
DEM	Digital Elevation Model
DSS	Decision Support System
DTM	Digital Terrain Data
ECMWF	European Centre for Medium-Range Weather Forecasts
EOC	Emergency Operation Centre
GEM	Global Earthquake Model
GIS	Geographic Information Systems
GoJ&K	Government of Jammu and Kashmir
GSI	Geological Survey of India
I&FC	Irrigation and Flood Control
ICAR	Indian Council of Agriculture Research
ICMOD	International Centre for Integrated Mountain Development
IMD	India Meteorological Department
ISC	International Seismological Centre
ISET	Indian Society of Earthquake Technology
LULC	Land Use Land Cover
MBT	Main Boundary Thrust
MCT	Main Central Thrust
MFT	Main Frontal Thrust
NEX-GDDP	NASA Earth Exchange Global Daily Downscaled Projections
NGRI	National Geophysical Research Institute
NRSC	National Remote Sensing Centre
NSDI	National Spatial Data Infrastructure
NSDI	National Spatial Data Infrastructure
NSDI	National Spatial Data Infrastructure
PDE	Preliminary Determination of Epicenters
SASE	Snow & Avalanche Study Establishment.
SICOP	Small Scale Industries Development Corporation Limited
SIDCO	State Industrial Development Corporation
SIDCO	State Industrial Development Corporation
SRTM	Shuttle Radar Topography Mission
SSDI	State Spatial Data Infrastructure

USGS	U. S. Geological Survey
WRF	Weather Research and Forecasting

Section 1: Background

Introduction

The State of Jammu and Kashmir is prone to a number of natural hazards, both geological and meteorological. Climate change is potentially further accentuating the impact of these hazards. Additionally, the developmental activities in the Himalayan terrain are also increasing the occurrence of hazards like landslides, floods and inundation, and urban as well as forest fire related incidents, to name a few. In recent years, the State has witnessed several natural disasters, including earthquakes, landslides, and floods and flash flood, which have led to loss of life and damage or loss to assets.

As an initiative towards reducing the risks from these natural hazards, the Government of Jammu and Kashmir (GoJ&K) commenced the Jhelum and Tawi Flood Recovery Project in 2015, with financial support from the World Bank. The project development objectives are to support recovery and increase disaster resilience in project areas, strengthen disaster risk management capacity, establish a robust Decision Support System (DSS) at the State Emergency Operation Centre (EOC) and provide technical support for risk reduction and response preparedness activities.

Under the Jhelum and Tawi Flood Recovery Project, GoJ&K has engaged RMSI Private Limited, India to carry out the present multi hazard risk assessment for the entire State. This Data Inventory and Data Review report is the second deliverable of the assignment. The report covers the status of the data collected so far from various sources, critical data gaps, and strategies proposed to be used to fill the data gaps. It is important to note that high resolution, good quality geo referenced data is required for developing a good risk assessment database at village level. This section discusses the activities that were performed to obtain various datasets from secondary sources.

Desk Research for identification of Data Sources

As a first step of this identification of data sources, the team conducted an extensive desk research keeping two key objectives in mind:

1. Find what all data available in the public domain can be utilized for this assignment
2. Find out publicly available data in the form of published reports or databases on websites of various state or national agencies

On the basis of this desk research, RMSI team created a catalog of datasets that are available in the public domain and which can be obtained directly. We leveraged our past experience in executing similar projects and most of the data available in the public domain for risk assessment, particularly for India, is archived in RMSI data library. This made our task to organize public domain data required for this assignment easier.

Similarly, basis the desk research, the team created an initial list of all the agencies that had to be contacted for various datasets. This list was further discussed with the PMU and finalized into a list of state agencies to be approached for data collection. The details of agencies consulted for data collection and the status of data received so far is provided below in Table 1.

The key sources for secondary data for hazard and exposure include different State and National organizations, and academic publications detailed in the subsequent sections. We also carried out desk research to document localized hazard events and loss information. However, we mainly relied on hazard impact (deaths, affected population and economic losses) information based on the records of the Revenue Department and District Administrations.

For the exposure database, there is a dearth of geo-referenced data of assets in the State. Some asset details have got pin code-level details and we are planning to geo-reference these since it is very critical to have all the exposure information in GIS with coordinate information.

Stakeholder Consultations and Data Collection

RMSI had a series of consultations with various stakeholders as part of the data collection exercise. Based on the data received, we have presented below the data status and gaps of different hazards and exposure in the subsequent sections. Some of the line departments are presently coordinating with the districts and divisional offices to get the data compiled. Department of Ecology and Remote Sensing has developed State Spatial Data Infrastructure (SSDI) and has several layers, which will be useful for exposure database development. During the inception report presentation on Oct 01, 2018, the officials of Department of Ecology and Remote Sensing communicated that they will seek permission from National Remote Sensing Centre (NRSC) and enter into an agreement with the State to share data. The data with several line departments are not available in digital format in a centralized place, making data collection more time consuming than anticipated.

Table 2: Summary status of organizations visited for data collection

S. No	Name of Organisation	Type of data/info collected	Contact person details	Number of visits
Jammu Region				
1	PCR Jammu	Police station & choki locations. No buildings, types and human resources working in the building	Kulbir Singh (SP) phone: 9419190200	2
2	PWD Jammu	No data received	SE N.D. Khawaja (94191880066)	2
3	Fire department	Event wise data for last 10 years received	Ramesh Raina (Dy. Director) phone 9419621369, Mr. Manoj Kumar (9469162054) nodal officer	
4	Town Planner, Jammu	Land use cover map in GIS for Jammu, Katara, Udhampur, Doda, Kathua, Riyashi	Anil Raina phone 9419191462, Sunil Nagari-9419192035	2
5	Animal Husbandry Department	Animal count Census 2011, district level	Dr. F.A. Kichloo phone 9419236474	

S. No	Name of Organisation	Type of data/info collected	Contact person details	Number of visits
6	Soil & water conservation	Soil map in hard copy 1:250k	Jt. Dir. Shaveta Jandial, phone 9419172132	
7	Horticulture Jammu	District level key horticulture data	Joint Director Tarvinder Singh, phone 9419125154	
8	Director, Industries & Commerce. Jammu	Received list of hazardous industries.	Dr. R.S. Sharma, phone 9419036354, Vikas Gupta	3
9	JKPCC, Jammu	Provided three geo technical reports	Executive Director, R.K. Makroo, phone 9419191289. Nodal officer Mr. Pradeep Sharma (9419129878)	
10	Director, Health	Not received any data so far	Dr. Gurjeet Singh, Dr. Sanjeev Puri:9419132864, dhsjammu@rediffmail.com b) Dr. Girish: 9419193063	4
11	Forest Department, Jammu	Forest fire events of last 10 years, compartment boundary for Jammu and forest cover map of entire state. Event data missing in some compartments	B. Mohan Dass, Conservator of Forests, phone 9906077183, Rakesh Verma-9419613844	4
12	IOCL	IOCL location address list	Sr. Manager (RS) Rakesh Roshan, phone 9419113567	2
13	I&FC	Flow data of last 20 years of Rabir canal, and 10 years flow for Udampur station	J.S. Chib, SE, HYDERO, Circle Jammu, phone 9419135085	4
14	Tourism	List of registered hotel with category and address	Dy. Dir. Subah Mehta, phone 9419145837, Dr. Rajesh: 9906045432	3
15	Handloom	District level total number of weavers provided	Jt. Director -Namirita	2
16	Tourism Corporation, Jammu	Asset details, Insurance value, Structure type of property owned	Vinakshi Kaur GM—Tourism, phone 9419212447, Ashwani Gupta: 9419212454	
17	Geological Survey of India	1:250K Geology Map of the J&K. Visited GSI Jammu and submitted a letter for 50K data in GIS form	Freely available data downloaded from the GSI portal	1
Kashmir Region				
18	I&FC, Kashmir	Hydrology data of Jhelum river and tributaries. Cross sections and L sections	Mutayib Bashir (AEE) 9419405100 email: mutayibshah@ifckashmir.com, and Shabeer Alangir (AEE) 9419066611	5

S. No	Name of Organisation	Type of data/info collected	Contact person details	Number of visits
		data of main channel (CAD form)		
19	JKPCC	Geo technical investigation reports of selected sites (4 locations)	Er. Suhail Baidar (Technical Officer to MD): 9419009744 and email: info@jkpcc.com, Er. Naved Aslam (phone 9419762448) appointed as nodal officer of this assignment	4
20	PWD (R&B)	No data received. Told they don't have any road bridge data available	Er. G.M Wani (Technical Officer to CE): 941901314, email: cepwdrnb@gamil.com	2
21	Lake and Waterway Authority (LAWDA)		Ms. Ismat Bhat Ishtiyaq 9419074536	2
22	Department of Agriculture	10 years crop data for entire state	Technical officer Suhel provided the data (phone - 9419005890)	4
23	BSNL	Provided tower locations of BSNL for whole state	General Manager Mr. Mufti. Shanawaz was nominated as nodal officer Phone 9419020115	5
24	Department of Health	List of private hospitals and govt. hospitals received with address.	Director General Dr. Saleem Ur Rehman and team. Nodal officer - Mr. Malik Sohail	4
25	Srinagar Development Authority		Vice Chairman and his team including Senior Town planner. Farzana Naqushbandi phone: 9419553470, 9797323355, Senior town planner SDA. Email: srinagardevelopment authority@gmail.com.	1
26	Directorate of Samagra Siksha, J&K State	Details of all schools in the State. There are some quality issues with location details and yet to be shared	Mr. Mustaq Ahmed (Field Officer) phone 9419008076	4
27	Department of Forest, Kashmir	Fire incidence data for last 10 years at compartment level. Only data received for 50% compartments	Chief Conservator Forests Kashmir Mr. SFA Gillani and his Sub Divisional Conservators (4)	6 (Made several phone calls)
28	Industries Department, Kashmir	Details of industrial units of one district received. Rest not received	Mr. Bilal Ah Bhat, Director Industries Kashmir. Mr Mohamad Amin in the department, E-mail id- industriescommerceplan@gmail.com and cell number - 9469386679	8 and phone calls

S. No	Name of Organisation	Type of data/info collected	Contact person details	Number of visits
29	PHED Kashmir	Though officer told there are is geo tagged data, this has not been received. Officers we need have been transferred	Chief Engineer Mr. Abdul Wahid	3
30	Department of Ecology and Remote Sensing	Provided GIS data of forest fire modis data (2000-2016). Provided Tiff file data of vegetation cover in J&K (mapped in year 2000 using LISS-3 images) in association with IRS Dehradun. Additional data expected land use map of 10k, road network and administrative boundaries in GIS	Mr. Majid Farooq, 9419551345. Nodal officer Mr. Javeed Scientist	6
31	SICOP	Promised to give location map of industrial estate in GIS	MD, SICOP J&K	4
33	JKPDD	GIS format data of Power substations, other assets, and transmission network for 30 towns	Chief Engineer, EM&RM, PDD. Mr. Ajaz Kirmani (AEE), Phone 9419409988	2
34	PMU	Traffic, drinking water, drainage data of Srinagar in GIS format	Iftikhar A Hakim/Sajjad	
35	Indian Meteorological Department	Daily weather data for entire J&K for last 30 years, locations of all rain gauge stations and AWS stations. EQ data for last 100 years	Mr. Sonam Lotus, Director IMD, phone 9419242642	2
40	Revenue Department	Event wise loss data for 10 years for two districts		2
41	Fire & Emergency Services, J&K	Not received so far	Mr. Shah Bashir	2
42	Industries Department Kashmir Jammu & Kashmir State Industrial Development Corporation Ltd. (J&K SIDCO)	Industries data including hazardous industries	Mr. Bilal Ah Bhat, Director Industries, Kashmir	4

S. No	Name of Organisation	Type of data/info collected	Contact person details	Number of visits
43	University of Kashmir	Glacier lake boundaries, road network, cluster built-up of selected wards of Srinagar, land use map of Kashmir	Prof. Shakil Ahmad Romshoo	Shared in email
Ladakh Region				
44	I&FC Leh	Discharge data for one station (Stakna) 20 years	Mr Vijay Khajuria, EE	1
45	PWD (Leh)	Details of bridges, repair duration, cost of construction received	Mr Shameem, AEE Construction	1
46	Divisional Commissioner Office	Information related to infrastructure available in the EOC in Leh and information on 2010 cloud burst	Mr Kunzang Mozes –Additional Deputy Commissioner, Mr P. Paldan, Scientist –D, NIC. Email id-leh@nic.in Cell number-949176566 01982-252632.	1
47	JKSPCDC	Information of electrical infrastructure in Leh	Mr Paljor Leh circle, phone - 9419179868, EE Sub transmission division Mr Spalzan Phone: 9419177464	1
48	Geological Division, Srinagar, JKSPDC	Geological and Geotechnical reports of various Engineering Projects taken up by Geological Division, JKSPDC	Chief Geologist & Divisional Geologist	2

Data Standard and Quality Assurance Framework

Standardization of data facilitates data sharing and increases interoperability among Geographic Information Systems (GIS). For the present project, the team intends to follow data standards laid down and followed by National Spatial Data Infrastructure (NSDI), India and SSDI, which is supposed to be followed by all the States in the country. The Department of Ecology and Remote Sensing has developed the SSDI, but we didn't get access to this and don't have an understanding of the structure and data they have in this system.

In addition to the SDI standards, which mainly define data standards for the exposure database, we will also review some hazard risk decision support system databases implemented elsewhere to benchmark the data standards to be used in the proposed DRDB.

The purpose of the Data Content Standards is to:

- Provide common definitions for geo-spatial information found in public records, which will facilitate the effective use, understanding, and automation of business processes
- Standardize attributes that will enhance data sharing
- Resolve discrepancies related to the use of homonyms and synonyms in the datasets of various organizations/agencies, which will minimize duplication within and among them
- Provide guidance and direction for geo-spatial professionals on standardized attributes and definitions, which will improve data creation and their management.

Administrative Boundaries Used for Database Development and Analysis

It is critical to follow a common boundary system for database development and analysis and this is critical for subsequent data updation including for field-based information. There are two key considerations while finalizing the boundary system for database development.

1. The International boundary and the Line of Control: We are following the international boundary line and Line of Control as defined by Survey of India (SOI), the Apex mapping agency of the country.
2. Administrative boundaries: Administrative boundaries include national, state, district, tehsil, and village boundaries. SOI map has administrative boundaries up to district level. However, tehsil and village boundaries are not available in any of the published SOI maps. We approached different State level departments to see whether any of them are using a standard boundary, including Department of Ecology and Remote Sensing, University of Kashmir, etc. We got a village boundary file in GIS format from University of Kashmir for Srinagar only, which is not matching with the SOI district boundaries. Moreover, for more than 50%, village polygon names are not available.

For exposure analysis, Census of India data for demography, occupancy classification, and amenities are used. Census provides these data in tabular format at village level. To know the spatial locations of these data, it is required to attach these data to village boundaries.

Since none of the departments have provided standard data for village and tehsil boundaries, the project team is planning to use census map for creation of village and tehsil boundaries.

Projection and Datum: We will be using UTM Zone 43 N projection with datum WGS 84 for the GIS database, which is accepted and followed by SOI.

Section 2: Data for Hazard Assessment

Data for Hazard Assessment

The hazard data mainly includes historical hazard event data (hazard catalogue), and biophysical and socio economic data that will go into the model for hazard assessment. All data essentially needs to be in spatial database format or with coordinate information to ensure spatial analysis. Compilation of the hazard database will cover all the hazards considered for this study and use various data sources including State and National organizations/agencies, and international and open source databases.

Earthquake Hazard

The Himalayan mountain range and Tibetan plateau have formed as a result of the collision between the Indian Plate and Eurasian Plate, which began about 50 million years ago and continues today. Global Positioning System (GPS) measurements show that approximately half of the convergence between India and Eurasia is currently absorbed within the Himalayas at rates of close to 20 mm per year but this convergence rates reduce westward to 12 mm per year in Kashmir Himalayas (Stevens and Avouac, 2015[1]). The present-day structure of the Himalayas is characterized by the existence of 3 major thrusts, namely, the Main Frontal Thrust (MFT), the Main Boundary Thrust (MBT), and the Main Central Thrust (MCT). These thrust systems, which demarcate distinct lithological formations all along the Himalayas and are also present in the northwestern Himalayas.

Several large damaging earthquakes, including the April 4, 1905 Kangra earthquake and the recent October 08, 2005 Kashmir earthquake, have struck the region in and around J&K State since historical times. The region between the rupture zones of these two great earthquakes is recognized as the *Kashmir seismic gap* that are interpreted to have accumulated potential slip for generating future great earthquakes. With the growth of population and infrastructure, seismic vulnerability has increased and previous earthquakes have provided only a glimpse of the devastating potential of large damaging earthquakes. If these earthquakes repeat again, there would be significant loss of life and property (Wyss et al., 2017[2], 2018[3]) in the J&K State and nearby areas.

The Kashmir valley located in NW Himalayas lies between the Pir-Panjal and the Zanskar thrusts, making it vulnerable to earthquakes. It has experienced frequent moderate to large earthquakes in the historical past. As mentioned above, the State falls under *Kashmir seismic gap*, which is one of the highest earthquake prone areas of the Himalayan belt. As mentioned earlier, several active faults exist along the Himalayan collision zone - particularly bigger ones such as the MBT, MCT and MFT. The 1905 and 2005 earthquakes originated in a similar seismotectonic setting over the ramp of the MHT under the Dhauladhar–Pir Panjal range,

[1] Stevens, V. L., and J.-P. Avouac (2015). Interseismic coupling on the main Himalayan thrust, Geophys. Res. Lett. 42, 5828–5837.
[2] Wyss, M., Gupta, S., Rosset, P. 2017; Casualty Estimates in Two Up-Dip Complementary Himalayan Earthquakes. Seismological Research Letters; 88 (6): 1508–1515. doi: https://doi.org/10.1785/0220170091
[3] Wyss, M., Gupta, S., Rosset, P. 2018; Casualty Estimates in repeat Himalayan earthquakes in India, Bulletin of the Seismological Society of America, DOI: 10.1785/0120170323, Sept 2018.

which is consistent with a model proposed for such type of Himalayan earthquakes (Mugnier et al., 2013[4]; Thakur and Jayangndaperumal, 2015[5]; among several others).

EARTHQUAKE CATALOGUE DATA

The history of reported earthquakes goes back to 2082-2041 BC in Jammu and Kashmir region (Ahmad et al., 2009[6]). However, details of their location and intensity are not available and hence may not be included in hazard modeling. The other subsequent bigger earthquakes reported are of 50 AD, 180 AD, 818 AD, 844 AD, 1052 AD, 1123 AD and so on. Ahmad and Shafi (2014[7]) further reported an account of earthquakes that reportedly occurred during the medieval period. A more detailed account of damaging earthquakes started from 15th century onwards. The 1555 earthquake event has been studied by several authors, as it caused significant damage in Kashmir valley (Ambraseys and Douglas, 2004[8]; Kaneda et al., 2008[9]; Mugnier et al., 2013[10]; Thakur and Jayangndaperumal, 2015[11]). Several missing earthquakes of the 18th century were reported by Ahmad et al. (2015)[12].

The earthquake catalog has been compiled and collated from different sources, including published research papers on specific earthquake events by different researchers. Different historical earthquake catalogs cover different periods, which are available from various catalogs and research papers. Some of the sources (apart from those mentioned above), which were used for the compilation of the earthquake catalog are:

- The Preliminary Determination of Epicenters (PDE) Bulletin
- Significant Earthquake Archive - Earthquake Hazards Program – USGS
- The Advanced National Seismic System (ANSS) Comprehensive Catalog
- The International Seismological Centre (ISC)- Global Earthquake Model (GEM) Global Instrumental Earthquake Catalogue (1900-2009)
- ISC-GEM Global Instrumental Earthquake Catalogue, Version 5.1
- The Amateur Seismic Centre (ASC), Pune
- The National Geophysical Research Institute (NGRI), Hyderabad
- India Metrological Department (IMD), Srinagar and New Delhi

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[4] Mugnier, J.-L., Gajure, A., Huyghe, P., Jayangndaperumal, R., Jouanne, F. and Upreti, B. N. (2013). Structural interpretation of the great earthquakes of the last millennium in the central Himalaya. Earth Sci. Rev., 2013, 127, 30–47.

[5] Thakur, V.C. and Jayangndaperumal, R. (2015). Seismogenic active fault zone between 2005 Kashmir and 1905 Kangra earthquake meizoseismal regions and earthquake hazard in eastern Kashmir seismic gap, Current Science, Vol. 109, N0. 3, 610 -617, 10 August 2015.

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- The Indian Society of Earthquake Technology (ISET) earthquake catalog
- Seismotectonic Atlas of India.

However, due to limitations in the availability of seismographic stations, which were in use during the early times, there might be inaccuracies in some of the earlier earthquake event source parameters. Such errors would be more in historical earthquakes and lesser and lesser in the instrumental part of the catalog as seismographic station density increased with time, especially for the events occurring in the last two decades. Figure 1 provides some of the major earthquake events, which occurred in and around J&K since the late 15th century. Generalized epicenter locations of historical events have been provided.

Past observed seismicity approximately 500 km in and around J&K (latitude 28º- 40ºN and longitude 68º-86ºE) has been compiled. The compiled earthquake event catalogue is presented in Annex-1. In order to ensure the quality of both international and local databases (e.g. the quality of location and magnitude uncertainties), this will be processed using standardized processes (e.g. magnitude conversion, removing duplicated events, removing foreshocks and aftershocks, etc.).

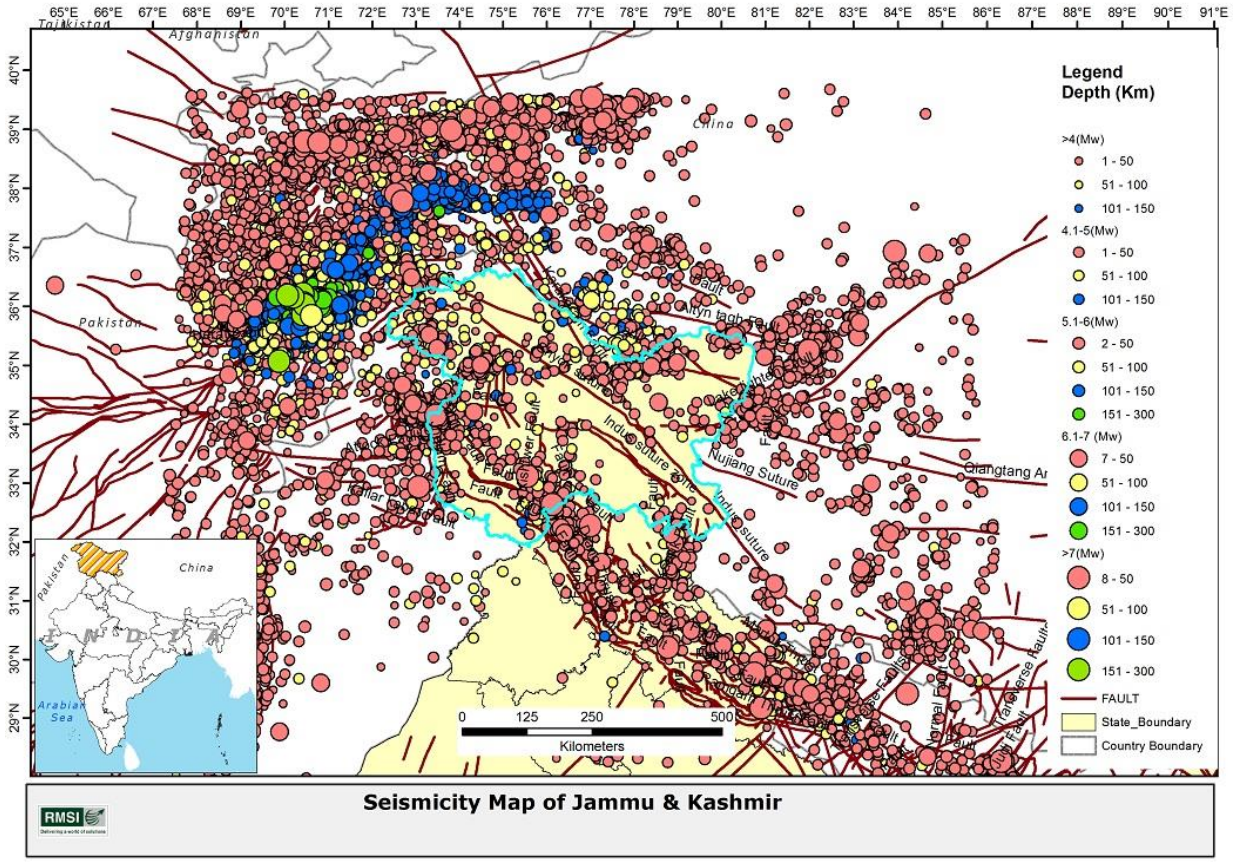

Figure 1: Seismotectonic map of J&K and surrounding area (50 AD to 2018)

Microearthquake Data

Microearthquake data is very helpful in understanding the current seismic activity on a fault or in identification of unknown/ buried faults. Efforts are being made to collect micro earthquake data (M < 3.0) from different sources. The one key source we came to know is from Jammu University broadband seismographic network, which has been running in the State for more than a decade under the aegis of the Ministry of Earth Sciences, Govt. of India. We have sent several communications to the Principal Investigators of this project. However, so far we have not received any data.

Mir et al. (2017) in his paper has delineate the crustal structure beneath the Kashmir Basin along with micro earthquakes recorded (*small Red Circle with CS symbol*, Figure 2). Further details about the period of recording and network details of microearthquakes are not available in the paper and we have requested the first author of the paper to share the digital file of microearthquake data.

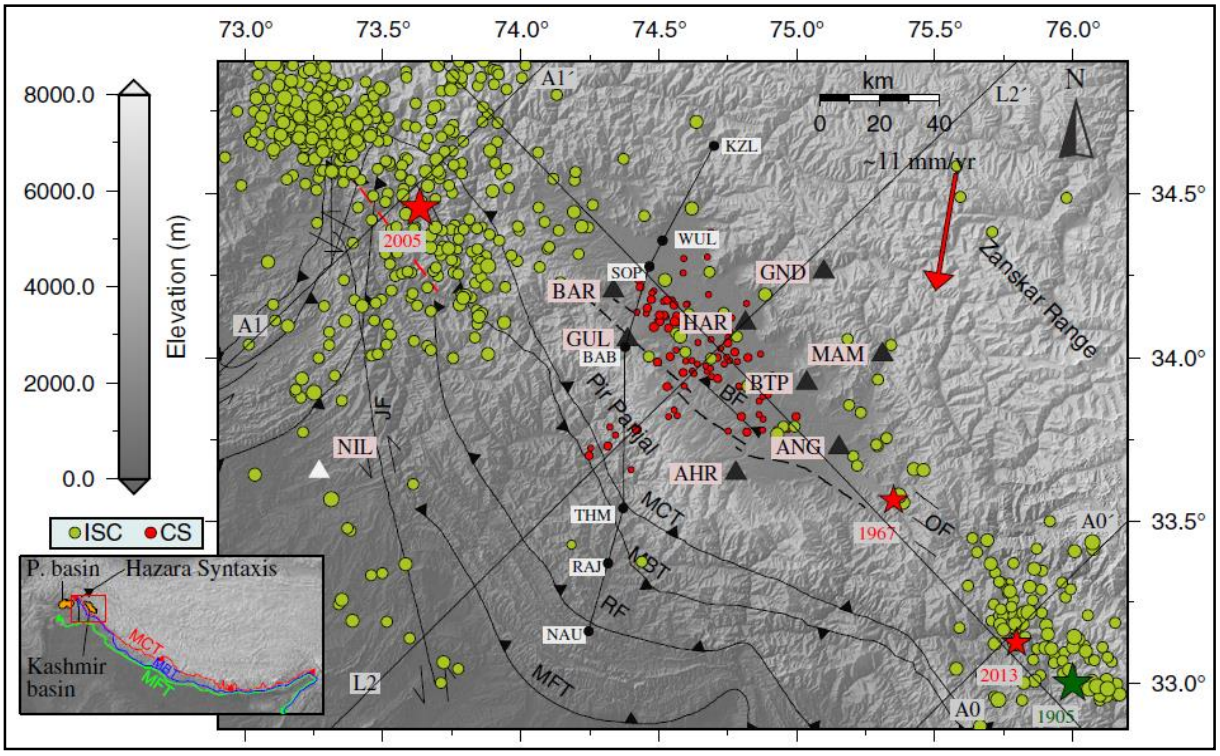

Figure 2: Seismicity and tectonics in and around Kashmir basin (red dots depict microearthquakes)

The data of seismic sources (both active fault lines and area sources) in and around J&K will be reassessed based on literature reviews and interpretation of geological evidence. The long term slip rates and estimates of earthquake sizes from paleo seismological studies will be incorporated since the historical seismicity alone might not reflect the earthquake hazard, especially at long return period (e.g. 2,475-year return period).

Strong Motion Time History Data and GMPEs

Strong Motion Time History data are critical data for the development as well as selection of suitable Ground Motion Prediction Equations (GMPEs) from other similar regions of the world. In Jammu and Kashmir State, very limited data has been recorded due to non-availability of a dense network of digital accelerographs. However, surrounding areas have recorded limited strong motion records. Many strong motion records that are available from the State and surrounding areas, including strong motion records from the 2005 earthquake, will be considered. These records were collected and reviewed along with other associated details (earthquake parameters, source type, site conditions of the recording stations, data processing procedures, etc.).

Table 3: Significant earthquakes in Jammu & Kashmir

Date	Epicenter		Affected Area	Casualty and Economic losses (INR)	Magnitude (M)	References
	Long (E)	Lat (N)				
Sep 1555	75 .5	35 .5	Kashmir valley and surrounding areas. Earthquakes continued for several days - landslides and liquefaction	Significant damage to life and property. 600 deaths reported alone at Khandanyar	7.6	Bashir et al. (2009)
23 Jun 1669	73 .25	33 .3		Not much loss of life occurred or was reported	8.0	Bashir et al. (2009)
26 Jun 1828	74 .83	34.08	Srinagar area	The earthquake destroyed some 1,200 houses and perhaps 1,000 persons died. For the next two months, there were about 100-200 or more aftershocks in a day, all accompanied with explosions.	6.0	Vigne (1844)[13]
30 May 1885	74 .38	34.6	NW of Srinagar	Reported causalities vary from 3,000 to 3,500. 67.33% of total human population died in Baramulla district alone. About 30,000 animals (20,000 horses and 10,000 cows, oxen, ponies and other domestic animals) were killed. Around 300 to 400 houses were damaged. The royal palace at Shergarhi also suffered damage.	6.3	Jones (1885); Ambraseys and Douglas (2004)
4 Apr 1905	76 º	33 º	Jammu and Kashmir, Kangra Valley and Himachal Pradesh	At least 20,000 people and 53,000 domestic animals were killed. As many as 100,000 buildings were reported to have been damaged. There was also major damage to the network of hillside aqueducts that fed water to the affected area. The total estimated damage was to the tune of INR 2.9 million(1905 Rupees)	7.8	Ambraseys and Douglas (2004)

[13] Vigne, G.T. (1844) Travels in Kashmir, Ladak and Iskardo, the countries adjoining the mountain course of the Indus, and the Himalaya, north of Panjab, with map, 2nd edn, vol. 1, p 406. H. Colburn, London

Date	Epicenter		Affected Area	Casualty and Economic losses (INR)	Magnitude (M)	References
	Long (E)	Lat (N)				
12 Sep 1981	73.59	35.69	Gilgit Wazarat	At least 220 people were killed and 2,500 were injured in the Gilgit region. There were also unconfirmed reports of surface faulting. The shock was felt in Srinagar (J&K, India) and in Peshawar and Rawalpindi (Pakistan).	6.3	
8 Oct 2005	73. 62	34.49	Pakistan, Northern India, Eastern Afghanistan	Earthquake-triggered landslides destroyed many houses on hillsides and blocked roads. 80,000 deaths were reported	7.6	
26 Oct 2015	78 .15	37.45	Hindukush mountain region of Afghanistan	This earthquake caused damage to property. Cracks appeared in most multi-storied public and private buildings but no loss of life occurred	7.5	

OTHER COLLECTED DATASETS AND GAP ANALYSIS

Table 4: Status of datasets for earthquake hazard assessment

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Remarks
1	Geological and Paleo-seismologic investigations data	WIGH, Kumar et. al. (2006)[14]	-	-
2	Micro earthquake monitoring data	Jammu University under Ministry of Environment and Forest (MoEF) program	From 2000 to recent	We are yet to get this data from the University
3	Active Fault Data including their dip, strike, and length	Based on published papers	-	We are planning to carry out some field investigations as well
4	Fault-plane solutions	Based on published papers	-	We are planning to carry out some field investigations as well
5	Strong Motion Time-History data	IMD and IIT Roorkee	-	Due to limited strong motion seismic instrumentation in the state, only a few records are expected. We are yet to get this data
6	Integrated Map of Vs30 values	JKPCC (geo technical data)	-	No cross-hole seismic surveys have been conducted in the State, hence, the available geotechnical data from JKPCC will be used to derive Vs30 values at different locations
7	GPS Strain Measurements Data	CMMACS Bangalore	-	We are yet to get this data. However, we collected a few research papers as referenced

[14] Kumar, S., S. G. Wesnousky, T. K. Rockwell, R. W. Briggs, V. C. Thakur, and R. Jayangondaperumal (2006), Paleoseismic evidence of great surface rupture earthquakes along the Indian Himalaya, J. Geophys. Res., 111, B03304, doi:10.1029/2004JB003309.

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Remarks
8	DEM	USGS	2000	Open source data. The best high resolution DEM available.
9	Geotechnical investigation report	JKPCC	Different locations during the last 10 years	We have received 3 such reports from Jammu and the rest are awaited

Landslide Hazard

HISTORICAL EVENT DATA

Based on desk research - review of technical reports, GSI publications and media articles, information related to some of the key landslide events that took place in the recent past in the state was compiled. The team has also identified landslide locations using temporal satellite data.

In addition to these, team is interacting with the revenue department to collect landslide event information from different districts as districts pay compensation for any damages to private assets due to landslides. The compiled historical landslide events and their impacts are provided in

Table 5, which presents landslide locations in the state compiled from various sources.

Table 5: Catalogue of historical landslide events

S. No	Date	Affected area	Casualties	Impacts, other than casualty
1	20-Aug-18	Kishtwar	4	Huge boulders and debris came down hitting mini-bus and a car (both vehicles damaged) plying on the Doda-Kishtwar road leading the casualty and injuring one person.
2	20-Aug-18	Kulligad, Kishtwar	4	1 person injured
3	21-Jul-18	Banihal		Hundreds of vehicles, including a Jammu-bound convoy carrying Amarnath pilgrims, were stranded. Incident happened during heavy rains
4	15-Jul-18	Doda-Kishtwar Highway	7	12 person injured
5	16-Jun-18	Peddar Tehsil, Kishtwar	3	Five children injured. The landslide hit the shack on the road side causing death and injury of people living in it.
6	31-Mar-18	Ladden Chadoora, Budgam	16	Traffic disrupted for over 10 days
7	3-Mar-18	Panthal stretch, Ramban	2	One car was badly damaged by the landslide. The Jammu-Srinagar highway was closed to traffic for almost a day due to landslide.
8	13-Aug-17	Panthal-Batote-Doda-Kishtwar		Fresh snowfall around Jawahar tunnel and landslides at Digdole and Panthal resulted in closure of the 294-

S. No	Date	Affected area	Casualties	Impacts, other than casualty
				km Srinagar-Jammu highway. About 30-40 vehicles were stranded at different places on the highway
9	21-Jun-17	Bali Nallah, Udhampur		Over 200 vehicles were stranded at various places on the highway
10	13-Mar-17	Panthal, Ramban		The Jammu-Srinagar highway was closed to traffic for over 3 days.
11	20-Feb-17	Ramban		The Jammu-Srinagar highway was closed for traffic due to multiple landslides.
12	5-Feb-17	Ramban and Digdol		Over 2,000 vehicles, including trucks loaded with essentials and tankers, were stranded on the highway due to the landslide.
13	17-Mar-16	Batote-Doda National Highways	5	Five injured due to landslides triggered by incessant rain
14	22-Sep-15	Banihal		Jammu-Srinagar highway was closed for traffic for 3-4 days due to landslides triggered by heavy rainfall.
15	26-Jul-15	Baltak road, Ladakh Highway		Ladakh highway and the Baltak road for Amarnath pilgrims got washed away at many places leading to massive blockages after landslides triggered by cloudbursts.
16	26-Feb-15	Banihal	2	Two seriously injured and a vehicle totally damaged on the Jammu-Srinagar highway
17	19-Jul-11	Doda	3	-
18	9-Jun-11	Kishtwar	3	Eight shops and 10 kiosks destroyed, dozen vehicles damaged
19	18-Apr-11	Phimram Shangus	5	All the 5 killed were of one family and another person was injured by this landslide triggered by heavy rain
20	4-Mar-11	Uri	1	Four houses damaged
22	14-Feb-11	Ramban		About 1,200 vehicles stranded as Jammu-Srinagar highway was closed for traffic after flash floods and heavy rains triggered landslides in Ramban District and damaged the highway.
23	12-Feb-11	Doda	2	1 injured
24	23-Oct-10	Uri district	3	Casualty of 3 army personnel. Landslides, triggered due heavy rains, hampered traffic movement.
25	3-Oct-10	Kishtwar	3	Casualty of 3 army personnel
26	7-Sep-10	Leh	2	1 injured
27	10-Aug-10	Uri	1	7 injured
28	6-Aug-10	Chang-la pass, Ladakh	145	The flash floods and mudslides triggered by cloudburst at Leh on 5th and 6th August 2010 destroyed more than 50 houses. Several villages along the Chang-la pass and stretches of road washed away. Apart from reported casualties, several people went missing
29	25-Jul-10	Ramban	-	Landslide triggered by heavy rains near Panthal between Ramban and Ramsu blocked the Jammu

S. No	Date	Affected area	Casualties	Impacts, other than casualty
				Srinagar highway. Amarnath pilgrims were stranded on the highway.
30	6-Jun-10	Uri	6	Traffic disrupted for several days
31	4-Jun-10	Leh	-	-
32	27-May-10	Turtuk area of Nubra valley	-	A school bus with 15 children on board was trapped and army personnel evacuated them
33	26-May-10	Ladakh		20 houses damaged
34	25-May-10	Chadiyan village Baramulla		Several houses damaged. Affected Chadiyan village located on a mountainous slope near the border town of Uri in Baramulla district
35	20-May-10	Srinagar	1	-
36	20-May-10	Leh	1	Army personnel was killed, hit by a heavy boulder during the landslide. Location near Siachen base camp Nobra, about 500 km from Srinagar, in Leh district
37	18-May-10	Vaishno Devi	2	-
38	18-May-10	Leh-Karu-Tangtse axis in Ladakh	2	Location two km short of the 17,350 ft Chang La top on Leh-Karu-Tangtse axis in Ladakh region. The Indian Army rescued 73 trapped people
39	18-May-10	Batote - Kishtwar Highway, Doda		Landslide triggered during widening of road stretch at Ragi Nallah, about 150 km from Jammu, on Batote - Kishtwar highway in Doda district led to the closure of the highway
40	17-May-10	Srinagar-Leh National Highway		The traffic on the 434-km Srinagar-Leh national highway was suspended after heavy landslides occurred at Captain Mode, 100 km from Srinagar, and other places on the highway due to incessant rain for the past one week.
41	28-Apr-10	Gandarbal, Srinagar	1	Srinagar-Leh highway closed
42	28-Apr-10	Srinagar-Leh National Highway	1	Heavy rains caused landslide along the Srinagar -Leh national highway, killing a BRO laborer.
43	20-Apr-10	Zojilla Village		Incessant rains caused landslides at many places on Srinagar-Ladakh highway and the highway was closed due to landslides at Zojilla
44	27-Feb-10	Siachen Glacier	2	
45	27-Feb-10	Reasi	2	Casualty of two pilgrims. Location of landslide at Hathi Matha, in Reasi district triggered due to heavy rains
46	22-Feb-10	Uri	1	6 injured
47	22-Feb-10	Chairvani Village, Ganderbal	6	6 injured in Chairvani Village, Ganderbal District
48	10-Feb-10	Gulmarg	3	--
49	8-Feb-10	Kishtwar	1	6 injured, 5 houses damaged
50	8-Feb-10	Vaishno Devi	17	--

S. No	Date	Affected area	Casualties	Impacts, other than casualty
51	9-Jan-10	Kupwara district	4	--
52	3-Jan-10	Vaishno Devi		1 injured
53	3-Jan-10	Reasi		Landslides triggered due to heavy rains injured one pilgrim.
54	12-Dec-09	Kishtwar	1	--
55	12-Dec-09	Keran Sector, Kupwara	1	The person killed was a BRO porter
56	23-Sep-09	Vaishno Devi	3	--
57	2-Aug-09	Amarnath	2	--
58	2-Aug-09	Atholi, Kishtwar	1	Two injured
59	29-Jul-09	Kupwara	3	Tourism affected killing three pilgrims
60	29-Jul-09	Vaishnodevi cave shrine in Reasi	1	The person killed was a woman pilgrim and two others were injured
61	17-Jun-09	Gurez	1	4,000 pilgrims stranded
62	6-Feb-09	Srinagar	4	--
63	20-Nov-08	Kishtwar district	6	--
64	26-Oct-08	Leh	2	32 cattle killed
65	2-May-08	Kathua	8	Several missing
66	31-Mar-08	Qazigund	2	1 injured
67	18-Feb-08	Uri	1	--
68	8-Feb-08	Ramban, Banihal	3	15 injured, 400-500 trucks stranded
69	10-Jan-08	Udhampur	15	-
70	9-Jan-08	Srinagar		200 vehicles stranded
71	8-Jan-08	Poonch	1	850 vehicles stranded
72	17-Dec-07	Ganderbal, Srinagar	2	6 injured, temple, bridge and army bunker damaged
73	10-Jul-07	Doda	2	--
74	25-Jun-07	Banihal	3	--
75	18-Mar-07	Khabbak Village	2	5 missing
76	22-Feb-07	Malori, Jammu		Highway closed and more than 100 vehicles stranded
77	16-Feb-07	Ramban	1	3 missing
78	1-Jun-95	Pani nallah, Kishtwar	6	Section of Jammu Srinagar highway badly damaged
79	1-Jan-94	Bali Nala and Narsoo slide		Section of Jammu Srinagar highway badly damaged
80	1-Jan-82	Ramgarh		Road and communication lines disrupted (NH-1)

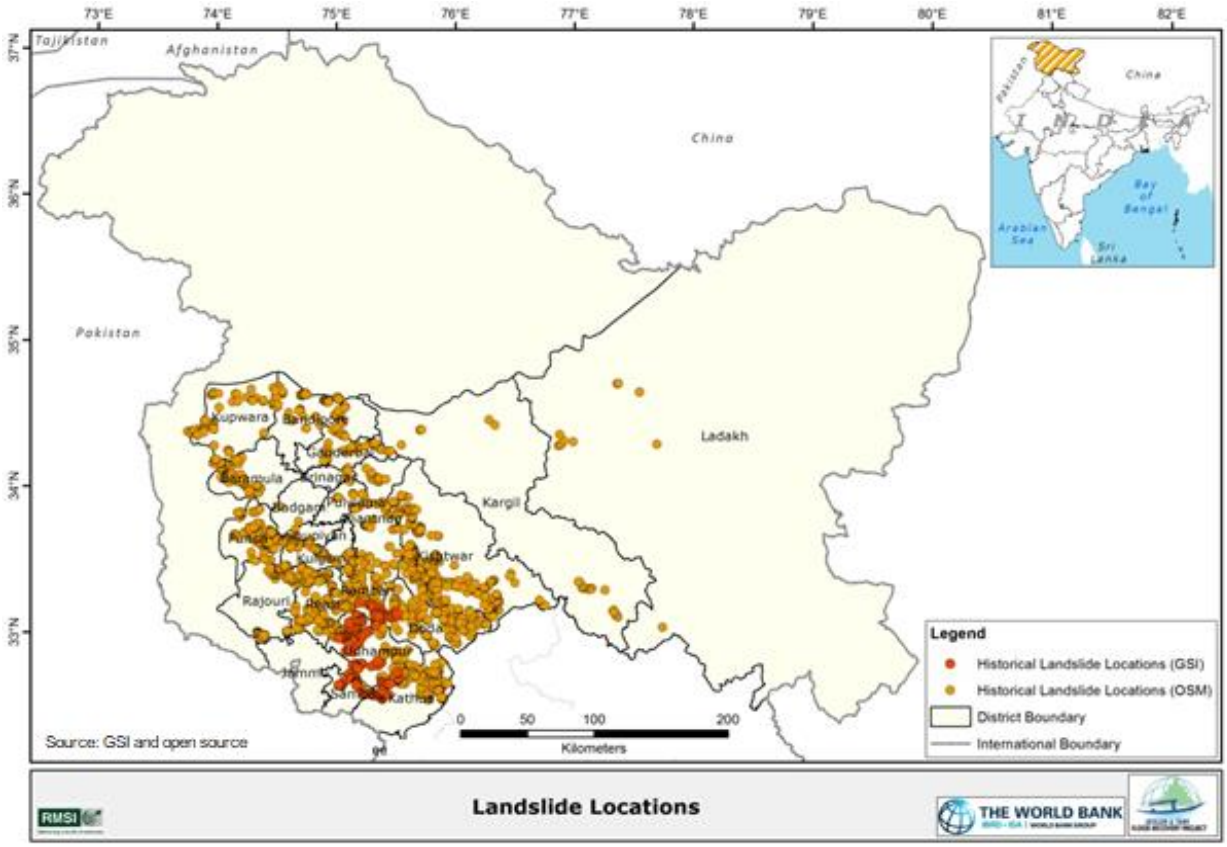

Figure 3: Historical landslide inventory of Jammu and Kashmir

OTHER COLLECTED DATASETS AND GAP ANALYSIS

Table 6 provides a summary of the status of data required and collected. This is in addition to the historical landslide event data compiled and presented in the above table.

Table 6: Status of datasets for landslide hazard assessment

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
1	Geology Map	GSI	Sheets published in 1957, 69, 71 and 1981	1:250,000	Downloaded from GSI portal in jpg format and converted into GIS format. Lithology, structures, dip-strike of geological strata available. Small portion missing (sheet no. 52K). Also received detailed lithology map of Kashmir region from University of Kashmir
2	Tectonic Structures	GSI	Geological maps published in 1957, 69, 71 and 1981	1:250,000	Tectonic structures have been extracted from published 1:250K geology maps

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
		USGS	Landsat-8, 2017	30 m	Lineament extracted from Landsat-8 images
3	Seismicity	As detailed in earthquake catalogue section	Events captured for whole century	Whole State and neighboring regions	Historical events data collected from different sources were mapped to generate the event catalogue presented in earthquake section above
4	Soil types with characteristics	Soil Department, J&K	Published by NBSS & Land Use Planning (ICAR) 1999	1:500,000	Received in paper form and converted into GIS format
5	Rainfall data	IMD	Last 30 years	All 12 rain gauge stations of the State	Hourly rainfall data with some gaps for some stations
6	DEM	USGS	2014	30 m spatial resolution with a vertical accuracy of ±5 m	Open source data. The best high resolution DEM available.
7	Base data including road, rail and other transport network data	University of Kashmir and remote sensing data	2017	1:10,000	The road data received from University was updated using high resolution satellite imagery
8	Land Use-Land Cover	Selected towns from Urban Planning Department, and University of Kashmir. RMSI data library has LULC data for whole state	2000 - 2011	Town data of 1:10,000 and RMSI data at 1:50,000	Department of Ecology and Remote Sensing, J&K has the LULC of the entire state in 1:10,000 scale in GIS, working out modalities to share the data
9	Drainage network data	LULC map	2017	1:10,000	Jhelum drainage network data received from I&FC. Also entire drainage network of the state was extracted from DEM.

DATA GAPS AND LIMITATIONS

The coordinate locations of historical landslides are not available. It is critical to have the exact locations of landslides, along with the dates of events, to correlate the event with various bio-

physical information (like slope, soil type and land use) and hydromet parameters (like rainfall). To fill this gap, we are using time series satellite imageries to identify the landslide scars and correlating these with the event dates, which will be further used for carrying out the correlation analysis of events verses bio-physical and hydromet parameters.

The base geology map available presently for the analysis is of 1:250,000. GSI has 1:50,000 scale data in GIS format, which would be ideal for landslide and earthquake modeling. As this is classified data and will only be shared with State agencies, we are approaching GSI to provide this data through the PMU.

GLOF Hazard

Glacier lakes are indirectly a result of climatic change impacts expressed by glacier fluctuations. The dominant type of glacial lakes may shift over time from supra-glacial lakes to moraine-dammed lakes due to the melting of glaciers under the changing climate depending upon the topographic setting. In the course of deglaciation, the extent and type of glaciers will change and therefore there will be a change in the type of glacial lakes. Glacier-dammed lakes occur mainly in the times of glacier advance, but there are also certain situations in which they are the result of glacier retreat. However, moraine-dammed lakes are mainly linked to glacier retreat regimes.

Glacier lake outbursts from some large glacial lakes can attain extremely high peak discharges due to the sudden dam failure under various conditions. Depending upon the topographical and climatic conditions, a characteristic distribution pattern of glacier lake types can be recognized in individual mountain ranges. In terms of natural hazards, sudden outbursts from small lakes with high peak discharges may have a more severe impact on human settlement and particularly hydropower infrastructure in mountainous terrains than the gradual drainage of large ice- or moraine-dammed lakes. Not all glacier lake outbursts will necessarily be released as water floods. The glacier lake outburst potential will depend upon their vulnerability to flooding determined using a number of criteria. They may also occur as debris flow with a high hazard potential. However, the number and size of these lakes has shown an increase over the time in the state of Jammu and Kashmir due to the enhanced melting of glaciers under changing climate. Glacial Lake Outburst Flooding (GLOF) is one of the major causes of flash floods and, therefore, the vulnerable landscapes in the vicinity of the river courses in the entire state need to be identified and monitored regularly beforehand in order to avoid disasters in the state of Jammu and Kashmir. The glacial lakes are formed usually in the higher reaches and cut off areas and it is difficult to physically reach them. Glacial lakes need to be monitored using satellite imagery or Unmanned Aerial Vehicles in order make preemptive interventions to prevent flash floods.

INVENTORY OF GLACIAL LAKES

Table 7: Distribution of glaciers in Indus basin

S. No	Basin	Sub Basin	Basin Area (sq. km)	Glacier numbers	Highest Elev.(m)	Lowest Elev.(m)	Glacier area (sq. km)	Ice reserves (cu km)
1	Panjnad, Sub basin of Indus Basin	Jhelum	50,844	733	6,285	3,404	222.8	8.974
2	Chenab	Chenab	44,840	2,039	7,103	3,001	2,341	210.7
3	Ravi	Ravi	30,590	217	5,824	3,276	113.6	5.508
4	Beas	Beas	19,500	384	6,196	3,079	416.6	31.78
5	Sutlej*	Sutlej*	395,000	2,108	6,652	3,606	1,315	82.89

S. No	Basin	Sub Basin	Basin Area (sq. km)	Glacier numbers	Highest Elev.(m)	Lowest Elev.(m)	Glacier area (sq. km)	Ice reserves (cu km)
	Total		2,86,383	5,481	7,103	3,001	4,409	339.9

Source ICIMOD, Kathmandu, Nepal

Table 8: Status of glaciers in Jhelum Basin in 1980, 1990, 2000 and 2010

Year	Glacier Number	Highest Elevation (m)	Lowest Elevation (m)	Diff Elv.(m)	Glacier Area (sq. km)	Ice Reserve (cu km)
1980	817	6,285	3,520	2,765	268.57	10.96
1990	823	6,285	3,520	2,765	248.15	10.04
2000	845	6,285	3,520	2,765	220.83	8.82
2010	846	6,285	3,527	2,758	211.16	8.36

Source ICIMOD, Kathmandu, Nepal

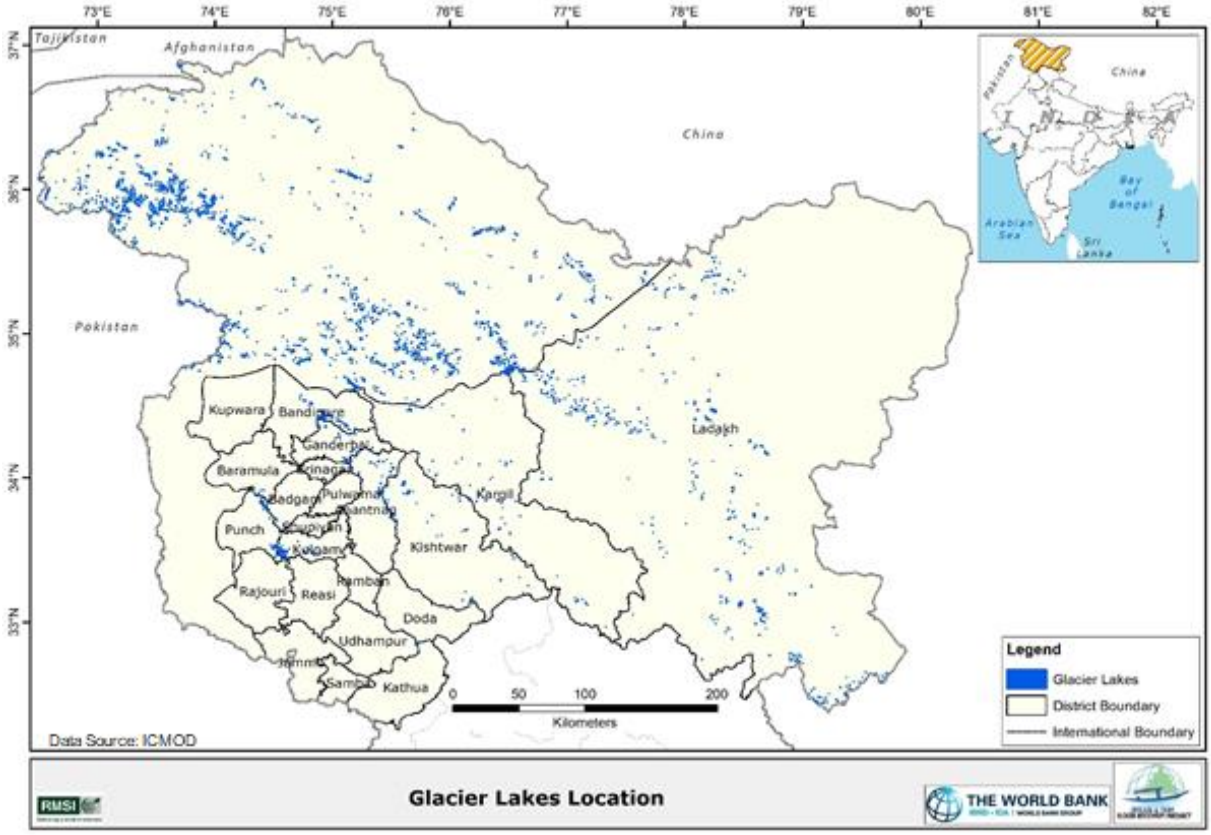

Table 9: Locations of glacier lakes

HISTORICAL EVENT DATA

Very few GLOF events have been reported in the state during the last 50 years and the details of the GLOF incidents reported in the state are summarized in Table 10.

Table 10: Catalogue of historical GLOF events

S. No	Date	Affected Area	No. of people affected	Casualty	Economic losses (INR)
1	07 Dec 2015	Phutkal area of Zanskar in Kargil	Nil	Nil	Damage to bridges, culverts, a few settlements and land
21	07 May 2015	Shyok river basin	Several houses washed away	Nil	Artificial lake burst triggering flashfloods washing away several bridges and caused extensive damage to houses

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

Table 11: Status of datasets required for GLOF hazard assessment

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintages/ Publication dates	Resolutions	Remarks
1	Glacier lakes	ICMOD and high resolution satellite imagery (time series data)	2018	30 m	ICMOD has published glacier lakes of J&K and are available in GIS. This data will be further updated using high resolution satellite imagery
2	Morphometric information	Analytical	2018	30 m	RMSI in-house analysis using biophysical data
3	DEM	USGS	2000	30 m spatial resolution with a vertical accuracy of ±5 m	Open source data. The best high resolution DEM available
4	Geology Map	GSI	Sheets published in 1957, 69, 71 and 1981	1:250,000	Received in paper form and converted into GIS format. Lithology, structures, dip-strike of geological strata available. Small portion missing (sheet no. 52K). Also received detailed lithology map of Kashmir from University of Kashmir
5	Engineering properties of the moraines	Field observations /literature	Published work	Location specific	The published literature about the engineering properties of moraines will be used

DATA GAPS AND LIMITATIONS

The volume of the water held in the glacier lakes shall be determined using the area-volume relationships developed on a large number of glacier lakes in the Indian Himalayas. This empirical relationship has certain errors in its estimation. Further, the engineering properties of the dammed lakes, essential for determining the breach thresholds, shall be determined based on the broad lithology of the dammed material and that will introduce some error in determining the place, timing, and duration of the GLOF breach.

Avalanche Hazard

For avalanche susceptibility mapping and hazard modeling and to predict occurrence of avalanches accurately, a continuous record of weather data in the higher reaches, particularly during the winters and early spring, is required. Further, the information about excessive loading of the snow cover due to high and incessant snow precipitation, cornice formation and its collapse, wind transportation, snow metamorphism etc. on the mountain ranges of the state is required. The information available on these factors on a synoptic scale is sufficient for assessment of the avalanche hazard on a larger scale. However, for a period-specific forecast for a particular area, it requires site-specific and time-specific information on a host of parameters related to an avalanche. This, to a certain extent, can be achieved through mesoscale modeling of various weather parameters on a high-end workstation. Mesoscale modeling of weather parameters (application of WRF) can assist in site- and time-specific forecast of an avalanche in the mountainous areas of the state.

HISTORICAL EVENT DATA

Table 12: Catalogue of historical avalanche events

S. No	Date	Affected Area	Casualty	Impact
1	07-Mar-05	Pir Panjal		Untimely snowfall created a lot of concern.
2	10-Jan-08	Udhampur	15	-
3	08-Feb-08	Ramban, Banihal	3	400-500 trucks stranded in avalanche
4	18-Feb-08	Uri	1	
5	06-Feb-09	Srinagar	4	
	09-Jan-10	Kupwara	4	
6	22-Jan-10	Kishtwar	3	At Padyarna village
7	08-Feb-10	Gulmarg	17	17 soldiers were killed and the event injured an equal number of soldiers
8	08-Feb-10	Vaishno Devi	17	
9	09-Feb-10	Kupwada	2	
10	10-Feb-10	Gulmarg	3	
11	14-Feb-11	Gulmarg	No death reported	Closure of the Srinagar-Jammu National Highway

S. No	Date	Affected Area	Casualty	Impact
				Heavy snow at Jawahar tunnel and landslides at Digdole and Panthal, 134 km from Srinagar
12	24-Jan-12	Kupwada	7	Casualty of five army men and two personnel of Border Security Force (BSF)
13	23-Feb-2012	Ganderbal and Bandipora districts	16	All sixteen were army personnel and many injured. 2 separate slides
14	24-Feb-12	Gurez Sector	13	All casualties related to army personnel
15	21-Mar-12	Gurez Sector	2	A civilian vehicle carrying five persons, including the driver, was caught in the avalanche at Kanzalwan road in Gurez, 124 km from Jammu. Three persons were pulled out alive from under the snow by a joint rescue team of civil administration and army while two were dead and one was still missing.
16	23-Dec-13	Gurez Sector	2	
17	13-Mar-14	Batalik	3	All three casualties were soldiers Two soldiers were rescued earlier.
18	04-04-2015	Ladakh	4	All casualties were soldiers and one went missing.
19	14-Mar-16	Kupwada	10	As many as 73 civilians were rescued by the Army from the Kupwara district. People were stranded in vehicles on the Tangdhar-Nasta Chhun road.
20	25-Jan-17	Gurez sector	24	4 civilians died.
21	26-Jan-17	Gurez Sector	10	All casualties were soldiers and four other soldiers were injured in a camp at Sonmarg in Ganderbal district.
22	06-Apr-17	Ladakh	5	All casualties were soldiers and two were rescued
23	13-Dec-17	Gurez Sector	5	All casualty were soldiers
24	06-Jan-18	Tangdhar district	11	A passenger vehicle was hit by a huge avalanche of snow at Khooni Nallah near Sadhna top on the Kupwara-Tangdhar road.

S. No	Date	Affected Area	Casualty	Impact
25	02-Feb-18	Kupwara	3	Avalanche struck army post at Kupwara, all casualties were soldiers, 1 injured.
26	16-Feb-18	Gulmarg	5	One international tourist and 4 nationals.
27	24-Feb-18	Guchibal Behak, Kupwara	3	Joint rescue team of police, SDRF and army recovered 3 dead bodies of civilians
28	01-Mar-18	Tulail area of Bandipora district	1	One person was injured
29	09-09-2018	Kolahoi	2	Not in inhabited area. 4,500m height, two local trekkers died

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

Table 13: Status of datasets required for avalanche hazard assessment

S. No	Data - types	Key Data Sources/ Agencies Consulted	Vintages /Publication dates	Resolutions	Remarks
1	Historical avalanche hazard events	Published literature and media	About 15 years	Location specific	Most of the data complied does not have location details
2	Satellite images (Landsat 8)	USGS	Different time periods	30 m	Open source data
3	Digital Elevation Model	USGS	2000	30 m spatial resolution with a vertical accuracy of ±5 m	Open source data. The best high resolution DEM available
4	Air temperature	SASE	Observations	Hourly	Only agency having observations on mountain ranges in J&K
5	Snow surface temperature	SASE	Observations	Hourly	Only agency having observations on mountain ranges in J&K
6	Snowfall	SASE	Observations	Hourly	Only agency having observations on mountain ranges in J&K

S. No	Data - types	Key Data Sources/ Agencies Consulted	Vintages /Publication dates	Resolutions	Remarks
7	Snowpack depth	SASE	Observations	Hourly	Only agency having observations on mountain ranges in J&K
8	Snowpack water equivalent	Estimate/ SASE	Estimated	Hourly	Only agency having observations on mountain ranges in J&K
9	Free Ram penetration	Ram profile and Ram resistance	Observations	6 hourly	From SASE
10	Wind speed	ECMWF forecasting system	Atmospheric Model high resolution 10-day forecast (HRES)	0.25X0.25 degree	Open source data

Note: We are yet to approach SASE to collect the data (item 4-9) mentioned in the above table.

DATA GAPS AND LIMITATIONS

We need to use almost real time data about a host of parameters identified in Table 13 above for avalanche susceptibility mapping and hazard modeling. Since there is scanty network of observations in the state and almost no meteorological observatories in the high mountainous ranges that are prone to avalanches, we are almost singularly dependent upon the SASE for data. Some of the parameters required for avalanche forecasting can be extracted from satellite data. However, cloud cover during the winters could sometimes pose a challenge for forecasting avalanches in vulnerable areas. It is, therefore, important for the state to develop a mechanism with SASE for sharing of near real-time meteorological data for the mutual benefit as most of the security set up along the LOC is located in the avalanche prone area making army personnel vulnerable to avalanches as can be seen from a perusal of the casualties given in the Table 12.

The coordinate locations of historical events are important for carrying out the spatial analysis of events.

Flood Hazard

Beyond India, the Indus basin extends over China (Tibet), Afghanistan and Pakistan draining a total area of 11,65,500 Sq.km. In India, the basin spreads over states of Jammu & Kashmir, Himachal Pradesh, Punjab, Rajasthan, Haryana and Union Territory of Chandigarh having an area of 3,21,289 Sq.km, which is nearly 9.8% of the total geographical area. The geographical extent of the basin is between 72°28’ to 79°39’ east longitudes and 29°8’ to 36°59’ north latitudes of the country with a maximum length and width of 756 km and 560 km. Out of the total area, the drainage area of Jammu and Kashmir is about 193,762 sq.km. The Jhelum River is the sole important river in the Himalayan mountain range that runs across the Jhelum basin in Kashmir region. The Tawi and Chenab rivers are two major rivers of Chenab basin in Jammu region, while the Indus and Zanskar rivers run across Ladakh region.

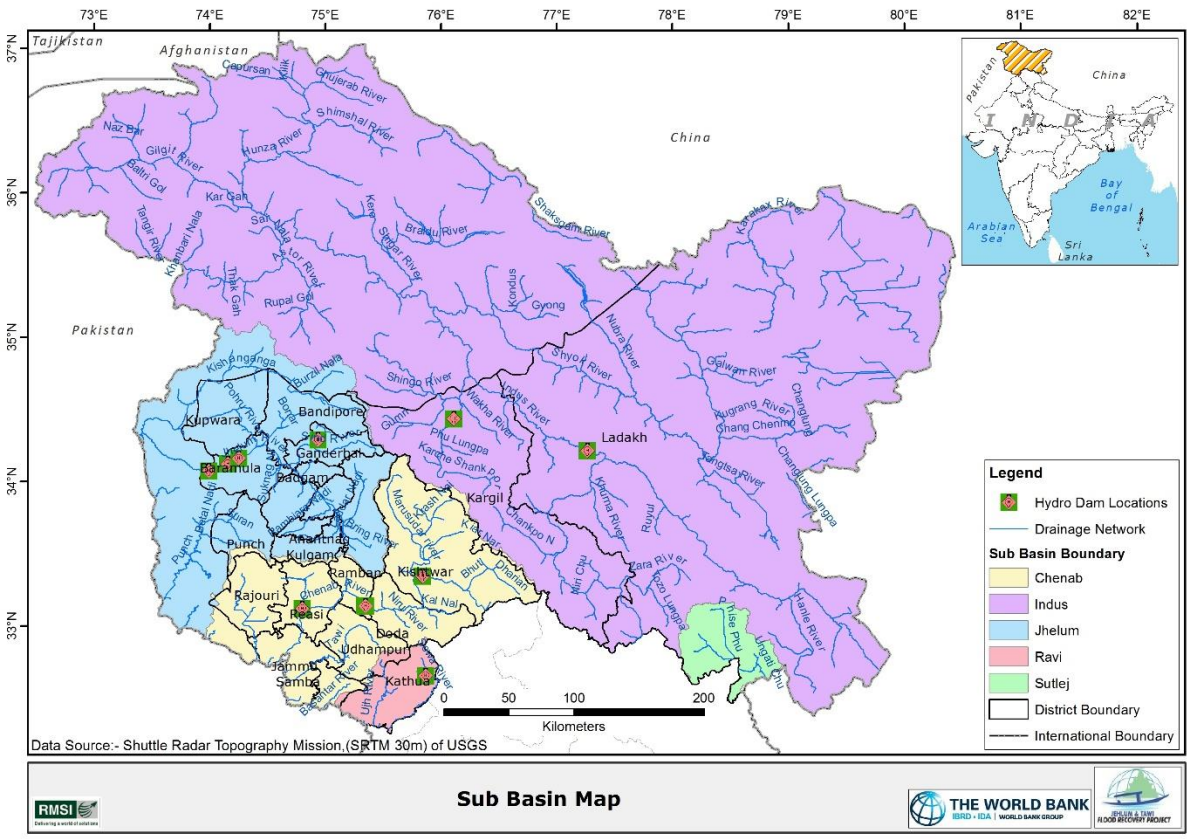

Figure 4 Sub basin boundaries of Jammu and Kashmir

HISTORICAL EVENT DATA

The valley of Kashmir has a long history of floods due to excessive water discharge from the tributaries of Jhelum river during strong western disturbances (November to April) and the monsoon period (July- September). According to Sir Walter Lawrence "Many disastrous floods are noticed in the vernacular history of the Kashmir valley."[15]

Table 14: Catalogue of historical flood events

Date	Affected Area	Socio-Economic Impact
635	Srinagar city	The city of Srinagar was drowned due to heavy rainfall and the dam and the Vitalan Marg [present Dal lake] built by King Pervarsen were destroyed. As a result of the Vitalan Marg being flooded, the Dal lake came into being.
725	Srinagar city	During the reign of King Lalitadatiya, all the buildings of the king in the town were destroyed due to a flood. So he rebuilt his palace in the Latipur. Most of the houses in the town were also destroyed.
855/56		Rock falls from the mountains lining both river banks had choked the Vitasta River and made its waters turn backwards in whirls.
917/18		The whole autumn crop got destroyed followed by famine.
1099		Cloud burst lead to torrential rain and flood. The bridge had been broken by the flood at the confluence of Sindhu [river Sindh] and

[15] 5 Sir Walter Roper Lawrence in his book, The Valley of Kashmir (1895)

Date	Affected Area	Socio-Economic Impact
		Vitasta [Jhelum]. The villages were flooded by an inundation, destroying crops and inflation of food prices.
1135		Flood
1144		Heavy rain due to cloud burst and thunderstorm
1146		Cloud burst and thunderstorm poured after long spell of dry season.
1360		The Srinagar city was under water, but the mighty inundation still increased and reached the hills. Several trees, bridges and houses were destroyed.
1462		The Vitasta [Jhelum], Lidri [Lidder], Sindhu [Sindh] and Kashpatika [Kethkul] and other rivers overflowed drowning the villages on their banks.
1573		Many houses and crops were swept away
1604		Excessive rains followed by floods culminated in famine
1642		Severe floods followed by famine
1643		Excessive rainfall, failure of crops followed by famine
1651		Severe flood followed by famine
1662		Many houses were destroyed
1665		Heavy and untimely rains followed by floods and famine
1678		Severe flood followed by famine
1683		An earthquake was followed by a flood, which destroyed houses of people. Many people died. This flood is described as an 'extreme flood'.
1706		Excessive rains and severe flood followed by famine
1711		Incessant rains followed by floods destroyed houses and crops.
1713		Heavy and untimely rains followed by severe flood and famine
1723/24		Heavy and untimely rains followed by severe flood and famine
1735		Flood occurred and the flood waters remained stagnant for a long time in villages and towns, including the capital city of Srinagar
1745		Untimely and heavy rains followed by famine
1747		Storms for a week, followed by untimely incessant rains for eight days. 3,000 houses were destroyed. Bridges on Jehlum River were swept away, crops were destroyed followed by famine.
1772		Amira Kadal bridge washed away
1801		Severe flood
1825/26		Flood
1832		Heavy and continuous rain started in autumn 1831 and resulted in a flood in 1832
1838		Great flood to which the Kashmir Valley has in all ages been subject, occurred, which forced the inhabitants to take to their boats
1841		Damage to life and property. Records states the flood of 1841 rose some nine feet higher on the Dal lake than it rose in 1893, but

Date	Affected Area	Socio-Economic Impact
		thanks to the strong embankments around the Dal the flood level in 1893 never rose on the lake to the level of the floods on the Jhelum.
10 Aug 1858		Severe Flood
1865-66		Continuous rains and flood which caused enormous damage to crops.
1869		Continuous rains and flood caused enormous damage to crops.
1871		Continuous rains and flood caused enormous damage to crops.
1877		Continuous rains from 1877 and continued till 1878, followed by unprecedented famine, people died for want of food.
1885		Earthquake followed by flood
1889		The details regarding this flood are lacking, except that the flood washed away the house of Mr. Bijex, the state engineer
1893		The flood of 1893 was highest on record at any rate in the 19th century. Continuous rains for 59 hours, from 4 pm of Tuesday, the 18th of July to 3 pm of Thursday the 20th. At Ram Munshi Bagh, water spilt over the banks. the river broke through the gate which protected the Dal Lake from the floods and submerged the lake garden and spread over Srinagar and adjoining areas for at least 8-10 miles. Six of the seven bridges over Jhelum in the city were washed away including iron girder bridge at Domel and Kohala suspension bridge. 49 people died, 329 cattle perished, 2,225 houses destroyed, 25,426 acres of land was submerged.
18/07/1893	Entire Kashmir valley	Rs. 64,804 in land revenue, 25,426 acres of crop were submerged, 2,225 houses were damaged and 329 cattle were killed.
1894		Unexpected flood in the month of June. River rose to height of about 3 feet below the level recorded the year before.
1900		Continuous rains caused floods succeeded by cholera in which 4,225 people died.
March 1902		This flood is an exception because of its occurrence in March
1903		83 villages were affected, out of which 26 lost the entire kharif harvest. 421 houses were completely destroyed.
1905		74 villages were affected, heavy loss to government records. Loss to the crops was extensive. There were also 6 deaths
1909		During this flood, a loss of Rs. 98,393 was estimated.
1912		Many bridges were damaged, 21 lives were lost
1928		76 people died and a total number of 1,750 houses were partially damaged while as many as 282 houses were fully damaged. There was loss of 2,228 cattle, including sheep and goats. Agricultural sector was very badly affected.
23/07/1903	Kashmir valley particularly Srinagar city	7,000 dwellings destroyed

Date	Affected Area	Socio-Economic Impact
1-Sep-50	Jhelum Basin	100 people lost their lives. More than 15,000 houses were damaged in Jammu district.
Sept 1992	North western border districts	Over 200 people lost their lives and over 60,000 people were affected in several north-western border districts. More than 2,000 people killed in Pakistan-occupied Kashmir.
6-Aug-10	Leh, Ladakh	Cloud burst led to 71 towns and villages being damaged, including Leh town. At least 255 people died including 6 foreign tourists. 200 people were reported missing in the initial aftermath of the storm, and thousands more were rendered homeless after the flooding caused extensive damage to property and infrastructure. Overall, 9,000 people were directly affected by the event.
8/16/2013	Poonch, Rajouri, Samba and Jammu	Over 50,000 people were affected across Jammu. As many as 12 people died. Around 300 people were stranded by the floods in Poonch, Rajouri, Samba and Jammu.
19/8/2014	Rajouri, Reasi, Poonch and Udhampu	One person was killed in Rajouri district. Seven people were washed away in Jammu city. Floods destroyed crops in the region.
02/09/2014	Worst affected districts - Srinagar, Anantnag, Baramulla, Pulwama, Ganderbal, Kulgam, Budgam, Rajouri, Poonch and Reasi.	190 and 78 people reported dead in Jammu and Kashmir divisions respectively. As many as 60 major and minor roads were cut off and over 30 bridges washed away, hampering the relief and rescue operations. Except for connectivity between Srinagar and North Kashmir's Ganderbal district, all other districts of the valley including Anantnag, Pulwama, Kulgam, Shopian, Badgam, Baramulla and Bandipora were cut off. 9,814 residential houses were fully damaged and 23,763 partially damaged in Jammu region. In Kashmir 103,938 pucca houses were fully damaged, 64,176 pucca houses were partially damaged, 7,372 kuccha houses were fully damaged and 9,220 kuccha houses were partially damaged.
4/9/2015	Various parts of the Kashmir valley	44 people and 862 cattle were killed, 25 people were injured and 12,565 structures (homes or buildings) were damaged. 211 camps were set up to house 2,907 families that were forced to evacuate their homes
4/8/2017	Srinagar, Poonch	Flooding was reported in Srinagar and other areas of the Kashmir Valley. The Jhelum River surpassed danger levels at Rammunshibagh near Srinagar on 06 April. No fatalities reported due to short duration of flood.
7/1/2018	Akhnoor, Poonch and Kishtwar	At least 3 people lost their lives in Akhnoor, Poonch and Kishtwar. Flooding was also reported in the city of Srinagar, where homes were damaged and police and emergency teams carried out rescues.
8/15/2018	Udhampur, Jammu and Poonch	At least 4 people died and three others were injured. The deaths occurred in Udhampur (2), Jammu, and Poonch districts. Two dozen houses and structures suffered damaged due to rains, flash floods and landslides in Jammu, Kathua, Poonch, Rajouri, Udhampur and Reasi districts and scores of vehicles were damaged in Jammu city."

Date	Affected Area	Socio-Economic Impact
9/26/2018	Doda, Kathua	Two people died in separate incidents in Kathua district. At least 5 people died after a building collapsed due to heavy rains in Doda district. Kathua recorded 104.4 mm of rain in 24 hours on 24 September according to IMD.

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

Table 15: Status of available datasets for flood hazard assessment

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
1	Daily weather data	IMD	1977-2017	For all 12 IMD stations. There are data gaps in 1997-2007 for some stations due to the disturbance in the State.	None
2	Gridded climatological data	IMD	1951-2015	Daily surface maximum/ minimum air temperature and precipitation (rainfall + snowfall)	Gridded climatological data for India
3	Hydrology data of Jhelum River	I&FC, Kashmir	1955 -2018	Flow data from all gauge stations including coordinate locations of the stations for Jhelum and its tributaries. Details about various bridges on the river in digital format We have also received detailed report on 2014 flood, water body map in GIS. We have requested I&FC to provide river cross sections and HFL data	Some data gaps, which will not impact the modeling work
4	River cross section data for Jhelum River	I&FC, Kashmir	2016-17	Main channel only at 20 km interval	
4	Hydrology data Chenab and Tawi River	I&FC, Kashmir	1997-2018	Received data for one gauge station of Chenab River at Ranbir canal. We have requested I&FC, Jammu to provide flow data for rest of the gauging stations, river cross section data, HFL	The data is available only in paper form

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
				and structures along/in the river	
5	Hydrology data of River basin of Ladakh Region	I&FC, Kargil and Leh		We have requested I&FC, Kargil and Leh separately for providing hydrology data and yet to receive this	Flow data available only in paper form
6	LULC	Selected towns from Urban Planning Department, and University of Kashmir	2000 - 2011	Town data of 1:10,000	Department of Ecology and Remote Sensing, J&K has the LULC for the whole state in 1:10,000 scale in GIS, working out modalities to share the data
7	Soil Data	Soil Department, J&K	Published by NBSS & Land Use Planning (ICAR) 1999	1:500,000	Received in paper form and converted into GIS format
8	Digital Terrain Data (DTM)	USGS	2000	30 m spatial resolution with a vertical accuracy of ±5 m	Open source data. The best high resolution DEM available

DATA GAPS AND LIMITATIONS

As of now, we have hydrology data for Jhelum basin only. We are interacting with I&FC Jammu and Ladakh region for the hydrology data for the sub basins in the respective regions. There are several hydro power projects in the State and we are planning to interact with the State Power Corporation to get the reservoir capacities, dam release curves, etc., which are required for developing flood mitigation scenarios.

Drought

Less snow in winter, deficit rain during certain months and increased runoff has led to water deficit conditions during the recent years in the State. The media has reported drought like conditions when farm communities in some villages faced water shortage for agricultural activities. As the drought analysis, we will consider the IMD definition of drought and will analyze rainfall data/snow fall data and crop yield data to assess historical drought events. Climate and yield data will be analyzed along with other variables for drought modeling. The historical drought event information will be generated based on analysis of the climate (precipitation) and crop (yield) data analysis. The status of data availability and gaps is presented in Table 16.

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

Table 16: Status of datasets for drought hazard assessment

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
1	Daily weather data	IMD	1977-2017	For all 12 IMD stations. There are data gaps in 1997-2007 for some stations due to the disturbance in the State.	Daily weather data
2	Gridded climatological data for India	IMD	1951-2015	Daily surface maximum/ minimum air temperature and precipitation (rainfall + snowfall)	Gridded climatological data for India
3	Crop yield data	Agriculture department	2007 - 2017	Tehsil-level crop data for major crops available	Ideally require crop yield data for a longer time span

DATA GAPS AND LIMITATIONS

The data available for drought hazard modeling is reasonably adequate though it is ideal to have at least 20 years crop yield data. The present 10-year data is organized by the state as part of the national agriculture insurance project. We will interact with the Agriculture Department to see whether we can get additional historical crop yield data.

Climate Variability and Climate Change

Table 17 provides a summary of data required and available for carrying out climate variability and climate change analysis. Further below, we have provided some additional explanation of the global data we plan to use for carrying out the analysis.

Table 17: Data required and its availability for climate variability/change analysis

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintage/Publication dates	Remarks
1	Daily weather data	IMD	1977-2017	For all 12 IMD stations. There are data gaps in 1997-2007 for some stations due to the disturbance in the State.
2	Gridded climatological data for India	IMD	1951-2015	Daily surface maximum/ minimum air temperature and precipitation (rainfall + snowfall)
3	Global gridded climatological data	CRU, UK	1951-2015	Daily surface maximum/ minimum air temperature and precipitation
4	Daily gridded precipitation	Open source (climatedataguide.ucar.edu)	1951-2017	Gridded daily precipitation data

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintage/Publication dates	Remarks
5	Down scaled daily ESM data for future projections	NASA	?	Global climatological model simulated data (daily max/min temperature and precipitation) for future (1951-2100)
6	Flow (surface runoff) data	I&FC	1987-2017	For Jhelum River, 30-year flow data is available in digital format. For other three basins, data is only available in paper format and we are yet to get access to these.

RMSI also has in its data library, the APHRODITE's[16] (Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation) daily gridded precipitation, which is the only long-term (1951 onward) continental-scale daily product that contains a dense network of daily rain-gauge data for Asia including the Himalayas, South and Southeast Asia and mountainous areas in the Middle East. The number of valid stations used for this data set represented 2.3 to 4.5 times the data available through the Global Telecommunication System network, which were used for most daily grid precipitation products (such as CRU UK precipitation data set). This data set would be useful for detailed analysis of rainfall/snowfall characteristics and trends in the three identified regions (Jammu, Kashmir Valley, and Ladakh) of the J&K State.

The IPCC's data distribution center[17] provides details on the availability of GCM outputs and associated guidance documents on downscaling and the use of direct GCM outputs, as well as downscaled data products for climate impact and risk assessments. The downscaled climate scenarios that are derived from the Earth System Model runs conducted under the Coupled Model Inter-comparison Project Phase 5 (CMIP5) are available as NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP, 2015) dataset and are archived at RMSI data library for a select list of ESMs (

Table 18). The dataset available with us includes projections for RCP 8.5 and RCP 4.5 scenarios for which daily scenarios were produced under CMIP5. Each of the climate projections includes daily maximum surface air temperature, minimum surface air temperature, and precipitation for the periods from 1950 through 2100. The spatial resolution of the climate model-based bias-corrected dataset for scenario development in this study would be 0.25 degrees x 0.25 degrees (approximately 25 km x 25 km).

This dataset shall facilitate in conducting climate change vulnerability assessment and sector-specific impacts at local to regional scales, and thus enhance our understanding of possible future climate patterns across the state.

Table 18: CMIP5 Earth System with relatively fair simulation skill over South Asia

[16]https://climatedataguide.ucar.edu/climate-data/aphrodite-asian-precipitation-highly-resolved-observational-data-integration-towards.

[17] See Intergovernmental Panel on Climate Change. http://www.ipcc-data.org

ESM Abbreviations	Institutions where ESM was developed and simulation experiments performed
MPI-ESM-MR	Max Planck Institute for Meteorology, Hamburg (Germany) Model
MIROC-ESM	National Institute for Environmental Studies Japan ESM
GFDL-CM3	Geophysical Fluid Dynamics Laboratory, Princeton (USA) Model
ACCESS1	Australian Community Climate and Earth System Simulator coupled model, (CAWCR), CSIRO and BOM

River runoff data: RMSI received hourly river discharge data for the last 30 years for Jhelum River from I&FC, Kashmir. For Chenab and Tawi River of Jammu Region and Zanskar River and Sindh River in Ladakh Region the flow data is available in paper format. RMSI is yet to get access to this and is expecting to get this soon. This data will facilitate identifying the trends in flood hazards and risks associated with glacier melting, which is required for climate variability analysis.

DATA GAPS AND UNCERTAINTIES

In terms of data resolution and vintage, we have adequate amount of data required for carrying out climate variability and climate change analysis. However, dealing with uncertainty is a fundamental task when using climate projections in a decision-making context. Three major sources of uncertainty exist, which should be considered while deriving the future projections of climate. These include the choice of climate model, the choice of emissions scenario, and the internal variability of the modelled climate system. The relative contribution to uncertainty depends on the climate variable considered, as well as the region and time horizon. Even where there is high confidence in the response of the climate system to forcings, there is uncertainty from natural variability[18] and our incomplete knowledge of how climate changes affect the context of the decision. Also, there will always be some inevitable uncertainty in the processes involved and their impacts.

The future projections of climate change in Jammu and Kashmir State that we intend to derive would be specific to a given set of assumptions, or future scenarios, regarding human activities (including changes in population, technology, economics, energy, and policy). These future changes also have some uncertainty due to natural variability, particularly over shorter time scales and limitations in scientific understanding of exactly how the climate system will respond to human activities. The relative importance of these three sources of uncertainty changes over time. Which type of uncertainty is most important also depends on what type of change is being projected: whether, for example, it is for average conditions or extremes, or for temperature or precipitation trends. In view of this, the projections of key climate variables and core indicators should be used with caution for all decision makings.

Forest Fire Hazard

There are 10 circles and 55 divisions under the forest department of the state. The forest fire occurrence in the State is both accidental as well as deliberate or intentional. There is a conflict between the grazing land and the forest peripheral and the communities reliant on grazing deliberately set fire to forest areas for reviving grazing ground.

HISTORICAL EVENT DATA

We have received historical forest fire event summary data at district level for the last 10 years for Kashmir Region. Jammu region has developed a GIS based Forest Information System and has forest fire event data at compartment-level. We have received compartment-level

[18] Deser, C., Phillips, A.S., Alexander, M.A. and Smoliak, B. 2014: Projecting North American climate over the next 50 years: Uncertainty due to internal variability, Journal of Climate, 27, 2271-2296.

forest fire data for last 10 years from 9 forest divisions of Kashmir and 1 forest division of Jammu. We are awaiting data from other forest divisions. The forest fire event data received from Pir Panchal Division is provided in Table 19.

Table 19: Catalogue of historical forest fire events Pir Panjal Forest Division, Budgam (2006-2018)

	Date and time of Fire occurrence		Date and time of extinguishing the fire		Compartment No. / Location	Area engulfed (figures in Ha)
Range	Date	Time	Date	Time		
Doodganga	03-09-2006	5:00 PM	03-09-2006	10:00 PM	RI-32,	0.5
Doodganga	09-10-2006	6:00 AM	09-09-2006	12:00 PM	N2b	0.5
Sukhnag	21-09-2006	5:30 AM	21-09-2006	03:00 PM	S-13	0.5
Raithan	03-11-2006	8:00 PM	04-11-2006	04:00 AM	D-34	1
Doodganga	07-09-2007	1:00 AM	07-09-2007	08:00 PM	N-2a	2.5
Doodganga	08-09-2007	9:00 AM	08-09-2007	3:00 PM	d-2	1.5
Doodganga	15-10-2007	9:00 PM	16-10-2007	12:00 PM	D-19a	1.72
Raithan	17-10-2007	6:00 PM	17-10-2007	11:00 PM	D-20	0.5
Raithan	23-10-2007	3:00 PM	23-10-2007	8:00 PM	D-33	0.5
Doodganga	27-08-2008	7:00 AM	27-08-2008	2:00 PM	N-3	0.75
Raithan	02-09-2008	9:00 AM	02-09-2008	5:00 PM	D-34	1
Sukhnag	29-10-2008	2:00 PM	29-10-2008	9:00 PM	S-16	1
Doodganga	25-10-2009	10:00 AM	25-10-2009	6:00 PM	RI-31	1
Raithan	03-11-2009	3:00 AM	03-11-2009	10:00 PM	S-1b	1
Doodganga	29-08-2010	1:00 PM	29-08-2010	12:00 AM	D-2	0.65
Sukhnag	06-09-2010	6:00 AM	06-09-2010	2:00 PM	S-8	1
Raithan	13-10-2010	5:00 PM	13-10-2010	1:00 AM	D-20	0.5
Sukhnag	22-09-2011	3:00 AM	22-09-2011	1:00 PM	S-9	0.75
Doodganga	12-10-2011	2:00 PM	12-10-2011	10:00 PM	N-5	1.5
Doodganga	28-09-2012	12:00 PM	28-09-2012	1:00 AM	N-5	1
Raithan	09-10-2012	10:00 AM	09-10-2012	6:00 PM	D-30	0.5
Doodganga	15-10-2012	10:00 AM	15-10-2012	5:00 PM	N-6	1
Doodganga	28-09-2012	4:00 PM	28-09-2012	1:00 AM	N-6	1
Sukhnag	27-08-2013	11:00 PM	28-08-2013	5:00 PM	S-10	2
Sukhnag	02-09-2013	1:00 AM	02-09-2013	3:00 AM	S-11	1.5
Raithan	10-09-2013	2:00 PM	11-09-2013	12:00 AM	D-29	2
Doodganga	15-09-2013	7:00 PM	27-08-2013	3:00 AM	N-1a	2.5
Raithan	27-09-2013	8:00 AM	27-09-2013	11:00 PM	S-1b	2
Sukhnag	02-10-2013	10:00 AM	02-10-2013	11:00 PM	S-19	2.5
Sukhnag	03-10-2013	9:00 AM	03-10-2013	9:00 PM	S-20	2
Doodganga	16-10-2013	3:00 AM	16-10-2013	5:00 PM	RI-31	1.5

	Date and time of Fire occurrence		Date and time of extinguishing the fire		Compartment No. / Location	Area engulfed (figures in Ha)
Range	**Date**	**Time**	**Date**	**Time**		
Sukhnag	21-10-2013	2:00 PM	21-10-2013	10:00 PM	D-23	2
Sukhnag	29-08-2014	5:00 PM	30-08-2014	3:00 AM	D-24	1
Raithan	13-09-2014	12:00 PM	13-09-2014	9:00 PM	D-28	1
Doodganga	22-09-2014	11:00 PM	23-09-2014	3:00 AM	N-2b	0.5
Doodganga	19-10-2014	1:00 AM	19-10-2014	2:00 PM	N-2b	1
Sukhnag	22-08-2015	2:00 PM	22-08-2015	5:00 PM	S-23	0.5
Raithan	26-09-2015	11:00 PM	27-09-2015	8:00 AM	D-30	1
Sukhnag	29-09-2015	6:00 AM	29-09-2015	9:00 PM	S-9	1
Doodganga	25-06-2016	6:00 AM	25-06-2016	11:00 PM	N-3	2
Doodganga	22-07-2016	5:00 AM	22-07-2016	11:00 AM	N-4	0.5
Sukhnag	09-08-2016	2:00 PM	10-08-2016	1:00 AM	S-20	1
Raithan	11-08-2016	8:00 AM	12-08-2016	11:00 AM	D-34	3
Sukhnag	17-08-2016	11:00 AM	17-08-2016	8:00 PM	S-24	0.5
Raithan	28-08-2016	12:00 PM	29-08-2016	5:00 AM	D-20	2.5
Raithan	03-09-2016	1:00 AM	03-09-2016	9:00 PM	D-20	4
Doodganga	09-10-2016	11:00 PM	10-10-2016	8:00 AM	RI-32	1
Raithan	15-10-2016	1:00 AM	16-10-2016	3:00 AM	S-1b	4
Doodganga	16-04-2017	8:00 PM	17-04-2017	6:00 AM	D-2	1.5
Doodganga	28-04-2017	1:00 AM	28-04-2017	9:00 PM	D-8	2
Raithan	16-06-2017	2:00 PM	16-06-2017	11:00 PM	S-1b	1.75
Doodganga	24-08-2017	7:00 PM	25-08-2017	3:00 AM	D-1	2
Doodganga	31-08-2017	12:00 PM	31-08-2017	11:00 PM	N-5	1.5
Raithan	02-09-2017	7:00 PM	03-09-2017	11:00 AM	D-30	2.25
Raithan	13-11-2017	6:00 PM	14-11-2017	1:00 AM	D-31	1.5
Raithan	06-12-2017	4:00 AM	06-12-2017	7:00 PM	D-20	1.5
Doodganga	10-01-2018	12:00 PM	10-01-2018	8:00 PM	D-2	1.25
Raithan	18-01-2018	2:00 AM	18-01-2018	11:00 PM	D-34	1.75
Doodganga	28-02-2018	6:00 AM	28-02-2018	12:00 PM	D-12	0.75
Doodganga	09-03-2018	10:00 AM	09-03-2018	9:00 PM	D-11	1
Raithan	10-05-2018	10:00 PM	11-05-2018	1:00 AM	D-34	0.25
Sukhnag	24-05-2018	2:00 AM	24-05-2018	11:00 PM	S-10	2

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

We have so far received forest fire event data from 9 forest divisions for the last 10 years and are awaiting data for the rest of the divisions. It is important to have at least past 10-year forest fire event data with location and date details for carrying out the modeling exercise.

Table 20: Status of datasets for forest fire hazard assessment

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
1	Land use-Land cover	Selected towns from urban planning department, and University of Kashmir. RMSI data library has LULC data for whole state	2000 - 2011	Town data of 1:10,000 and RMSI data at 1:50,000	Department of Ecology and Remote Sensing, J&K has the LULC for the entire state at 1:10,000 scale in GIS, working out modalities to share the data
2	Forest stock cover	Department of Forest	2015	1:50,000	Latest information will be updated using satellite data
3	Base data including road, rail and other transport network data	University of Kashmir and remote sensing data	2017	1:10,000	The road data received from the University was updated using high resolution satellite imagery
4	Settlement clusters	Extracted from high resolution satellite data	2017	1:10,000	RMSI will extract this from high resolution satellite data as part of exposure data development
5	Wind distribution	ECMWF forecasting system	Atmospheric Model high resolution 10-day forecast (HRES)	0.25X0.25 degree	Open source data
6	Slope, aspect	SRTM 30	2000		Slope and aspect will be derived from

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
					DEM and is sufficient for the analysis
7	Historical fire occurrence	Department of Forest	For last 10 years	Compartment -level. Received only for 30%	Ideally, coordinate information is required for carrying out modeling work
8	Forest compartment map	Department of Forest	2017	1:10,000	In GIS format

DATA LIMITATIONS AND SUGGESTIONS FOR IMPROVEMENT

Ideally, historical forest fire event data with location details (geographic coordinates) and dates of events is required for carrying out forest fire susceptibility mapping. Presently, the data available and promised to be provided by the department is at compartment-level, which would be a limitation in carrying out the analysis. We will try to use multi temporal satellite images to at least identify some of the historical forest fire locations, which can go as inputs to the spatial modeling exercise.

Industrial and Urban Fire Hazard

There are no major industrial belts in J&K. The State is developing industrial estates to encourage small and medium scale entrepreneurs under the State Industrial Development Corporation (SIDCO) and Small Scale Industries Development Corporation Limited (SICOP). The State has mapped the industrial cluster areas in GIS. We are yet to get this data even though we have had several meetings and follow ups with SIDCO and SICOP.

As part of Urban Fire Hazard, we will analyze the reported fire incidences in the State based on fire call data from the Fire Service Department. RMSI has fire call data at fire station-level for the period 2007-11 collected as part of an earlier project that was implemented. We have requested the Fire Service Department to provide fire call data for the period 2011-2018.

HISTORICAL EVENT DATA

There are some fire accident events recorded in the industrial cluster area, which will be captured in urban fire hazard data. There is no industrial hazard event recorded in the State. Therefore, as part of the industrial hazard analysis, we will analyze the types of industries, including data on materials they are handling, e.g., inflammable and toxic, and analyze the real impact in case of any hazard occurrence.

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

Table 21: Status of datasets for industrial and urban fire hazard assessment

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
1	Industrial cluster location	SIDCO and SICOP	2017	1:10,000	SICOP has carried out GIS based mapping of the industrial estates of the State. We are yet to receive this data
2	Fire call data	Fire Service Department	2007-2011	Fire station level	Requested Department to provide data for period 2011-2018
3	Settlement clusters	Extracted from high resolution satellite data	2017	1:10,000	RMSI will extract this from high resolution satellite data as part of exposure data development
4	Land Use-Land Cover	Selected towns from Urban Planning Department, RMSI data library has LULC data for whole state	2000 - 2011	Town data of 1:10,000 and RMSI data at 1:50,000	Department of Ecology and Remote Sensing, J&K has the LULC of the entire state at 1:10,000 scale in GIS, working out modalities to share the data
5	Wind distribution	ECMWF forecasting system	Atmospheric Model high resolution 10-day forecast (HRES)	0.25X0.25 degree	Open source data
6	Slope, aspect	SRTM 30	2000		Slope and aspect will be derived from DEM and is

S. No.	Data -types	Key Data Sources/ Agencies Consulted	Vintage/ Publication dates	Resolutions	Remarks
					sufficient for the analysis

DATA LIMITATIONS AND GAPS

Location details and types of industries are critical for carrying out spatial modeling of industrial hazards. We are yet to get this data from the line department. We have received the addresses of industries in Kashmir region. This has to be geo-coded for any spatial analysis.

For urban fire hazard analysis, data ideally should be location-specific rather than fire station-specific. Present data restrains our analysis to fire station-level and not location level.

Section 3: Data for Exposure Development

Data for Exposure Database Development

Exposure is a critical component of any risk assessment exercise. Exposure data constitutes data related to exposed life and assets including demography, the built environment, infrastructure system and livelihood functions that are subjected to potential losses due to the hazards considered.

The development of the exposure database includes the organization and categorization of different exposed elements at risk. For example, the population in the hazard zone can be categorized by age, gender, education, and occupation; and buildings in which they live and the infrastructural facilities can be categorized by their line of business (occupancy), construction material, structural type, age, and height.

The status of the exposure data collected and data gaps and proposed plans to address the data gaps is presented in subsequent sections. We have approached the line departments in Kashmir, Jammu, and Ladakh regions separately and the data status is summarized in two tables – Kashmir and Jammu. The data related to Ladakh region is integrated along with information on Kashmir.

Table 22: Data inventory for exposure elements for Kashmir division

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
1	Administrative boundary	District name, Tehsil name, Village name	All	Need to validate the village boundary information. Department of Ecology and Remote Sensing has village boundary data in GIS, working out modalities to share the data. The boundary details are not authenticated	2011 and 2018	University of Kashmir, RMSI digitized the village boundary of Census 2011. We will update the new district, tehsil and village boundaries as per district records.
2	Demographic data at village level	All key demographic variables	All	Data available as per 2011 statistics. We can apply growth rates to some demographic variables to arrive at latest estimated statistics. Aggregated figures at village level will be used for the analysis	2011	Census of India
3	Building data	Building occupancy and type	All	Buildings have been classified into residential, commercial and industrial. Location information of	2011	Census of India

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
				buildings is not available so aggregated figures at village level will be used for the analysis.		
4	Road	Road types, lengths, no. of lanes, conditions and construction costs	Road network in GIS will type and length	Number of lanes, conditions and construction costs. The network data needs to be validated using recent high resolution satellite data	2011	University of Kashmir and RMSI data library
5	Bridges	Bridge types, locations, structural types, lengths, widths, no. of spans, conditions, and construction costs	No data received	No data received		
6	Tunnels	Locations, lengths and construction costs	No data received	No data received		Ideally this should come from PWD R&B, JKPCC and BRO
7	Railways	Rail network, railway stations, yards, quantity of goods transported, unit cost of construction of rail	Railway network with length	Railway stations, yards, quantity of goods transported, unit cost of construction of rail network and stations/yards	2018	Indian Railways, The railway network was mapped from high resolution satellite imageries

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
		network and stations/yards				
8	Airport	Locations, runway lengths, surface types, airport building area, construction costs	No data received	No data receive		
9	Educational center	Location, name, type, ownership, no of rooms, construction type, Built-up area, construction material and cost, year of construction	Name, type, ownership, no. of rooms, staff and student enrollment	Location, cost, built-up area, no. of floors and year of construction have not been received	2018	Directorate of Samagra Siksha, J&K State has promised to give the locations of the schools.
10	Health Centre	Location, name, type, ownership, no of rooms, no. of beds, construction type, Built-up area, construction material and cost, year of construction	Name, type and ownership of health facilities are received	Location, no. of beds, construction type, cost, built-up area, no. of floors and year of construction have not been received	2018	Directorate of Health Services, Kashmir has promised to provide these missing details
11	Safe Shelter	Location, type, capacity of building, construction type, facilities, plinth height, construction material, and cost	No data received	No data received		This data is available with Revenue department.
12	Government buildings	Location, type, built-up area, no. of floors, construction	No data received	No data received		Plan to use satellite imagery, LULC map and open street map

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
		year, construction material and cost				
13	Fire Station	Location, staff, addresses, fire event details, built-up area, equipment, construction material, construction years and costs,	Location, no. of staff, address, fire event details, built-up area, equipment, construction material, construction year and cost,	Location-level event details are available with the Fire Department and they have promised to share the data, Because all details are on paper, it will be a time consuming task to convert into digital form.	2018	Will use RMSI data library and it will be further updated
14	Police Station	Location, name, type, no. of staff, built-up area, construction type and cost, construction year	No data received	No data received		Department of Police, Kashmir can provide this data
15	Potable water	Length of pipelines, Structural types, Diameter/capacity of water pipeline, construction costs	No data received	No data received		Expecting to get this data for at least the major towns from the Public Health Engineering Department, J&K
16	Waste water	Length of pipelines, structural types diameter/capacity of waste water pipelines, unit construction costs	No data received	No data received		Expecting to get this data for at least the major towns from the Public Health Engineering Department, J&K

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
17	Oil and Gas Infrastructure	Storage location, length and diameter of pipe, type, capacity, structural type, construction cost	No data received	No data received		
18	Electricity	Sub-station locations, Sub-stations capacity, types, length, no. of poles, building structural types, construction year, no. of rooms, no. of floors, plinth height, built-up area, construction cost	Data received for 30 towns of state which also include towns of Kashmir in GIS format	No data available for rural areas	2018	Power Development Department, Kashmir
19	Communication systems	Telephone exchange locations, mobile tower locations, length of landline network, building structural types, built-up area, construction years, construction costs	Location of mobile towers (lat/long) received for BSNL towers	Location details of offices, length of landline network, building structural types, built-up area, construction year, construction cost	2018	Department of Telecommunications, J&K
20	Cultural heritage/ religious places	Location, structure type, built-up area, construction year, construction cost	No data received	No data received		
21	Agriculture	Crop area, and yield of key crops	Crop area, 8 years yield production	Ideally, longer time period (20 years) crop yield data will	2009 - 2017	Agriculture Department, J&K and official website

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
				provide better modeling results		
22	Horticulture	Types of fruit crops, production, production areas	Types of fruit crops, production, production areas for last 10 years	No gap in this data	2017	Directorate of Horticulture J&K and official website
23	Livestock	Total Number of livestock and poultry at tehsil level	Received at district level	Data available as per livestock census 2011 statistics.	2011	Agriculture Department, J&K and official website

Table 23: Data inventory for exposure elements for Jammu division

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
1	Administrative boundary	District name, Tehsil name, Village name	All	Need to validate the village boundary information. Department of Ecology and Remote Sensing has got the village boundary data, yet to receive this. The boundary details are not authenticated	2011 and 2018	University of Kashmir. RMSI digitized the village boundary of Census 2011. We will update the new district, tehsil and village boundary as per district records.
2	Demographic data at village level	All key demographic variables	All	Data available as per 2011 statistics. We can apply growth rate to	2011	Census of India

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
				some demographic variables to arrive at latest estimated statistics. Aggregated figures at village level will be used for the analysis		
3	Building data	Building occupancy and type	All	Building classification has been done into residential, commercial and industrial. Location information of buildings is not available so aggregated figures at village level will be used for the analysis.	2011	Census of India
4	Road	Road type, length, no. of lanes, condition and construction cost	Road network in GIS with type and length	Number of lanes, conditions and construction costs. The network data needs to be validated using recent high resolution satellite data	2011	University of Kashmir and RMSI data library
5	Bridges	Bridge type, location, structural type, length, width, no. of spans,	No data received	No data received		

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
		condition, and construction cost				
6	Tunnels	Location, length and construction cost	No data received	No data received		Ideally this should come from PWD R&B, JKPCC and BRO
7	Railways	Rail network, railway stations, yards, quantity of goods transported, unit cost of construction of rail network and stations/yards	Railway network with length	Railway stations, yards, quantity of goods transported, unit cost of construction of rail network and stations/yards	2018	Indian Railways. The railway network was mapped from high resolution satellite imageries
8	Airports	Locations, runway lengths, surface types, airport building area, construction costs	No data received	No data receive		
9	Educational centers	Location, name, type, ownership, no of rooms, construction type, built-up area, construction material and cost, year of construction	Name, type, ownership, no. of rooms, staff and student enrollment	Location, construction type, cost, built-up area, no. of floors and year of construction have not been received	2018	Directorate of Samagra Siksha, J&K State has promised to give the location of the schools.
10	Health Centers	Location, name, type, ownership, no of rooms, no. of beds, construction type, Built-up area, construction	No data received	No data received		Directorate of Health Services, Jammu

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
		material and cost, year of construction				
11	Safe Shelters	Location, type, capacity of building, construction type, facilities, plinth height, construction material, and cost	No data received	No data received		This data is available with Revenue department.
12	Government buildings	Location, type, built-up area, no. of floors, construction year, construction material and cost	No data received	No data received	2018	Satellite imagery, LULC and open street data
13	Fire Stations	Location, staff, address, fire event details, built-up area, equipment, construction material, construction year and cost,	Location, no. of staff, address, fire event details, built-up area, equipment, construction material, construction year and cost,	Location level event details are available with fire department and they have promised to share the data, Because all details are on paper it will take time to convert into digital form.	2018	Will use RMSI data library and it will be further updated
13	Police Stations	Location, name, type, no. of staff, built-up area, construction type and cost, construction year	List of police stations with addresses received for Jammu region	type, no. of staff, built-up area, construction type and cost, construction year	2018	Department of Police, Jammu
14	Potable water	Length of pipelines, Structural types, Diameter/capacity	No data received	No data received		Expect to get at least for major urban areas from Public

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
		of water pipelines, construction costs				Health Engineering Department, J&K
15	Waste water	Length of pipelines, Structural types Diameter/capacity of waste water pipelines, Unit construction cost	No data received	No data received		Expect to get at least for major urban areas from Public Health Engineering Department, J&K
16	Oil and Gas Infrastructure	Storage locations, length and diameter of pipes, type ,capacity, Structural types, construction costs	No data received	No data received		
17	Electricity	Sub-station locations, Sub-station capacities, types, length, no. of poles, building structural types, construction year, no. of rooms, no. of floors, plinth height , built-up area construction cost	Received data for 30 towns of the state including that of Jammu region in GIS format	No data received for rural areas	2018	Power Development Department, Kashmir
18	Communication systems	Telephone exchange locations, mobile tower locations, lengths of landline network, Building structural types, built-up area,	Location of all BSNL towers, name of the base transceiver station (BTS) site along with name and address of	Length of landline network, building structural types, built-up area, construction year, construction cost	2018	Department of Telecommunications, J&K

S. No.	Data Sub-types	Key Attributes Required	Key Attributes Received	Identified Data Gaps	Vintage	Data Sources
		construction year, construction cost	Landlord of Bits sites			
19	Cultural heritage/ religious places	Location, Structure type, Built-up area, Construction year, construction cost	No data received	No data received		
20	Agriculture	Crop area and yield of key crops	Crop area, 8 years yield production	Ideally longer time period (20 years) crop yield data will provide better modeling results	2009 - 2017	Agriculture Department, J&K and official website
21	Horticulture	Types of fruit crops, production, production area	Type of fruit crops, production, production area for last 10 years	No gap in this data	2107	Directorate of Horticulture J&K and official website
22	Livestock	Total Number of livestock and poultry at tehsil level	Received at district level	Data available as per livestock census 2011 statistics.	2011	Agriculture Department, J&K and official website

Exposure data gaps and proposed plans to fill the gaps

Built up and infrastructure: There are extensive data gaps on several of the built up themes mentioned above, particularly in terms of location-specific information. The location details available presently of health institutions and government offices are available in the form building addresses with pin code only. For carrying out risk assessment, it is important to have location information in the form of coordinates. RMSI plans to use open source data including open street maps to locate the assets' coordinate details.

The occupancy and structure type of buildings in Census data is available for 2011 only at tehsil level. As we are planning to carry out analysis at village level, we plan to use statistical techniques and growth rates to disaggregate tehsil-level to village-level. We will also use built up cluster data extracted from high resolution satellite images to distribute the information across the villages.

Demography: While key demographic variables like male, female population, etc. are available at village level, some of the demographic variables like age classification, occupation type, etc. are available at tehsil level. For this, we will apply statistical techniques to disaggregate the data at village level.

Historical hazard event and lost data: historical hazard event data along with casualty, affected population and economic loss is critical for carrying out loss validation of the risk models planned to be developed for different hazards. We have been able to get significant event information and loss details based on desk research. The project team is collecting data from district authorities on event wise compensation details for the last 10 years. These are not organized systematically but are available in the monthly compensation report that districts send to the Divisional Commissioner's office. The compensation details, to a good extent, provide an indicator to the economic losses of an event. However, this does not capture business interruption type economic losses. For assessing economic impact of business interruption as proposed in the methodology section of the inception report, we will use deductive economic methods. Sector specific economic impact of hazards are likely to be available at district level and will be analyzed at district level only against the district GDP of that particular sector.

Essential facilities and safe shelters: Location specific information related to essential facilities and safe shelters are critical for developing decision support systems particularly for response and relief operations in the event of any disaster. A map, not to scale, showing the locations of hospitals of J&K is available on the health department web site. The addresses of the hospitals, once received, will be geo coded to have the exact locations of all the hospitals. The Education Department has confirmed that they will be providing the locations (lat/long details) of all schools in the State. The state has mapped all the schools in GIS and the data is being quality checked. The project team will consult respective district agencies to get information on all the safe shelters in the state. Information on safe shelters include the location details, structure type, condition of the structures, capacity of the shelter, and the accessibility to the shelters.

Section 4: Data for Vulnerability Assessment

Data for Vulnerability Assessment

Vulnerability assessment methodology under this project largely emphasizes on defining the damageability of specific structure typologies due to varying severity of hazard intensities. The hazard intensity measures will be made based on common practice internationally as well as widely used in India. Vulnerability related data – physical and social vulnerability will be collected at the same time of the exposure survey for buildings and infrastructure. We will largely rely on data generated from the structural survey and socio economic sample survey planning to do as part of this assignment along with historical damage data for the State and similar geographies. For social vulnerability, we will consider several social indicators and assess casualty and shelter needs for different hazards.

Physical Vulnerability Assessment

REQUIRED DATASETS AND THEIR COLLECTION, PROCESSING, AND GAP ANALYSIS/FILLING STATUS

Table 24: Status of datasets for Physical Vulnerability Assessment

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintages/ Publication dates	Resolutions	Remarks
1	Building occupancy type	Census Data	2011	At district and city level	Residential, commercial and industrial and this will be distributed at village level using statistical method
2	Structure typology	Census Data and field survey	Census data on 2011 and survey data 2018	Sample survey at tehsil level	We will classify the buildings based on roof and wall materials. We will also consider the local building typology based on field survey Field survey is expected to start in Dec 2018
3	Design specifications of buildings and structures	Sample drawing and field survey	2018	Sample survey	Design drawing requested to JKPCC for typical big structures
4	Damage functions of buildings and	Damage reports for major events	-	Hazard specific and	We will take expert opinion from the State

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintages/ Publication dates	Resolutions	Remarks
	structures to different hazards	in the State, published papers		structure specific	to further supplement the information
5	Building occupancy and structure type distribution	High resolution satellite data	2017	0.6 m	We will carry out cluster mapping using high resolution satellite imagery

Social Vulnerability Assessment

Wide range of social and economic data is required for carrying out social vulnerability assessment. While we rely on Census data to analyze the variations of social vulnerability across communities and space, we will depend on the primary data (household survey) for carrying out household specific vulnerability analysis.

Socio economic data were collected as part of the exposure data collection and is explained in the above Table 22 and Table 23. As mentioned in the tables, some of the demographic data is available at tehsil level, which will be disaggregated at village level using statistical techniques.

As part of the primary data collected, we are planning to collect extensive information at household level, which will be used for assessing the casualty functions of key hazards – earthquake and flood, shelter needs assessments, and community perception and awareness towards disaster management. We will also get a good understanding of the last mile connectivity of early warning systems presently available in the state, which will help in devising appropriate strategies while designing the IOFS.

Table 25: Status of datasets for Physical Vulnerability Assessment

S. No.	Data types	Key Data Sources/ Agencies Consulted	Vintages/ Publication dates	Resolutions	Remarks
1	Demographic data	Census Data	2011	At village level	Some of the demographic variable like disability, marital status, female HH, etc. are not available at village level. Statistical method will be adopted to distribute this at village level
2	Casualty data	Household survey	2018	Sample survey at tehsil level	Field survey is expected to start in Dec 2018
3	Safe shelter data	Household survey and Revenue Dept.	2018	Sample survey at tehsil level	We are yet to get safe shelter data from the Revenue Department. Field survey is expected to start in Dec 2018

Section 5: Summary

Summary

This section presents a summary of how the key gaps in data will be filled in the present study.

Hazard data

- Collected substantial data for hazard modeling including the historical event data, and bio-physical variables which are inputs for hazard modeling
- High resolution terrain model is required for all hydro-meteorological hazard modeling and as of now we have only SRTM 30 data available. We are planning to procure high resolution DEM for the flood plain areas of Jhelum River, which is relatively flat terrain to improve the quality of the hazard model. This will be integrated with SRTM 30 and used for the hydrological modeling
- We plan to replace the Jhelum hydrological model with the high resolution model that is being developed by other consultants as they are planning to procure LIDAR data for the modeling work. However, since the model will not be ready as per our project schedule, we will first develop our model and later replace this
- As location details of historical landslide hazard events are not available, we have reviewed satellite imageries to map landslide scars
- There are no industrial hazard events recorded in the past. Based on the information of the types of industries, we are planning to prepare an industrial hazard susceptibility map
- Urban fire hazard events are only available at fire station level and do not have event location details. This will limit the urban fire hazard modeling to a fire station level

Exposure and Vulnerability data

- There is a lack of geo referenced data of exposure elements. We plan to devise alternate methods of geo referencing the asset information mainly using satellite imageries and open source data. Where there is limitation of geo referencing asset data, we will confine exposure development to the use of aggregate information at village level or tehsil level
- Transport assets and building cluster data will be refined using high resolution satellite data and attributes will be collected from line departments and field based information
- For demographic and asset information, which are not available at village level, statistical methods will be applied to translate tehsil level information to village level.
- The team will continue collecting the pending data particularly related to utilities
- Information related to physical vulnerability and structural vulnerability will be mainly generated from the survey data. Damage functions available for India, particularly for other mountain states, will be reviewed to make necessary modifications and will be used in the present study. The building types typical to the state have been documented based on the reconnaissance survey and the building material table from Census data
- Data related to economic and/or cost of construction of various assets will be collected in the subsequent months.

DRDB

- We will keep provisions in the DRDB for data updating, which the state can update at a later stage. This will help in replacing low resolution data with better quality data as and when it is available and to help update the data over the time
- To ensure that the DRDB database is progressively updated, we will identify one or two resource persons in the Disaster Management Department of the state to play the role of data administrator. The data administrator will be trained to edit and replace the data layers in the DRDB. The data administrator will coordinate with all the line departments

to collect data on a regular basis and update it. The state may need to issue necessary government orders to formalize this process of data sharing.

- Key line department will be given training in DRDB to use the database not only for DRR activities but also for routine planning activities of the respective departments.

Section 6: Annexes

Annex 1: Details of historical earthquakes of more than 3.5 magnitude in and around J&K

Lat (deg)	Long (deg)	Depth (km)	Date	M
33.50	75.50	0.0	1555-09-02	7.6
33.30	73.25	0.0	1669-06-04	8.0
34.08	74.83	0.0	1828-06-06	5.6
34.60	74.38	0.0	1885-05-30	6.3
33.00	76.00	0.0	1905-04-04	7.8
32.00	77.00	0.0	1906-02-28	6.4
37.00	76.00	0.0	1910-07-12	6.8
34.20	77.50	0.0	1917-05-09	4.2
34.20	77.50	0.0	1917-05-17	4.2
32.00	74.00	0.0	1919-09-05	4.2
34.20	77.50	0.0	1921-11-11	4.2
35.50	77.00	0.0	1923-09-30	4.2
32.00	74.00	0.0	1924-04-03	4.2
37.00	72.00	0.0	1924-10-13	4.2
37.00	76.50	0.0	1925-12-07	5.6
35.50	78.50	0.0	1926-08-06	5.8
35.00	78.00	0.0	1926-08-06	4.2
34.00	73.00	0.0	1927-06-27	4.2
34.00	73.00	0.0	1927-06-29	4.2
35.50	77.00	0.0	1927-07-24	4.2
34.20	72.00	0.0	1927-09-05	4.2
34.20	72.00	0.0	1927-09-30	4.2
36.50	75.00	0.0	1928-04-12	4.2
34.20	72.00	0.0	1928-05-02	4.2
35.00	72.50	0.0	1928-11-14	5.6
36.50	75.00	0.0	1929-09-24	4.2
35.00	78.00	0.0	1929-11-16	4.2
36.00	78.00	0.0	1930-05-17	4.2
37.00	72.00	0.0	1930-05-24	4.2
37.00	72.00	0.0	1930-09-05	4.2
37.00	72.00	0.0	1931-01-20	4.2
37.00	72.00	0.0	1933-05-27	4.2
36.60	77.80	0.0	1933-07-15	4.2
32.96	77.88	0.0	1998-06-26	3.8
32.99	75.63	0.0	1998-07-06	4.3
37.35	72.08	0.0	1998-07-10	4.1
34.19	72.66	0.0	1998-07-12	4.7
35.36	78.38	0.0	1998-07-18	4.8
35.52	78.29	0.0	1998-07-19	4.8
35.50	78.40	0.0	1998-07-19	3.9
36.60	72.79	0.0	1998-07-21	4.1
36.90	73.75	0.0	1998-07-27	4.4
36.93	72.43	0.0	1998-07-30	3.9
35.24	77.82	0.0	1998-08-07	4.2
33.22	76.00	0.0	1998-08-17	3.6
37.40	72.22	0.0	1998-08-20	4.2
36.83	76.93	0.0	1998-08-31	3.9
35.46	78.28	0.0	1998-09-04	4.2
32.22	76.54	0.0	1998-10-17	4.6
35.41	77.48	0.0	1999-01-11	4.2
36.39	76.71	0.0	1999-01-21	4.4
36.28	76.66	0.0	1999-01-25	3.9
36.50	76.43	0.0	1999-01-29	4.0
33.20	74.12	0.0	1999-02-17	4.1
35.80	77.57	0.0	1999-02-22	4.3
34.06	74.44	0.0	1999-02-23	4.9
37.34	73.30	0.0	1999-02-27	3.8
37.28	72.00	0.0	1999-03-02	3.9
35.57	77.79	0.0	1999-04-22	4.2
33.24	73.22	0.0	1999-04-28	5.0
36.75	73.21	0.0	1999-05-09	5.3
32.51	78.43	0.0	1999-05-16	4.6
36.92	73.07	0.0	1999-05-18	4.2
36.88	73.83	0.0	1999-05-20	4.2
35.40	77.51	0.0	1999-05-29	4.7
34.56	80.08	0.0	1999-06-09	4.6

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.00	79.90	0.0	1933-10-19	4.2
36.70	72.20	0.0	1934-10-25	4.2
32.80	72.00	0.0	1935-06-02	4.2
36.50	75.00	0.0	1936-03-02	4.2
35.00	73.00	0.0	1937-11-07	5.4
35.40	78.00	0.0	1937-11-12	4.2
35.00	78.00	0.0	1937-11-15	4.2
36.70	74.00	0.0	1938-05-24	4.2
35.10	78.10	0.0	1938-09-30	4.2
34.00	77.00	0.0	1941-01-10	4.2
35.90	72.50	0.0	1942-12-19	4.2
36.50	74.00	0.0	1943-09-24	6.8
32.50	76.50	0.0	1945-06-22	6.3
36.00	77.00	0.0	1945-10-21	4.2
35.30	76.70	0.0	1946-05-06	4.2
36.00	77.00	0.0	1946-08-04	4.2
37.50	75.00	0.0	1946-12-29	4.2
33.00	77.00	0.0	1947-07-10	5.6
36.00	80.50	0.0	1948-02-13	4.2
35.80	74.20	0.0	1949-08-01	4.2
32.60	75.90	0.0	1950-08-12	5.6
33.50	80.00	0.0	1950-08-13	4.2
33.50	80.00	0.0	1950-08-17	4.2
36.50	75.50	0.0	1950-08-19	4.2
36.20	73.00	0.0	1950-09-12	5.6
33.30	76.50	0.0	1950-10-06	4.2
33.30	76.50	0.0	1951-09-12	4.2
32.60	75.90	0.0	1951-09-20	5.6
37.10	72.50	0.0	1952-02-04	4.2
37.00	77.20	0.0	1952-03-14	4.2
34.00	74.50	0.0	1953-03-01	4.2
37.20	72.50	0.0	1953-03-13	4.2
33.70	72.50	0.0	1953-05-01	5.3
35.70	74.80	0.0	1953-05-01	4.2
37.30	72.50	0.0	1954-01-23	6.5
34.60	73.20	0.0	1955-03-12	5.3

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.79	80.08	0.0	1999-06-13	4.4
34.89	80.01	0.0	1999-06-30	4.3
37.38	72.54	0.0	1999-07-08	5.4
37.22	72.64	0.0	1999-07-10	4.3
36.16	76.26	0.0	1999-07-12	4.5
32.72	72.75	0.0	1999-07-15	4.6
37.34	72.32	0.0	1999-07-18	4.9
37.11	77.35	0.0	1999-07-18	4.2
35.07	77.36	0.0	1999-09-04	4.1
33.18	75.22	0.0	1999-09-18	4.4
35.88	73.28	0.0	1999-10-07	4.6
34.99	72.93	0.0	1999-10-31	4.3
36.85	72.02	0.0	1999-11-26	3.9
33.14	75.57	0.0	1999-11-29	4.7
34.54	78.47	0.0	2000-01-08	4.7
33.53	76.48	0.0	2000-01-16	4.1
35.81	77.13	0.0	2000-01-23	4.4
37.50	72.55	0.0	2000-02-02	3.5
36.76	79.77	0.0	2000-02-18	4.3
33.46	75.60	0.0	2000-02-22	3.5
35.07	72.13	0.0	2000-02-29	4.4
35.29	73.58	0.0	2000-03-30	3.9
37.35	73.53	0.0	2000-04-09	4.4
32.37	79.07	0.0	2000-04-11	3.8
37.46	72.06	0.0	2000-05-15	4.4
33.41	78.56	0.0	2000-05-19	3.8
36.63	72.05	0.0	2000-05-20	4.0
37.27	72.17	0.0	2000-05-21	4.4
37.34	72.31	0.0	2000-05-25	4.1
33.74	74.71	0.0	2000-05-28	4.1
37.34	72.39	0.0	2000-06-03	4.5
35.47	75.09	0.0	2000-06-07	4.2
37.40	72.41	0.0	2000-06-09	4.7
32.02	78.44	0.0	2000-06-17	4.8
37.49	78.59	0.0	2000-06-17	4.1
32.17	78.49	0.0	2000-06-18	3.9

Lat (deg)	Long (deg)	Depth (km)	Date	M
32.50	78.60	0.0	1955-06-17	5.6
34.70	72.00	0.0	1956-09-25	4.2
37.10	72.90	0.0	1956-10-02	4.2
37.00	76.00	0.0	1956-11-15	6.8
32.40	78.70	0.0	1959-05-12	4.2
35.50	78.00	0.0	1960-02-04	5.3
33.50	75.40	0.0	1961-06-04	5.3
33.30	76.20	0.0	1962-06-17	5.6
36.40	77.50	0.0	1963-04-01	5.3
36.40	76.60	0.0	1963-06-26	5.6
33.90	74.70	0.0	1963-09-02	5.2
37.00	73.00	0.0	1964-01-23	4.9
35.60	74.40	0.0	1964-01-24	4.2
34.90	72.70	0.0	1964-02-13	4.6
37.10	72.10	0.0	1964-02-22	4.2
37.30	76.90	0.0	1964-03-03	4.2
37.20	74.00	0.0	1964-04-07	4.2
36.60	75.70	0.0	1964-05-19	4.2
37.10	72.10	0.0	1964-06-06	4.2
34.40	74.80	0.0	1964-06-12	4.2
35.80	73.40	0.0	1964-07-07	5.0
37.50	73.60	0.0	1964-07-11	4.2
35.50	73.00	0.0	1964-07-29	4.2
33.90	74.50	0.0	1964-08-03	4.8
37.50	74.50	0.0	1964-08-03	4.2
34.10	74.90	0.0	1964-08-03	4.2
35.00	72.30	0.0	1964-08-07	4.2
36.70	72.00	0.0	1964-08-12	4.2
34.60	72.90	0.0	1964-08-21	4.2
34.50	73.00	0.0	1964-09-01	4.2
37.30	72.00	0.0	1964-09-07	4.2
35.00	76.00	0.0	1964-09-16	4.2
36.00	73.10	0.0	1964-09-28	4.2
32.50	76.50	0.0	1964-10-04	6.3
35.50	76.00	0.0	1964-10-08	4.2
34.30	73.50	0.0	1964-11-01	4.2

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.25	77.45	0.0	2000-06-19	5.4
35.53	77.42	0.0	2000-06-23	4.1
32.10	78.44	0.0	2000-07-04	4.2
33.97	79.76	0.0	2000-07-05	4.7
37.42	72.89	0.0	2000-07-05	4.2
34.20	79.77	0.0	2000-07-05	4.1
34.10	79.78	0.0	2000-07-07	4.7
34.22	80.00	0.0	2000-07-09	4.1
33.81	79.90	0.0	2000-07-14	3.8
34.77	73.03	0.0	2000-07-17	5.0
37.21	72.00	0.0	2000-07-18	4.9
35.64	73.55	0.0	2000-07-20	4.6
35.42	77.67	0.0	2000-07-31	3.9
33.95	79.43	0.0	2000-08-09	3.7
35.62	75.73	0.0	2000-08-10	4.3
37.09	77.79	0.0	2000-08-30	4.6
32.00	78.41	0.0	2000-08-31	4.7
35.97	78.08	0.0	2000-09-10	4.3
35.67	74.02	0.0	2000-09-16	4.6
33.38	75.61	0.0	2000-09-26	4.7
37.47	72.33	0.0	2000-10-02	4.3
32.57	78.17	0.0	2000-10-12	4.7
35.26	77.59	0.0	2000-10-13	4.7
32.63	76.23	0.0	2000-10-13	4.2
35.57	78.53	0.0	2000-11-04	4.5
37.00	73.01	0.0	2000-12-11	4.1
32.54	76.89	0.0	2000-12-26	4.0
33.51	75.68	0.0	2001-01-08	4.3
34.21	79.71	0.0	2001-01-17	3.8
33.84	75.77	0.0	2001-01-25	4.5
36.04	77.52	0.0	2001-01-27	4.8
32.88	76.38	0.0	2001-01-30	3.6
33.21	75.81	0.0	2001-02-04	4.7
34.05	79.63	0.0	2001-02-09	4.3
34.58	73.80	0.0	2001-02-09	3.9
33.29	75.89	0.0	2001-02-20	4.7

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.00	75.50	0.0	1964-12-21	4.2
34.90	73.00	0.0	1964-12-31	4.6
35.30	72.80	0.0	1965-01-23	4.6
35.60	75.60	0.0	1965-01-29	5.4
35.60	73.60	0.0	1965-01-29	5.3
37.50	73.40	0.0	1965-02-02	5.6
36.40	73.00	0.0	1965-02-08	5.0
32.40	76.90	0.0	1965-02-21	4.6
36.80	73.10	0.0	1965-03-14	4.4
36.80	73.10	0.0	1965-04-27	4.4
32.60	78.20	0.0	1965-05-31	5.3
36.30	77.70	0.0	1965-06-22	5.6
36.60	73.00	0.0	1965-07-06	4.6
37.30	72.00	0.0	1965-08-14	4.2
34.60	73.40	0.0	1965-11-08	4.6
34.00	72.00	0.0	1966-01-11	5.2
33.90	73.00	0.0	1966-02-02	5.1
34.80	80.20	0.0	1966-03-09	4.6
33.10	75.90	0.0	1966-03-16	5.0
35.00	73.00	0.0	1966-04-06	5.4
35.70	72.20	0.0	1966-06-11	4.8
37.20	72.40	0.0	1966-06-13	4.8
32.60	79.60	0.0	1966-08-05	5.1
37.20	73.20	0.0	1966-08-24	4.6
37.30	72.10	0.0	1966-09-22	4.6
36.50	72.00	0.0	1966-10-16	4.2
36.90	72.00	0.0	1966-10-17	4.2
33.60	78.50	0.0	1966-10-20	4.9
34.00	72.50	0.0	1966-11-04	4.2
37.00	73.30	0.0	1966-12-01	4.4
33.00	75.50	0.0	1967-02-10	4.8
33.70	75.30	0.0	1967-02-20	5.4
33.60	75.30	0.0	1967-02-21	5.0
37.40	72.70	0.0	1967-04-24	5.3
36.10	77.80	0.0	1967-05-27	5.2
33.20	75.60	0.0	1967-07-02	4.8

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.53	78.96	0.0	2001-03-14	3.8
33.44	76.13	0.0	2001-03-24	3.6
36.39	74.44	0.0	2001-04-01	4.3
34.80	80.42	0.0	2001-04-11	4.6
37.13	72.00	0.0	2001-04-20	4.4
36.26	76.35	0.0	2001-04-21	3.8
32.71	76.80	0.0	2001-04-25	4.0
34.44	74.21	0.0	2001-05-04	4.4
35.21	77.68	0.0	2001-05-05	4.4
37.34	72.32	0.0	2001-05-06	4.9
37.44	72.08	0.0	2001-05-25	4.1
34.88	80.22	0.0	2001-06-14	3.8
32.48	78.31	0.0	2001-06-17	4.7
34.90	73.79	0.0	2001-06-20	4.8
33.01	73.12	0.0	2001-07-16	5.1
37.31	72.07	0.0	2001-07-24	5.1
37.04	72.08	0.0	2001-08-22	4.3
37.45	75.89	0.0	2001-09-25	3.8
33.26	75.74	0.0	2001-09-28	5.1
33.31	76.32	0.0	2001-10-03	3.9
32.56	76.07	0.0	2001-10-14	4.8
33.66	76.32	0.0	2001-10-20	4.2
34.06	79.69	0.0	2001-11-06	4.8
36.01	74.17	0.0	2001-11-13	4.7
35.48	77.62	0.0	2001-11-19	3.9
36.80	76.93	0.0	2001-12-14	3.9
34.59	73.03	0.0	2001-12-22	4.3
35.25	77.01	0.0	2001-12-25	4.7
35.31	76.89	0.0	2001-12-27	4.3
37.16	72.04	0.0	2001-12-27	3.9
35.22	76.86	0.0	2001-12-30	4.7
35.37	76.89	0.0	2001-12-30	4.6
35.34	76.88	0.0	2001-12-30	4.3
33.78	74.79	0.0	2002-01-07	4.2
33.12	75.91	0.0	2002-01-27	5.3
35.25	72.68	0.0	2002-02-18	4.7

Lat (deg)	Long (deg)	Depth (km)	Date	M
36.50	80.10	0.0	1967-08-28	4.7
32.60	76.10	0.0	1967-09-20	4.3
37.50	72.00	0.0	1967-12-19	5.2
34.10	78.50	0.0	1968-02-10	5.0
34.20	78.60	0.0	1968-02-11	5.0
34.70	72.30	0.0	1968-03-03	5.0
35.50	73.30	0.0	1968-04-09	4.5
37.40	72.30	0.0	1968-06-17	4.8
34.70	75.10	0.0	1968-07-03	4.6
37.20	72.70	0.0	1968-09-15	4.7
37.50	73.30	0.0	1968-10-19	5.2
37.40	73.20	0.0	1968-10-30	5.2
32.40	76.40	0.0	1968-11-05	4.8
32.20	76.00	0.0	1969-01-23	4.2
37.10	72.70	0.0	1969-08-26	4.7
36.20	76.10	0.0	1969-11-05	4.6
37.40	72.10	0.0	1970-01-23	4.6
37.10	72.00	0.0	1970-02-22	4.7
32.40	76.50	0.0	1970-03-05	4.8
37.50	72.60	0.0	1970-04-23	5.0
33.10	73.40	0.0	1970-04-30	4.9
34.80	73.20	0.0	1970-07-26	5.0
34.10	79.30	0.0	1970-08-11	4.8
34.40	73.50	0.0	1971-04-28	4.8
36.10	77.90	0.0	1971-05-16	4.6
36.10	77.70	0.0	1971-08-07	4.8
36.50	78.50	0.0	1971-08-29	4.9
37.50	72.10	0.0	1971-10-06	4.8
35.50	74.20	0.0	1971-12-21	5.0
35.10	73.10	0.0	1971-12-27	5.2
32.90	76.00	0.0	1972-01-29	4.7
34.60	80.30	0.0	1972-02-20	4.8
33.80	72.70	0.0	1972-03-10	4.8
36.10	73.60	0.0	1972-04-02	4.9
35.10	74.60	0.0	1972-04-09	4.8
34.00	72.90	0.0	1972-04-17	4.8

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.23	76.45	0.0	2002-03-14	4.3
34.35	76.22	0.0	2002-03-15	4.0
32.95	76.21	0.0	2002-03-18	4.4
34.37	76.26	0.0	2002-04-06	4.5
35.64	72.14	0.0	2002-04-07	4.3
35.59	76.55	0.0	2002-04-11	4.2
37.48	72.12	0.0	2002-04-14	4.1
35.36	74.33	0.0	2002-04-18	4.7
36.78	72.74	0.0	2002-04-24	4.0
37.37	72.62	0.0	2002-04-25	4.9
37.25	72.01	0.0	2002-04-28	3.6
36.37	73.45	0.0	2002-05-19	4.3
34.32	76.43	0.0	2002-05-23	4.5
34.37	76.74	0.0	2002-05-23	4.4
37.44	72.06	0.0	2002-05-23	3.9
37.25	72.61	0.0	2002-05-30	4.5
34.30	76.44	0.0	2002-06-04	4.4
35.86	72.12	0.0	2002-06-10	4.1
37.37	72.67	0.0	2002-06-18	4.7
37.30	72.14	0.0	2002-07-11	4.2
36.51	79.23	0.0	2002-08-01	4.6
33.88	72.87	0.0	2002-08-03	4.1
34.09	72.95	0.0	2002-08-18	4.3
36.78	72.14	0.0	2002-08-29	4.1
36.08	73.47	0.0	2002-09-09	4.2
37.19	78.08	0.0	2002-09-21	4.7
36.83	72.92	0.0	2002-10-02	4.5
35.52	74.65	0.0	2002-11-01	5.4
35.65	74.42	0.0	2002-11-02	5.2
35.43	74.55	0.0	2002-11-02	4.7
35.48	74.50	0.0	2002-11-02	4.7
35.44	74.49	0.0	2002-11-02	4.5
35.42	74.60	0.0	2002-11-03	5.3
35.18	74.54	0.0	2002-11-03	4.7
35.49	74.98	0.0	2002-11-03	3.8
35.53	74.76	0.0	2002-11-04	4.3

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.50	73.00	0.0	1972-07-21	4.3
35.90	73.30	0.0	1972-09-03	5.3
35.80	73.40	0.0	1972-09-04	5.0
35.80	73.50	0.0	1972-09-05	5.0
32.50	78.30	0.0	1972-09-06	5.1
36.00	73.60	0.0	1972-09-07	4.8
35.80	73.30	0.0	1972-09-17	5.2
36.00	73.60	0.0	1972-09-26	4.8
36.10	73.40	0.0	1972-09-27	5.0
33.90	72.70	0.0	1972-09-27	4.8
33.90	72.80	0.0	1972-10-01	4.2
34.50	73.60	0.0	1972-10-08	4.5
35.70	73.40	0.0	1972-10-15	5.0
35.90	73.50	0.0	1972-10-31	4.7
35.90	77.40	0.0	1972-11-22	4.8
35.10	72.40	0.0	1972-11-23	4.4
36.10	73.40	0.0	1973-01-15	5.0
33.20	75.70	0.0	1973-01-16	5.0
35.80	73.30	0.0	1973-01-29	5.2
33.10	75.70	0.0	1973-04-10	4.4
36.10	73.50	0.0	1973-04-14	4.3
36.60	77.10	0.0	1973-05-12	4.2
33.10	75.50	0.0	1973-07-13	4.8
33.20	75.50	0.0	1973-07-18	4.6
33.90	72.20	0.0	1973-09-27	4.8
34.00	73.90	0.0	1973-09-29	4.2
35.90	73.40	0.0	1973-10-02	4.8
35.90	73.30	0.0	1973-10-06	5.3
33.10	75.90	0.0	1973-10-24	5.0
32.90	75.50	0.0	1973-10-25	4.3
33.30	76.30	0.0	1973-10-30	4.2
37.20	72.20	0.0	1973-11-16	4.7
34.20	74.10	0.0	1973-12-16	5.0
32.30	76.00	0.0	1973-12-16	4.8
36.20	77.40	0.0	1974-01-01	4.6
34.00	72.60	0.0	1974-03-26	4.4

Lat (deg)	Long (deg)	Depth (km)	Date	M
36.60	74.48	0.0	2002-11-07	3.9
35.40	74.43	0.0	2002-11-08	4.1
35.37	74.17	0.0	2002-11-08	3.9
35.41	74.22	0.0	2002-11-19	3.8
35.41	74.51	0.0	2002-11-20	6.5
33.55	73.59	0.0	2002-11-22	4.4
35.04	73.80	0.0	2002-11-24	4.0
35.26	75.16	0.0	2002-12-19	3.9
35.73	75.81	0.0	2002-12-31	4.0
34.67	72.85	0.0	2003-01-28	4.2
35.37	76.29	0.0	2003-02-04	4.2
37.48	78.59	0.0	2003-02-05	4.0
35.51	76.86	0.0	2003-02-06	3.8
35.53	76.58	0.0	2003-02-11	4.1
33.38	75.69	0.0	2003-03-02	4.7
33.29	72.18	0.0	2003-03-03	4.0
37.48	72.14	0.0	2003-03-20	3.9
35.54	74.84	0.0	2003-03-22	4.1
35.37	74.47	0.0	2003-04-04	4.1
37.42	72.36	0.0	2003-04-06	3.9
33.49	76.58	0.0	2003-04-16	4.5
32.87	76.76	0.0	2003-04-27	4.2
35.78	78.32	0.0	2003-05-02	4.2
33.11	75.94	0.0	2003-05-11	4.5
37.15	79.00	0.0	2003-05-13	4.7
33.39	73.33	0.0	2003-05-22	4.7
35.66	74.82	0.0	2003-05-24	4.6
35.29	74.51	0.0	2003-05-31	4.4
37.28	72.70	0.0	2003-06-07	3.9
35.24	76.81	0.0	2003-06-18	4.3
35.66	73.08	0.0	2003-07-07	4.5
37.46	72.22	0.0	2003-07-08	4.7
37.36	72.09	0.0	2003-07-16	4.2
36.07	77.82	0.0	2003-08-23	4.6
35.47	74.66	0.0	2003-09-11	4.6
35.54	74.42	0.0	2003-09-11	4.1

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.10	72.50	0.0	1974-04-06	4.2
36.60	77.00	0.0	1974-04-13	4.7
36.90	72.50	0.0	1974-04-30	4.4
35.70	72.10	0.0	1974-05-11	4.7
36.40	76.40	0.0	1974-05-15	4.9
34.60	74.30	0.0	1974-05-20	4.8
35.90	79.70	0.0	1974-05-28	4.7
37.40	72.50	0.0	1974-07-05	5.0
37.10	78.90	0.0	1974-07-13	4.5
36.10	77.10	0.0	1974-08-15	4.6
37.50	72.30	0.0	1974-09-30	4.6
37.50	75.10	0.0	1974-10-22	4.2
35.60	77.50	0.0	1974-10-30	4.8
37.40	76.90	0.0	1974-11-15	4.9
32.80	76.10	0.0	1974-11-16	4.8
37.30	72.90	0.0	1974-12-18	4.4
35.10	72.90	0.0	1974-12-28	5.6
32.50	78.40	0.0	1975-01-19	5.7
32.50	78.60	0.0	1975-01-20	5.6
36.00	73.00	0.0	1975-02-01	4.8
32.20	78.50	0.0	1975-02-11	4.7
32.20	78.80	0.0	1975-03-10	4.8
35.50	74.40	0.0	1975-03-23	4.8
37.20	72.00	0.0	1975-03-31	4.6
34.90	73.10	0.0	1975-04-07	4.9
35.80	79.90	0.0	1975-04-28	5.4
35.90	80.00	0.0	1975-04-28	5.0
35.80	80.00	0.0	1975-04-29	4.9
35.90	79.80	0.0	1975-05-04	4.8
35.90	79.90	0.0	1975-05-05	4.9
32.80	73.20	0.0	1975-05-07	4.3
37.10	72.10	0.0	1975-05-07	4.2
32.40	78.50	0.0	1975-05-08	4.8
35.10	72.90	0.0	1975-05-10	5.6
35.90	79.80	0.0	1975-06-04	4.8
32.50	78.60	0.0	1975-06-10	5.6

Lat (deg)	Long (deg)	Depth (km)	Date	M
36.01	73.39	0.0	2003-09-20	4.9
36.47	76.61	0.0	2003-10-04	3.9
37.48	72.00	0.0	2003-10-05	3.8
36.85	72.32	0.0	2003-10-29	4.6
37.32	72.11	0.0	2003-11-25	4.5
37.30	72.02	0.0	2003-12-03	3.9
36.50	72.16	0.0	2003-12-08	3.9
32.55	76.63	0.0	2003-12-21	4.3
36.36	76.81	0.0	2003-12-24	4.0
36.39	72.04	0.0	2004-01-24	4.5
33.95	75.15	0.0	2004-02-04	4.2
37.35	79.39	0.0	2004-02-06	4.8
34.77	73.22	0.0	2004-02-14	5.5
36.79	78.44	0.0	2004-02-15	5.1
33.01	78.87	0.0	2004-02-23	3.9
36.69	73.09	0.0	2004-03-02	4.6
36.25	77.88	0.0	2004-03-15	4.7
34.91	72.88	0.0	2004-03-21	4.6
37.48	72.18	0.0	2004-04-05	4.3
37.48	73.57	0.0	2004-04-17	4.5
36.58	72.22	0.0	2004-04-17	4.3
37.19	72.16	0.0	2004-04-20	4.4
36.93	73.67	0.0	2004-04-27	4.4
35.73	78.37	0.0	2004-05-01	4.6
35.65	78.54	0.0	2004-06-29	4.4
33.69	77.00	0.0	2004-07-13	4.0
35.33	75.89	0.0	2004-07-15	4.0
32.19	77.17	0.0	2004-07-22	4.0
36.78	72.64	0.0	2004-07-28	4.6
33.96	72.84	0.0	2004-08-10	4.3
35.51	75.28	0.0	2004-08-11	4.0
35.38	74.60	0.0	2004-09-01	3.8
37.50	72.64	0.0	2004-09-01	3.6
35.72	78.25	0.0	2004-09-07	4.3
37.25	72.09	0.0	2004-09-27	4.1
35.20	77.67	0.0	2004-10-17	4.4

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.50	79.80	0.0	1975-07-17	4.7
32.10	78.50	0.0	1975-07-21	4.7
35.80	79.50	0.0	1975-07-23	4.4
35.60	74.30	0.0	1975-08-15	4.2
37.00	77.70	0.0	1975-08-25	4.4
34.80	80.50	0.0	1975-08-27	4.8
32.00	77.00	0.0	1975-09-16	6.4
32.00	78.80	0.0	1975-09-19	4.7
34.50	74.10	0.0	1975-10-17	4.4
37.20	78.00	0.0	1975-10-27	5.0
32.90	75.90	0.0	1975-10-30	5.0
32.00	78.80	0.0	1975-11-05	4.7
33.00	76.00	0.0	1975-12-05	7.8
35.70	79.70	0.0	1975-12-15	4.7
37.50	72.40	0.0	1975-12-15	4.2
35.70	79.70	0.0	1975-12-18	4.7
35.80	79.60	0.0	1976-01-17	4.8
37.10	72.10	0.0	1976-01-23	4.2
32.90	74.30	0.0	1976-02-25	4.6
36.80	74.30	0.0	1976-03-11	4.8
35.80	73.40	0.0	1976-03-22	5.0
32.70	76.50	0.0	1976-04-10	4.6
32.90	76.00	0.0	1976-04-16	4.7
32.70	75.70	0.0	1976-05-22	4.4
37.10	78.70	0.0	1976-06-30	4.9
32.30	78.30	0.0	1976-07-06	4.8
35.80	79.80	0.0	1976-07-13	4.8
35.60	79.50	0.0	1976-07-14	4.6
35.80	79.40	0.0	1976-07-15	4.6
35.70	79.50	0.0	1976-07-16	4.8
34.70	79.30	0.0	1976-08-01	4.6
37.30	78.60	0.0	1976-08-28	4.6
32.00	78.70	0.0	1976-09-08	5.2
37.20	75.20	0.0	1976-09-24	4.4
37.20	73.00	0.0	1976-11-24	4.7
37.30	72.20	0.0	1976-12-18	4.7

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.46	76.80	0.0	2004-10-17	4.3
37.20	72.12	0.0	2004-10-19	4.0
37.40	75.75	0.0	2004-10-27	4.5
35.37	74.41	0.0	2004-10-31	5.6
35.49	74.57	0.0	2004-10-31	4.8
35.21	74.11	0.0	2004-10-31	3.9
36.51	76.75	0.0	2004-11-03	3.7
37.39	72.24	0.0	2004-11-04	4.4
37.23	72.09	0.0	2004-11-10	4.4
32.44	76.51	0.0	2004-11-11	4.9
32.22	76.41	0.0	2004-11-11	4.2
36.62	72.12	0.0	2004-11-14	4.8
37.28	72.22	0.0	2004-11-28	4.1
33.24	74.89	0.0	2004-11-28	4.0
36.59	76.86	0.0	2004-12-19	3.9
34.79	72.67	10.0	2005-01-01	4.1
34.27	80.01	39.0	2005-01-17	4.5
34.68	73.37	22.0	2005-02-05	4.8
34.73	73.58	18.0	2005-02-09	4.4
32.53	76.62	12.0	2005-02-28	4.8
35.82	75.86	22.0	2005-02-28	4.6
34.52	74.81	40.0	2005-04-05	4.1
32.57	76.36	31.0	2005-04-14	4.8
32.67	76.41	20.0	2005-04-18	4.2
37.29	72.40	194.0	2005-05-03	4.2
33.75	73.18	10.0	2005-05-07	4.4
35.63	78.38	98.0	2005-05-19	4.3
36.62	72.08	200.0	2005-06-13	4.2
37.45	72.22	181.0	2005-06-23	4.6
32.73	76.31	20.0	2005-07-04	4.8
37.37	72.15	122.0	2005-07-08	4.2
36.54	76.77	63.0	2005-07-14	4.1
37.26	72.05	178.0	2005-07-19	4.8
35.34	77.79	10.0	2005-07-20	4.3
37.49	72.35	169.0	2005-07-26	4.4
35.69	73.71	95.0	2005-08-15	4.8

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.40	72.30	0.0	1976-12-19	4.8
32.80	75.80	0.0	1977-01-21	4.6
33.60	73.30	0.0	1977-02-14	5.0
36.80	72.10	0.0	1977-03-04	4.9
36.70	76.80	0.0	1977-03-24	4.6
32.70	78.50	0.0	1977-03-27	4.9
33.30	74.00	0.0	1977-04-09	4.7
32.00	78.50	0.0	1977-04-14	4.4
37.40	72.00	0.0	1977-05-10	4.6
33.10	76.00	0.0	1977-06-22	4.8
37.40	72.00	0.0	1977-07-04	4.6
34.90	76.50	0.0	1977-09-13	4.7
37.00	79.60	0.0	1977-09-14	4.8
37.30	72.10	0.0	1977-10-13	4.6
32.70	78.40	0.0	1977-10-19	4.8
33.40	76.10	0.0	1977-12-20	4.7
32.80	76.60	0.0	1977-12-21	5.0
37.38	72.00	0.0	1978-02-19	3.9
33.49	76.05	0.0	1978-02-23	4.9
35.91	77.93	0.0	1978-03-14	4.7
32.85	78.30	0.0	1978-03-30	4.3
32.63	78.62	0.0	1978-04-11	4.6
35.07	72.96	0.0	1978-04-27	5.0
33.44	73.53	0.0	1978-05-07	5.0
37.37	72.22	0.0	1978-05-30	4.2
34.47	80.48	0.0	1978-06-01	4.7
32.31	76.52	0.0	1978-06-14	5.0
33.51	76.15	0.0	1978-09-28	4.7
37.10	72.18	0.0	1978-10-21	4.0
32.89	72.72	0.0	1978-11-18	4.9
37.15	73.86	0.0	1978-12-28	4.7
37.46	72.21	0.0	1979-01-26	4.7
35.98	77.36	0.0	1979-03-04	4.7
33.92	73.16	0.0	1979-03-04	4.7
35.81	73.16	0.0	1979-03-17	4.5
32.06	78.61	0.0	1979-03-27	4.4

Lat (deg)	Long (deg)	Depth (km)	Date	M
36.94	79.17	18.0	2005-08-25	5.4
37.05	79.46	10.0	2005-08-25	4.6
34.46	73.58	19.0	2005-10-08	7.6
33.08	76.21	10.0	2005-10-11	4.2
34.51	75.56	10.0	2005-11-16	4.8
34.75	80.07	35.0	2005-11-29	4.6
34.81	77.47	10.0	2005-12-15	4.1
36.77	72.28	165.0	2005-12-24	4.2
34.61	73.35	10.0	2006-01-04	4.4
34.58	73.14	10.0	2006-01-04	4.3
34.51	73.62	25.0	2006-01-06	4.6
34.25	73.73	10.0	2006-01-07	4.1
34.61	73.19	10.0	2006-01-08	4.1
34.08	73.93	10.0	2006-01-11	4.8
34.18	73.67	10.0	2006-01-13	4.5
32.79	78.58	10.0	2006-01-17	4.7
34.68	80.23	10.0	2006-01-22	4.4
34.21	73.50	10.0	2006-01-22	4.1
34.20	73.86	10.0	2006-02-01	4.7
34.68	73.18	10.0	2006-02-02	4.9
34.39	73.68	32.0	2006-02-05	4.5
34.79	73.28	10.0	2006-02-08	4.8
34.75	73.28	10.0	2006-02-08	4.2
34.46	73.39	10.0	2006-02-09	4.5
34.34	73.75	10.0	2006-02-11	4.8
34.66	73.36	10.0	2006-02-12	4.1
34.63	73.50	10.0	2006-02-22	4.4
34.41	73.60	10.0	2006-03-02	4.8
33.13	73.89	10.0	2006-03-10	4.9
34.62	73.20	14.0	2006-03-19	4.9
34.58	73.21	10.0	2006-03-19	4.5
34.76	73.75	12.0	2006-03-20	5.2
34.62	73.41	10.0	2006-03-26	4.2
37.36	72.20	116.0	2006-03-28	4.1
34.60	73.14	10.0	2006-04-04	4.6
37.27	72.16	173.0	2006-04-09	4.1

Lat (deg)	Long (deg)	Depth (km)	Date	M
32.09	78.81	0.0	1979-05-11	4.5
36.33	77.88	0.0	1979-05-24	4.7
33.55	76.37	0.0	1979-05-27	4.8
33.11	76.23	0.0	1979-06-11	4.7
34.44	74.30	0.0	1979-07-02	4.6
35.86	78.32	0.0	1979-08-29	4.5
36.37	78.79	0.0	1979-09-07	4.6
36.97	78.31	0.0	1979-10-14	4.5
35.70	79.74	0.0	1979-12-03	4.3
37.40	72.11	0.0	1979-12-05	4.7
33.15	75.84	0.0	1979-12-22	4.8
33.14	75.85	0.0	1980-01-07	4.8
36.72	78.73	0.0	1980-01-08	4.7
32.74	72.53	0.0	1980-02-09	4.1
36.52	76.89	0.0	1980-02-13	6.2
36.47	72.09	0.0	1980-03-12	4.5
32.78	73.96	0.0	1980-03-29	4.7
33.14	73.21	0.0	1980-03-29	4.3
33.02	75.92	0.0	1980-05-01	5.0
33.06	75.99	0.0	1980-05-01	4.7
37.45	72.29	0.0	1980-05-09	4.1
37.18	72.22	0.0	1980-05-15	4.7
35.72	72.14	0.0	1980-07-10	4.7
35.68	77.58	0.0	1980-08-11	5.0
32.91	75.63	0.0	1980-08-23	5.2
32.46	78.52	0.0	1980-09-22	4.7
34.65	74.33	0.0	1980-10-05	4.3
35.13	77.11	0.0	1980-10-08	5.1
35.16	77.98	0.0	1981-01-26	4.6
35.17	72.83	0.0	1981-01-31	4.7
35.09	72.40	0.0	1981-02-18	4.7
37.21	72.70	0.0	1981-06-10	4.8
34.10	74.67	0.0	1981-06-23	4.9
32.74	76.00	0.0	1981-07-12	4.6
36.42	76.21	0.0	1981-07-24	4.9
37.23	78.55	0.0	1981-08-12	4.7

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.59	73.20	10.0	2006-04-10	4.1
34.60	72.98	10.0	2006-04-27	4.1
34.50	73.40	10.0	2006-05-02	4.2
34.68	73.22	10.0	2006-05-03	4.4
37.47	72.41	184.0	2006-05-05	4.2
32.66	76.69	14.0	2006-05-09	4.5
36.29	76.14	25.0	2006-05-25	4.4
37.32	72.11	168.0	2006-05-25	4.2
33.15	76.24	67.0	2006-05-26	5.0
37.20	72.16	143.0	2006-05-31	4.1
34.75	73.71	10.0	2006-06-26	4.2
34.95	73.97	48.0	2006-07-08	4.7
32.78	77.38	31.0	2006-07-18	4.3
34.77	80.41	15.0	2006-08-02	4.7
37.37	74.73	11.0	2006-08-06	5.6
37.39	72.12	182.0	2006-08-11	4.8
34.83	80.25	55.0	2006-08-13	4.1
34.90	73.00	58.0	2006-09-09	4.2
35.47	78.23	15.0	2006-09-11	5.5
36.66	76.60	106.0	2006-09-14	4.9
34.75	73.13	10.0	2006-09-25	4.3
33.23	75.49	10.0	2006-09-28	4.1
34.66	80.20	10.0	2006-10-13	4.5
34.43	73.49	10.0	2006-10-24	4.3
37.45	74.54	72.0	2006-11-04	4.2
37.34	72.10	217.0	2006-11-06	4.5
36.06	75.95	42.0	2006-11-09	4.6
35.70	78.20	10.0	2006-11-25	4.2
34.63	73.60	10.0	2006-11-29	4.2
37.30	72.19	180.0	2006-12-08	4.2
36.99	72.20	189.0	2006-12-22	4.6
35.89	74.17	55.0	2007-01-18	4.7
37.43	72.27	198.0	2007-01-22	4.7
37.32	72.37	120.0	2007-01-27	4.1
32.10	78.58	35.0	2007-02-03	4.8
36.73	72.97	54.0	2007-02-11	5.1

Lat (deg)	Long (deg)	Depth (km)	Date	M
33.27	75.44	0.0	1981-08-17	4.8
37.23	72.11	0.0	1981-08-29	4.1
34.58	78.97	0.0	1981-08-31	4.8
35.69	73.59	0.0	1981-09-12	6.3
34.83	77.38	0.0	1981-09-15	4.6
35.74	73.91	0.0	1981-09-15	4.5
37.46	73.16	0.0	1981-09-25	4.7
33.24	75.52	0.0	1981-09-27	4.6
36.44	74.40	0.0	1981-10-18	4.3
33.35	75.75	0.0	1981-11-09	4.7
37.20	72.01	0.0	1981-11-22	4.4
33.03	75.46	0.0	1981-12-14	4.6
36.83	72.07	0.0	1981-12-21	4.4
35.59	73.76	0.0	1982-02-22	5.4
36.55	80.29	0.0	1982-03-12	4.8
37.17	78.60	0.0	1982-04-26	4.7
32.61	75.89	0.0	1982-05-07	4.8
35.48	73.51	0.0	1982-05-15	4.6
36.00	79.65	0.0	1982-06-28	4.7
36.34	76.75	0.0	1982-07-09	5.3
35.77	79.51	0.0	1982-07-28	4.6
35.69	73.60	0.0	1982-08-12	4.8
37.40	72.36	0.0	1982-08-18	4.8
37.25	75.11	0.0	1982-08-24	4.7
37.32	72.10	0.0	1982-08-29	4.4
33.01	76.11	0.0	1982-09-04	4.4
37.26	72.89	0.0	1982-09-29	5.4
37.16	72.66	0.0	1982-10-06	4.7
37.21	72.00	0.0	1982-10-08	4.9
36.95	77.14	0.0	1983-01-14	4.7
35.73	77.92	0.0	1983-02-25	4.9
32.61	78.55	0.0	1983-02-27	5.3
34.53	79.73	0.0	1983-05-31	5.0
32.09	72.55	0.0	1983-07-13	4.7
34.89	74.86	0.0	1983-08-09	4.4
35.87	73.79	0.0	1983-08-11	4.7

Lat (deg)	Long (deg)	Depth (km)	Date	M
36.85	79.53	26.0	2007-02-12	4.4
37.15	72.10	160.0	2007-02-13	4.1
37.31	72.12	205.0	2007-02-17	4.8
37.44	72.22	190.0	2007-02-22	4.5
32.44	72.24	54.0	2007-02-22	4.1
34.74	73.20	10.0	2007-03-09	4.1
35.87	78.31	88.0	2007-04-11	4.5
37.18	72.18	200.0	2007-05-14	4.7
34.05	72.49	10.0	2007-05-20	4.4
34.25	73.68	15.0	2007-06-08	4.7
37.41	72.28	197.0	2007-06-13	4.8
32.11	76.82	10.0	2007-06-14	4.4
37.41	74.06	117.0	2007-06-28	4.2
36.79	72.17	77.0	2007-07-05	4.6
37.41	72.18	194.0	2007-07-10	4.4
34.83	73.22	57.0	2007-07-21	4.5
37.32	78.73	35.0	2007-07-22	4.6
37.48	72.56	205.0	2007-07-22	4.1
36.35	76.78	84.0	2007-07-30	4.8
37.44	72.46	139.0	2007-08-03	4.2
35.50	75.04	169.0	2007-08-05	4.3
34.77	73.21	55.0	2007-08-12	4.7
37.24	72.05	164.0	2007-08-23	4.7
33.58	73.65	53.0	2007-08-29	4.1
37.28	72.21	218.0	2007-09-03	4.8
37.43	72.42	201.0	2007-09-27	4.8
32.69	76.34	10.0	2007-10-04	4.7
34.52	74.40	51.0	2007-10-06	4.3
37.00	72.16	120.0	2007-10-18	4.4
35.65	77.43	82.0	2007-10-24	4.3
35.30	76.75	10.0	2007-10-26	5.2
37.39	72.15	190.0	2007-10-30	4.6
35.43	73.33	53.0	2007-11-12	4.9
36.67	80.05	43.0	2007-11-13	4.9
37.29	72.33	211.0	2007-12-06	4.4
34.99	77.48	16.0	2007-12-11	5.1

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.47	72.57	0.0	1983-09-24	4.6
33.52	75.46	0.0	1983-10-12	4.7
34.69	73.02	0.0	1984-01-18	5.3
34.28	72.13	0.0	1984-02-18	4.8
34.22	79.64	0.0	1984-03-14	5.2
34.67	79.63	0.0	1984-04-11	4.8
36.42	79.12	0.0	1984-05-18	4.8
32.95	75.92	0.0	1984-05-23	4.8
34.83	73.10	0.0	1984-06-04	4.9
37.32	72.09	0.0	1984-06-21	4.8
35.88	74.71	0.0	1984-07-29	4.7
34.87	74.20	0.0	1984-08-15	4.6
37.01	72.11	0.0	1984-09-06	4.8
36.31	76.33	0.0	1984-09-10	5.1
36.83	76.78	0.0	1984-09-26	4.7
36.80	75.75	0.0	1984-10-25	4.8
37.12	72.04	0.0	1984-11-08	4.6
32.98	72.71	0.0	1984-12-20	4.7
32.76	72.65	0.0	1984-12-27	4.6
34.62	73.66	0.0	1984-12-28	4.7
36.26	78.04	0.0	1985-01-05	4.8
37.17	72.47	0.0	1985-01-21	4.7
37.41	72.15	0.0	1985-02-11	4.7
34.23	74.42	0.0	1985-02-25	4.8
37.36	73.65	0.0	1985-03-29	4.6
37.44	72.27	0.0	1985-04-02	4.5
33.01	73.25	0.0	1985-04-23	4.7
36.29	73.39	0.0	1985-05-14	4.7
36.63	76.96	0.0	1985-06-13	5.0
36.90	77.17	0.0	1985-06-13	4.5
35.93	73.72	0.0	1985-06-24	4.7
33.89	74.74	0.0	1985-08-10	4.7
37.17	72.08	0.0	1985-09-08	4.6
35.41	72.95	0.0	1985-09-12	4.3
37.49	76.83	0.0	1985-11-03	4.7
33.16	72.97	0.0	1985-11-18	4.3

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.64	73.22	16.0	2007-12-12	4.2
37.14	72.00	180.0	2007-12-14	4.8
37.26	72.11	204.0	2007-12-19	4.6
35.22	76.66	74.0	2007-12-26	4.1
36.94	72.36	150.0	2008-01-08	4.5
37.47	72.48	136.0	2008-01-29	4.1
36.27	75.83	10.0	2008-02-12	4.1
37.47	72.02	215.0	2008-02-21	4.2
37.23	72.06	118.0	2008-02-25	4.8
33.71	74.94	28.0	2008-02-25	4.4
35.46	74.99	31.0	2008-03-01	4.5
35.38	74.88	35.0	2008-03-01	4.4
37.35	72.27	203.0	2008-03-05	4.4
33.77	75.03	39.0	2008-03-05	4.3
34.61	73.29	19.0	2008-03-09	4.7
34.13	73.90	47.0	2008-03-11	4.2
35.33	75.15	121.0	2008-03-16	4.3
36.80	72.24	254.0	2008-03-19	4.1
35.49	73.45	10.0	2008-03-27	4.1
37.21	72.03	127.0	2008-04-02	4.4
35.97	72.46	35.0	2008-04-07	4.1
37.45	72.18	174.0	2008-04-20	4.6
36.86	77.24	112.0	2008-05-07	4.9
33.06	76.12	45.0	2008-05-10	4.5
37.35	72.15	224.0	2008-06-04	5.0
32.97	76.37	36.0	2008-06-15	4.4
35.26	75.89	44.0	2008-08-04	4.2
37.31	72.00	194.0	2008-08-21	4.6
36.67	76.95	97.0	2008-08-22	4.7
36.09	73.70	57.0	2008-09-22	4.8
37.27	72.22	229.0	2008-09-25	4.1
34.97	73.66	56.0	2008-09-27	4.2
37.43	76.10	123.0	2008-09-30	4.8
37.41	72.56	183.0	2008-10-08	4.4
37.40	72.16	200.0	2008-10-29	4.1
37.36	72.17	166.0	2008-11-08	4.6

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.86	73.61	0.0	1985-12-11	4.7
32.62	76.10	0.0	1985-12-29	4.9
37.15	72.06	0.0	1986-01-07	4.3
37.34	72.02	0.0	1986-04-24	4.1
34.94	73.60	0.0	1986-04-25	4.0
32.13	76.37	0.0	1986-04-26	5.5
37.26	72.09	0.0	1986-04-26	4.6
36.18	77.62	0.0	1986-05-08	4.6
35.20	78.71	0.0	1986-05-11	4.5
36.97	73.14	0.0	1986-06-01	4.7
34.42	80.16	0.0	1986-07-06	6.2
34.67	79.72	0.0	1986-07-06	4.4
34.13	79.66	0.0	1986-07-19	4.7
33.16	75.79	0.0	1986-07-30	4.7
36.85	77.23	0.0	1986-08-10	4.9
35.84	72.94	0.0	1986-08-24	4.8
36.09	77.92	0.0	1986-08-26	4.9
36.38	78.19	0.0	1986-08-26	4.2
36.89	76.81	0.0	1986-09-10	4.8
32.66	78.56	0.0	1986-09-11	4.8
36.46	79.47	0.0	1986-11-06	4.6
37.50	72.90	0.0	1986-12-20	4.5
34.56	80.33	0.0	1987-01-10	4.7
34.84	75.57	0.0	1987-02-02	4.5
37.23	72.06	0.0	1987-02-04	4.8
36.34	77.61	0.0	1987-04-07	4.1
34.49	80.28	0.0	1987-04-18	4.7
37.42	72.35	0.0	1987-05-04	4.6
36.47	73.67	0.0	1987-07-11	4.4
33.34	73.45	0.0	1987-07-12	4.6
34.58	79.89	0.0	1987-08-29	4.7
36.72	76.34	0.0	1987-08-31	4.9
35.74	78.01	0.0	1987-09-22	4.7
36.76	76.64	0.0	1987-10-13	4.7
37.38	75.07	0.0	1987-11-06	4.0
37.31	72.00	0.0	1987-11-25	4.9

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.09	72.11	178.0	2008-11-20	4.2
37.37	72.27	197.0	2008-12-05	4.3
37.10	72.27	110.0	2008-12-06	4.8
36.40	76.96	98.0	2008-12-15	4.3
37.45	72.31	192.0	2008-12-17	4.8
34.67	73.24	39.0	2008-12-17	4.3
36.20	76.22	42.0	2008-12-19	4.1
35.87	73.51	85.0	2008-12-21	4.6
37.23	72.00	201.0	2008-12-22	4.4
37.23	72.06	145.0	2008-12-31	4.6
35.87	72.34	42.0	2009-01-13	4.8
37.09	72.04	138.0	2009-01-20	4.8
36.18	76.39	37.0	2009-01-27	4.1
34.38	73.62	71.0	2009-02-04	4.2
34.40	73.48	9.0	2009-02-08	4.7
34.20	73.90	12.0	2009-02-20	5.5
36.10	78.02	107.0	2009-03-08	4.7
36.12	77.09	20.0	2009-03-16	4.7
35.30	72.31	65.0	2009-03-20	4.2
34.67	73.09	42.0	2009-04-03	4.6
34.77	73.10	13.0	2009-04-06	4.7
33.20	75.79	21.0	2009-05-19	4.9
36.27	77.54	99.0	2009-05-21	5.1
35.01	73.16	66.0	2009-06-06	4.4
34.88	73.13	63.0	2009-07-13	4.5
32.72	76.71	35.0	2009-07-17	4.7
34.90	73.22	49.0	2009-07-27	5.0
34.85	80.38	23.0	2009-10-25	5.0
36.91	79.48	10.0	2009-11-14	4.6
36.44	80.13	10.0	2009-11-14	4.5
36.92	79.30	10.0	2009-11-15	4.7
35.53	72.96	63.0	2009-11-22	4.5
35.78	77.35	72.0	2009-12-06	5.2
37.06	72.78	150.0	2009-12-19	4.5
35.02	73.01	64.0	2009-12-29	4.1
34.29	75.71	57.0	2010-03-13	4.8

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.13	72.73	0.0	1987-12-08	4.5
32.13	76.69	0.0	1987-12-26	4.4
34.81	74.98	0.0	1988-01-20	4.7
36.70	73.16	0.0	1988-03-15	4.6
32.13	74.46	0.0	1988-04-02	4.1
34.63	79.56	0.0	1988-04-12	4.6
36.56	73.00	0.0	1988-04-23	4.8
36.93	73.26	0.0	1988-04-25	4.8
36.57	72.67	0.0	1988-04-25	4.7
37.03	72.91	0.0	1988-07-20	5.5
34.59	79.63	0.0	1988-07-25	4.3
36.78	72.32	0.0	1988-07-27	4.6
35.71	75.93	0.0	1988-08-13	4.7
32.60	79.79	0.0	1988-09-23	4.7
32.74	80.05	0.0	1988-09-26	4.5
36.23	72.65	0.0	1988-12-03	4.8
33.97	72.91	0.0	1988-12-07	4.7
36.35	78.46	0.0	1988-12-19	4.7
37.34	72.08	0.0	1988-12-31	4.4
36.34	78.32	0.0	1989-01-06	4.1
36.31	76.76	0.0	1989-02-14	4.7
35.83	77.68	0.0	1989-03-07	4.7
33.72	73.08	0.0	1989-04-07	4.3
36.47	73.42	0.0	1989-04-19	4.9
33.22	75.52	0.0	1989-05-10	4.8
33.31	75.45	0.0	1989-05-10	4.0
37.15	72.07	0.0	1989-06-25	4.2
36.79	73.07	0.0	1989-11-24	4.5
36.57	73.25	0.0	1990-02-05	4.1
34.37	76.65	0.0	1990-02-07	4.7
34.62	79.85	0.0	1990-03-04	4.7
36.91	73.02	0.0	1990-03-05	6.1
36.73	72.71	0.0	1990-03-08	4.4
37.03	72.94	0.0	1990-03-25	6.4
35.59	73.88	0.0	1990-04-05	5.4
36.45	72.27	0.0	1990-05-21	4.4

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.30	74.50	44.0	2010-03-14	5.2
37.49	74.63	50.0	2010-03-23	5.1
33.78	75.15	40.0	2010-03-23	4.3
36.43	77.24	88.0	2010-04-08	4.5
34.90	73.09	53.0	2010-04-20	4.6
35.99	76.92	102.0	2010-04-23	4.7
35.16	75.18	48.0	2010-04-26	4.7
36.08	75.98	66.0	2010-06-02	4.5
36.64	76.95	86.0	2010-06-03	4.7
33.24	76.30	35.0	2010-06-04	4.6
37.44	72.36	206.0	2010-06-23	4.5
34.12	78.74	68.0	2010-08-14	4.2
36.98	72.34	53.0	2010-08-17	4.5
35.97	73.49	48.0	2010-08-27	4.1
33.72	75.37	26.0	2010-09-11	4.8
33.87	72.89	33.0	2010-10-10	5.2
37.13	73.23	55.0	2010-10-21	4.8
35.00	73.81	59.0	2010-10-29	4.1
34.39	74.08	71.0	2010-11-07	4.5
36.24	73.19	54.0	2011-02-09	4.9
34.98	74.00	42.0	2011-03-18	4.5
36.28	76.49	77.0	2011-03-23	4.8
36.61	76.71	87.0	2011-04-02	4.7
36.23	72.18	90.0	2011-04-25	5.0
33.05	76.82	10.0	2011-04-28	4.3
34.76	72.90	50.0	2011-06-03	4.3
32.30	72.35	48.0	2011-06-07	4.7
36.20	73.04	58.0	2011-06-10	4.7
36.10	72.63	83.0	2011-06-14	4.4
35.15	75.49	47.0	2011-06-21	4.6
34.62	73.32	46.0	2011-07-12	4.3
33.32	76.00	33.0	2011-07-28	4.6
33.10	76.86	15.0	2011-08-23	5.1
36.85	72.21	35.0	2011-08-29	4.3
34.04	75.25	61.0	2011-09-24	4.3
36.59	76.70	82.0	2011-09-27	5.0

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.31	72.60	0.0	1990-05-22	4.1
37.33	72.12	0.0	1990-06-14	4.2
37.26	72.33	0.0	1990-06-24	4.6
37.12	72.56	0.0	1990-06-25	4.5
37.19	72.92	0.0	1990-07-02	5.1
37.38	72.13	0.0	1990-07-09	4.7
34.76	80.21	0.0	1990-08-05	4.4
35.56	73.82	0.0	1990-08-08	4.8
37.41	72.14	0.0	1990-08-12	4.1
37.38	72.00	0.0	1990-09-20	3.9
36.57	77.88	0.0	1990-10-04	4.3
37.45	72.26	0.0	1990-11-10	4.5
33.41	75.71	0.0	1990-11-12	4.8
34.85	75.08	0.0	1990-12-20	4.3
35.77	73.66	0.0	1990-12-21	4.7
35.66	78.47	0.0	1990-12-23	4.2
33.33	75.71	0.0	1990-12-25	5.3
34.33	74.66	0.0	1991-01-10	4.0
32.00	72.84	0.0	1991-01-13	4.6
37.39	72.06	0.0	1991-01-26	4.1
34.03	73.80	0.0	1991-01-28	5.2
36.25	76.25	0.0	1991-02-07	3.9
32.68	72.38	0.0	1991-02-12	4.5
33.47	72.03	0.0	1991-02-17	4.7
37.42	72.28	0.0	1991-02-23	4.7
34.69	79.06	0.0	1991-02-25	4.7
34.59	72.66	0.0	1991-03-16	4.7
34.33	79.73	0.0	1991-03-23	4.6
37.06	73.39	0.0	1991-04-04	4.1
37.39	72.05	0.0	1991-04-08	4.7
36.88	73.20	0.0	1991-04-16	4.9
36.82	73.17	0.0	1991-04-22	3.9
35.90	79.74	0.0	1991-04-26	3.5
37.47	77.71	0.0	1991-05-08	4.3
35.26	74.29	0.0	1991-05-17	3.9
35.59	72.03	0.0	1991-05-24	4.1

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.76	73.03	50.0	2011-10-07	4.5
37.20	77.59	35.0	2011-10-09	4.1
35.68	76.38	46.0	2011-10-16	4.6
32.94	75.81	10.0	2011-10-22	4.3
35.54	76.35	10.0	2011-11-04	4.1
35.33	73.03	10.0	2011-11-11	4.6
37.34	72.21	212.0	2011-11-18	4.8
37.24	72.05	94.0	2011-12-22	4.5
35.78	77.35	63.0	2012-01-03	4.7
33.62	74.89	23.0	2012-01-04	4.3
37.33	72.22	178.0	2012-02-05	4.1
35.72	79.72	10.0	2012-02-20	5.0
35.84	79.84	10.0	2012-02-20	5.0
35.70	79.60	10.0	2012-02-20	4.7
36.68	76.83	79.0	2012-02-21	4.6
32.03	78.11	56.0	2012-03-07	4.4
37.43	78.65	24.0	2012-03-08	4.4
36.74	73.15	11.0	2012-03-12	5.6
36.45	73.10	10.0	2012-03-12	4.6
36.64	72.88	21.0	2012-03-12	4.6
36.56	72.91	10.0	2012-03-12	4.6
36.48	73.03	10.0	2012-03-12	4.6
37.00	73.02	82.0	2012-03-19	4.2
34.45	73.56	43.0	2012-03-31	4.3
37.46	72.08	170.0	2012-04-12	4.5
34.19	79.77	30.0	2012-04-14	4.1
35.63	76.50	80.0	2012-05-01	4.1
33.90	72.60	16.0	2012-05-22	4.3
33.88	72.80	48.0	2012-05-27	4.7
35.83	79.72	45.0	2012-06-03	4.4
34.94	73.62	41.0	2012-06-20	4.4
34.32	80.25	41.0	2012-06-24	4.4
34.91	73.63	41.0	2012-06-26	4.4
36.44	79.36	37.0	2012-06-27	4.2
35.62	76.51	68.0	2012-07-11	4.3
35.54	76.53	65.0	2012-07-11	4.2

Lat (deg)	Long (deg)	Depth (km)	Date	M
32.31	76.72	0.0	1991-06-23	4.7
37.49	72.00	0.0	1991-08-19	4.9
37.39	74.71	0.0	1991-10-24	5.2
34.51	79.65	0.0	1991-12-12	4.6
33.99	73.93	0.0	1992-01-06	4.4
37.44	72.05	0.0	1992-01-13	4.5
34.37	72.01	0.0	1992-01-16	3.6
35.51	74.53	0.0	1992-01-24	5.5
32.28	76.42	0.0	1992-01-26	4.6
34.22	78.73	0.0	1992-02-05	4.4
34.64	72.62	0.0	1992-02-06	4.2
32.64	76.51	0.0	1992-02-13	4.7
36.17	73.43	0.0	1992-03-01	3.9
33.36	72.97	0.0	1992-03-10	4.6
33.83	72.90	0.0	1992-03-24	5.0
36.00	72.55	0.0	1992-03-27	4.9
35.77	72.96	0.0	1992-03-27	3.9
33.57	72.31	0.0	1992-03-29	5.1
35.85	72.37	0.0	1992-03-30	4.5
37.09	73.01	0.0	1992-04-07	4.4
34.10	72.43	0.0	1992-04-17	4.3
37.21	72.91	0.0	1992-05-10	5.8
36.79	73.49	0.0	1992-05-11	4.7
36.85	72.76	0.0	1992-05-14	4.1
36.01	73.19	0.0	1992-05-15	4.4
36.33	72.21	0.0	1992-05-31	4.0
37.43	72.10	0.0	1992-06-06	4.1
34.67	75.16	0.0	1992-06-19	4.3
32.21	72.09	0.0	1992-06-19	4.0
35.42	74.92	0.0	1992-06-24	4.5
37.31	77.35	0.0	1992-07-15	4.3
35.59	74.72	0.0	1992-07-17	4.9
36.38	75.75	0.0	1992-08-14	4.4
34.70	80.11	0.0	1992-08-21	4.7
34.52	79.99	0.0	1992-08-23	4.7
34.68	80.24	0.0	1992-08-24	4.9

Lat (deg)	Long (deg)	Depth (km)	Date	M
33.47	76.11	56.0	2012-07-26	4.5
33.73	75.45	10.0	2012-08-02	4.2
35.80	77.71	73.0	2012-08-06	4.7
35.71	77.54	81.0	2012-08-08	4.4
34.85	73.66	28.0	2012-08-13	5.4
36.89	78.79	41.0	2012-09-04	4.7
36.82	78.72	14.0	2012-09-09	4.8
37.09	78.91	52.0	2012-09-09	4.2
37.45	76.15	35.0	2012-09-16	4.3
36.02	73.30	40.0	2012-09-21	4.3
32.47	76.63	10.0	2012-10-02	4.8
32.40	76.51	19.0	2012-10-02	4.7
32.30	76.25	10.0	2012-10-03	4.3
33.50	75.96	35.0	2012-10-03	4.2
37.28	72.01	93.0	2012-10-04	4.5
34.11	73.70	26.0	2012-10-11	4.7
36.99	73.21	66.0	2012-10-25	4.1
36.88	73.09	51.0	2012-11-09	4.5
32.29	76.33	10.0	2012-11-11	4.1
37.44	72.20	205.0	2012-12-04	4.3
35.05	73.83	57.0	2012-12-14	4.2
34.21	80.31	38.0	2013-01-22	4.1
34.29	80.44	30.0	2013-02-06	4.8
37.43	72.21	201.0	2013-03-30	4.1
34.70	73.24	20.0	2013-04-19	4.7
33.14	75.75	10.0	2013-04-30	4.7
33.10	75.84	10.0	2013-05-01	5.7
32.67	76.60	41.0	2013-06-04	4.9
32.91	76.29	43.0	2013-06-05	4.1
36.65	77.05	96.0	2013-06-09	4.5
37.36	72.01	187.0	2013-06-16	4.4
36.94	73.21	50.0	2013-06-21	4.8
35.16	72.24	50.0	2013-06-29	4.7
32.78	78.21	18.0	2013-07-09	5.1
32.48	76.59	19.0	2013-07-13	4.5
37.46	72.18	137.0	2013-07-24	4.5

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.65	79.98	0.0	1992-08-26	4.1
34.66	80.12	0.0	1992-09-03	5.2
32.44	76.34	0.0	1992-09-06	4.7
34.65	80.23	0.0	1992-09-07	4.8
35.60	80.41	0.0	1992-09-16	4.5
34.21	79.33	0.0	1992-09-16	4.5
36.15	73.91	0.0	1992-10-13	4.6
36.77	77.61	0.0	1992-10-17	4.0
34.58	79.92	0.0	1992-11-06	4.7
34.83	80.18	0.0	1992-12-08	4.3
37.49	72.17	0.0	1992-12-29	4.5
37.26	72.06	0.0	1993-01-14	4.5
34.44	80.00	0.0	1993-01-15	4.0
33.53	72.51	0.0	1993-02-17	5.0
36.71	74.07	0.0	1993-02-18	5.0
37.36	72.46	0.0	1993-03-19	4.5
35.65	77.65	0.0	1993-04-08	5.2
35.37	75.32	0.0	1993-04-08	4.7
35.80	78.30	0.0	1993-04-08	3.9
35.29	75.55	0.0	1993-04-08	3.7
35.90	78.49	0.0	1993-04-26	4.5
35.61	78.41	0.0	1993-05-08	4.7
33.58	72.75	0.0	1993-06-08	4.8
36.26	76.76	0.0	1993-06-13	4.4
35.57	78.41	0.0	1993-06-14	5.1
35.63	77.79	0.0	1993-06-15	5.0
37.24	72.60	0.0	1993-06-26	4.7
36.92	77.08	0.0	1993-08-17	4.3
33.32	75.74	0.0	1993-09-15	5.0
36.23	77.74	0.0	1993-10-29	4.8
37.30	72.04	0.0	1993-11-05	4.1
37.11	72.00	0.0	1994-01-06	4.8
37.46	72.08	0.0	1994-01-13	4.7
36.90	78.08	0.0	1994-03-21	3.9
36.25	72.97	0.0	1994-03-30	4.2
34.57	74.07	0.0	1994-04-15	4.6

Lat (deg)	Long (deg)	Depth (km)	Date	M
33.30	75.95	42.0	2013-08-02	5.2
33.27	75.94	14.0	2013-08-02	5.0
33.46	76.02	47.0	2013-08-05	4.4
36.80	72.88	153.0	2013-08-21	4.5
33.22	75.40	10.0	2013-09-05	4.6
37.43	72.18	202.0	2013-09-11	4.2
37.38	75.43	70.0	2013-09-19	4.3
37.47	72.19	209.0	2013-09-20	4.1
35.76	77.42	97.0	2013-10-20	5.4
37.50	72.33	215.0	2013-10-20	4.4
35.34	77.08	49.0	2013-10-21	5.4
35.29	77.00	35.0	2013-10-21	4.6
33.10	75.94	42.0	2013-10-26	4.6
36.23	74.42	89.0	2013-11-03	4.4
34.54	77.75	31.0	2013-11-15	4.3
33.12	73.73	29.0	2013-12-04	4.3
36.75	73.21	35.0	2013-12-05	4.8
32.89	78.66	41.0	2013-12-06	4.4
35.49	76.92	69.0	2013-12-09	4.1
37.43	78.64	39.0	2013-12-18	4.3
36.71	73.10	53.0	2013-12-27	4.4
34.28	79.78	44.0	2014-01-22	4.3
34.79	73.11	28.0	2014-01-27	4.7
36.90	73.73	79.0	2014-02-22	4.2
34.45	80.16	36.0	2014-03-08	4.5
33.29	73.47	5.0	2014-03-26	4.1
34.73	73.66	24.0	2014-03-27	4.8
37.10	72.60	10.0	2014-04-09	4.1
37.46	78.69	45.0	2014-04-18	4.3
34.10	76.24	34.0	2014-04-19	4.2
32.80	73.41	46.0	2014-04-19	4.1
37.48	72.22	193.0	2014-05-16	4.1
33.29	75.58	43.0	2014-06-13	5.0
32.33	76.45	34.0	2014-06-17	4.3
37.40	72.07	101.0	2014-06-23	4.2
35.55	75.09	35.0	2014-07-03	4.9

Lat (deg)	Long (deg)	Depth (km)	Date	M
36.79	72.13	0.0	1994-04-22	4.5
37.47	72.33	0.0	1994-05-11	4.3
32.49	75.53	0.0	1994-05-13	4.5
37.05	72.50	0.0	1994-05-27	4.6
36.35	78.47	0.0	1994-06-06	4.7
36.51	78.56	0.0	1994-06-09	4.2
32.54	76.11	0.0	1994-07-02	4.0
33.82	76.42	0.0	1994-08-20	4.6
34.17	74.60	0.0	1994-10-02	4.6
37.19	72.90	0.0	1994-10-19	4.7
37.48	72.28	0.0	1994-11-24	5.2
34.03	72.06	0.0	1994-12-19	4.2
37.14	72.05	0.0	1995-02-07	4.2
36.99	72.19	0.0	1995-02-25	4.8
37.50	72.36	0.0	1995-03-08	4.1
37.47	72.04	0.0	1995-03-13	4.7
32.56	76.00	0.0	1995-03-24	4.9
35.84	74.19	0.0	1995-03-30	4.4
36.91	72.26	0.0	1995-04-24	4.3
35.48	73.14	0.0	1995-04-26	4.6
35.70	77.21	0.0	1995-05-04	3.9
37.40	72.14	0.0	1995-06-16	4.1
34.20	76.21	0.0	1995-06-17	4.7
36.61	72.38	0.0	1995-07-12	4.5
36.28	72.12	0.0	1995-07-23	4.8
33.85	76.37	0.0	1995-08-17	4.2
37.25	72.94	0.0	1995-09-13	4.2
37.15	72.11	0.0	1995-10-03	3.9
35.55	77.60	0.0	1995-10-04	4.7
37.23	72.10	0.0	1995-10-07	4.1
35.99	73.50	0.0	1995-10-08	4.0
37.39	72.83	0.0	1995-10-22	4.1
35.31	76.07	0.0	1995-11-13	4.2
36.95	77.18	0.0	1995-11-13	4.0
32.00	78.53	0.0	1995-11-26	4.3
35.03	72.02	0.0	1995-11-28	4.9

Lat (deg)	Long (deg)	Depth (km)	Date	M
35.47	74.96	67.0	2014-07-06	4.6
35.56	75.04	51.0	2014-07-07	4.5
36.24	73.91	75.0	2014-07-08	4.8
36.58	77.27	98.0	2014-07-08	4.6
33.13	76.37	17.0	2014-07-25	4.1
37.48	72.12	183.0	2014-07-27	4.3
33.90	72.42	35.0	2014-08-02	4.2
32.33	76.43	10.0	2014-08-21	4.9
36.48	76.08	45.0	2014-09-09	4.5
37.45	72.15	8.0	2014-09-13	4.9
34.29	73.92	27.0	2014-09-22	4.8
37.44	72.17	193.0	2014-09-22	4.1
35.91	73.06	42.0	2014-09-27	4.8
34.33	79.15	45.0	2014-10-10	4.1
34.39	79.20	35.0	2014-10-11	4.6
36.09	78.19	54.0	2014-10-21	4.1
34.92	73.88	35.0	2014-10-23	4.8
37.50	72.14	201.0	2014-11-06	4.4
33.01	75.98	65.0	2014-11-18	4.4
34.47	79.01	42.0	2014-11-21	4.4
35.52	74.94	66.0	2014-12-19	4.3
34.91	73.84	41.0	2014-12-21	4.3
36.23	75.79	74.0	2014-12-24	4.2
37.47	72.13	197.0	2015-01-23	4.2
37.44	72.05	186.0	2015-01-31	4.5
36.81	72.95	62.0	2015-02-02	4.6
36.83	73.24	49.0	2015-02-07	4.6
34.43	76.20	48.0	2015-02-15	4.7
34.67	73.28	30.0	2015-02-26	5.4
34.59	73.38	33.0	2015-02-27	4.3
34.55	73.31	27.0	2015-02-27	4.1
35.65	76.80	10.0	2015-03-02	4.6
35.65	76.82	39.0	2015-03-10	4.2
37.38	72.21	208.0	2015-04-24	4.4
34.16	73.77	27.0	2015-05-18	4.4
34.45	73.71	10.0	2015-07-02	5.3

Lat (deg)	Long (deg)	Depth (km)	Date	M
33.38	72.64	0.0	1995-12-08	4.3
34.76	80.13	0.0	1995-12-10	4.2
37.13	77.49	0.0	1995-12-12	4.1
37.44	77.84	0.0	1995-12-24	4.1
34.90	72.11	0.0	1995-12-30	3.9
37.37	72.07	0.0	1996-01-02	3.7
35.92	78.27	0.0	1996-01-08	3.9
36.78	73.14	0.0	1996-01-10	3.9
33.15	76.18	0.0	1996-01-17	4.2
35.55	75.68	0.0	1996-01-21	4.4
36.26	77.70	0.0	1996-01-26	4.5
35.60	77.53	0.0	1996-01-30	4.6
37.16	78.13	0.0	1996-02-07	4.3
35.96	78.60	0.0	1996-02-11	4.1
35.07	72.77	0.0	1996-02-14	4.0
33.97	72.72	0.0	1996-02-20	4.8
35.73	78.70	0.0	1996-02-26	4.1
32.76	72.64	0.0	1996-02-26	4.0
35.67	78.60	0.0	1996-02-27	3.9
35.64	78.53	0.0	1996-02-28	4.8
34.69	77.60	0.0	1996-02-29	4.0
35.71	77.54	0.0	1996-03-02	4.1
37.01	73.40	0.0	1996-03-04	4.2
35.69	78.50	0.0	1996-03-05	5.3
35.99	78.15	0.0	1996-03-05	3.9
35.50	79.03	0.0	1996-03-13	4.3
37.07	72.22	0.0	1996-03-17	4.1
35.76	78.65	0.0	1996-03-23	3.8
37.27	72.25	0.0	1996-03-24	3.9
33.13	73.37	0.0	1996-03-25	4.7
35.66	75.68	0.0	1996-04-15	3.9
34.74	73.26	0.0	1996-04-21	4.1
35.01	72.59	0.0	1996-05-08	4.2
32.84	76.33	0.0	1996-05-09	4.1
33.26	75.98	0.0	1996-05-15	3.6
33.27	76.40	0.0	1996-05-16	4.0

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.46	78.15	20.0	2015-07-03	6.4
37.31	78.12	10.0	2015-07-03	4.9
37.39	78.19	10.0	2015-07-03	4.7
37.46	78.03	10.0	2015-07-03	4.7
37.39	77.93	10.0	2015-07-03	4.6
37.45	78.13	31.9	2015-07-14	4.5
34.37	73.74	25.4	2015-07-14	4.5
33.86	73.19	17.0	2015-07-24	5.1
37.50	78.07	39.5	2015-07-24	4.9
33.30	73.30	39.1	2015-07-24	4.6
34.66	73.31	29.2	2015-08-14	4.5
35.36	78.43	10.0	2015-09-15	4.6
35.33	78.51	10.0	2015-09-16	4.9
37.46	72.10	195.3	2015-09-20	4.5
34.83	73.93	5.0	2015-11-27	5.0
34.98	73.05	48.9	2015-12-29	4.7
36.13	78.10	35.7	2016-02-21	4.5
32.85	76.04	58.67	2016-02-04	4.3
32.99	76.08	40.2	2016-02-09	4.2
36.13	78.10	35.7	2016-02-21	4.5
37.34	78.13	10	2016-02-29	4.0
37.33	78.48	41.84	2016-03-17	3.9
34.04	78.07	31.9	2016-03-17	4.1
37.35	72.06	149.34	2016-04-27	4.1
33.08	76.09	35	2016-05-24	4.1
36.20	77.91	84.78	2016-05-27	4.1
36.46	77.64	94.29	2016-05-31	4.0
35.44	74.26	35	2016-06-21	4.5
33.94	72.71	55.87	2016-08-02	4.2
34.70	80.36	25.59	2016-08-12	4.4
36.77	76.93	92.12	2016-08-28	4.2
34.68	72.96	34.89	2016-09-02	4.5
34.74	73.10	25.92	2016-09-05	4.7
35.67	73.55	57.64	2016-09-06	4.3
36.86	73.13	52.75	2016-09-27	4.4
37.00	73.20	73.9	2016-09-27	4.5

Lat (deg)	Long (deg)	Depth (km)	Date	M
32.71	76.49	0.0	1996-05-23	4.3
34.39	72.21	0.0	1996-05-24	4.2
37.29	72.11	0.0	1996-05-25	4.2
37.28	72.46	0.0	1996-06-15	3.9
37.42	72.39	0.0	1996-06-26	4.4
36.00	80.20	0.0	1996-07-06	4.2
32.63	76.52	0.0	1996-07-14	4.2
37.18	72.16	0.0	1996-07-29	3.8
33.98	72.88	0.0	1996-08-08	4.8
37.46	75.17	0.0	1996-08-14	4.6
33.59	75.73	0.0	1996-08-17	3.6
32.83	76.37	0.0	1996-09-14	4.7
36.95	72.28	0.0	1996-10-03	4.6
33.55	76.30	0.0	1996-10-11	4.7
37.46	72.03	0.0	1996-11-09	4.7
36.68	72.03	0.0	1996-11-15	4.6
35.35	78.13	0.0	1996-11-19	7.1
37.14	72.17	0.0	1996-12-03	3.9
32.40	76.89	0.0	1996-12-23	3.9
37.37	72.31	0.0	1996-12-25	3.8
32.78	76.18	0.0	1997-01-19	3.8
33.73	74.99	0.0	1997-01-19	3.4
34.92	76.53	0.0	1997-01-25	3.9
35.79	79.93	0.0	1997-02-05	3.3
37.03	72.75	0.0	1997-02-20	4.4
37.18	72.22	0.0	1997-04-11	4.7
35.65	77.63	0.0	1997-05-01	3.7
34.67	72.58	0.0	1997-05-19	4.1
34.11	77.66	0.0	1997-05-27	4.7
37.15	78.05	0.0	1997-05-30	5.2
34.89	73.68	0.0	1997-05-31	5.0
35.71	74.61	0.0	1997-06-06	4.7
36.71	75.88	0.0	1997-06-14	4.7
35.44	78.40	0.0	1997-06-16	3.8
32.83	73.68	0.0	1997-07-29	4.8
33.83	72.82	0.0	1997-09-05	4.1

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.43	73.76	14.28	2016-09-30	4.3
34.90	73.68	10	2016-10-01	5.4
33.75	75.69	35	2016-10-04	4.3
37.42	72.28	219.21	2016-10-05	4.2
36.82	76.76	116.72	2016-11-11	4.4
33.23	72.77	37.81	2016-11-24	4.5
34.05	73.81	36.07	2016-12-17	4.5
34.47	73.76	49.03	2016-12-27	4.3
34.88	73.82	24.52	2017-01-02	4.2
35.68	77.83	82.09	2017-01-09	4.1
37.36	72.14	224.37	2017-01-26	4.5
37.05	73.50	90.32	2017-03-06	4.4
37.20	77.89	45.18	2017-03-19	4.4
33.55	72.67	40.98	2017-03-21	4.3
37.24	72.14	98.17	2017-03-26	4.2
33.96	76.42	51.3	2017-04-18	4.6
37.44	75.54	95.76	2017-04-25	4.3
36.77	73.98	77.3	2017-05-06	4.2
33.02	76.14	42.99	2017-05-19	4.5
32.87	76.30	35.36	2017-05-20	4.2
33.30	75.93	35.9	2017-05-29	4.5
34.87	72.92	25.09	2017-06-14	4.7
34.66	73.44	22.29	2017-07-08	4.7
32.87	76.24	44.78	2017-08-16	4.4
35.41	74.58	49.61	2017-08-23	4.6
33.57	73.00	32.11	2017-08-27	4.6
34.21	74.59	35	2017-09-23	4.6
33.51	76.26	32.12	2017-10-19	4.6
37.24	75.33	41.08	2017-10-25	4.5
37.48	72.44	188.01	2017-11-05	4.1
37.45	72.17	209.56	2017-11-07	4.5
37.24	72.26	228.81	2017-11-14	4.4
35.72	77.56	74.3	2017-12-06	5.2
33.42	76.91	20.3	2017-12-09	4.7
34.32	78.57	35.55	2017-12-10	4.6
34.24	73.84	10	2017-12-25	4.2

Lat (deg)	Long (deg)	Depth (km)	Date	M
34.76	80.26	0.0	1997-10-17	3.9
36.22	77.82	0.0	1997-10-23	4.6
35.39	78.37	0.0	1997-11-22	4.7
33.84	75.21	0.0	1997-12-23	4.3
35.26	78.60	0.0	1998-01-13	4.7
35.41	78.35	0.0	1998-01-13	3.9
36.40	77.57	0.0	1998-01-18	4.5
37.26	77.48	0.0	1998-01-27	3.6
32.88	76.01	0.0	1998-01-29	3.5
35.40	73.89	0.0	1998-03-18	3.5
32.54	76.21	0.0	1998-03-19	3.7
32.63	76.19	0.0	1998-03-20	3.9
35.67	78.28	0.0	1998-03-22	3.9
32.46	73.90	0.0	1998-03-24	4.1
37.26	72.13	0.0	1998-04-07	4.3
35.58	79.97	0.0	1998-04-08	3.5
35.36	77.90	0.0	1998-04-23	3.6
35.87	73.70	0.0	1998-05-14	4.3
37.39	72.24	0.0	1998-05-23	4.4
34.57	74.05	0.0	1998-05-24	3.9
37.39	78.84	0.0	1998-05-28	5.6
34.26	72.86	0.0	1998-05-29	4.4

Lat (deg)	Long (deg)	Depth (km)	Date	M
37.37	72.12	217.06	2017-12-31	4.1
37.07	72.01	166.14	2018-01-17	4.0
36.43	76.92	10	2018-01-19	4.1
35.71	76.05	10	2018-03-10	4.4
33.03	76.10	39.8	2018-03-15	4.5
37.38	72.22	225.37	2018-04-07	4.4
33.48	73.46	32.94	2018-04-10	3.6
32.88	76.12	41.61	2018-05-06	4.1
37.42	72.04	154.23	2018-05-06	4.4
35.79	78.35	23.01	2018-06-06	5.0
34.23	78.05	10	2018-06-07	4.4
32.56	76.36	10	2018-06-14	4.5
35.81	78.35	10	2018-06-18	4.6
35.69	74.45	83.27	2018-07-07	4.3
34.97	81.00	10	2018-07-21	4.6
34.29	74.08	40.06	2018-07-21	4.5
34.36	74.00	43.84	2018-07-21	4.2
33.81	72.66	38.09	2018-07-30	3.8
37.34	72.15	225.41	2018-08-14	4.3
37.48	72.18	192.05	2018-08-26	4.3
36.34	76.37	73.21	2018-09-11	4.5

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