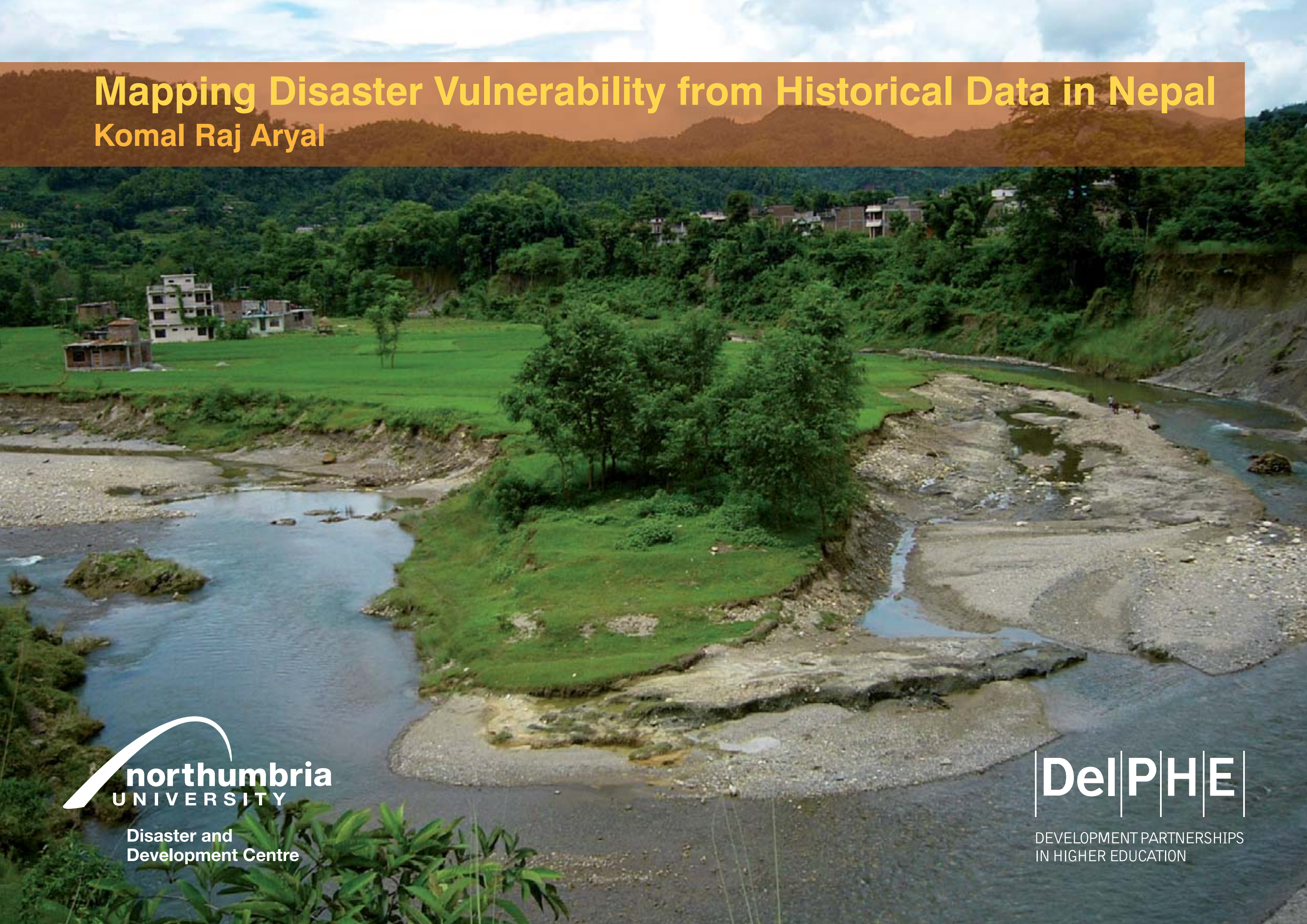
Mapping Disaster Vulnerability from Historical Data in Nepal

Komal Raj Aryal



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Cover Page: *This photo taken in Vayas Municipality in 2003. Picture shows Nepalese housing at risk from lack of localised disaster scenarios.*

Back Page: *This picture is taken in outskirts of Kathmandu district in 2003. People in the area use their land (earth) in non agricultural activities for livelihoods security. Picture shows lack of communication of risk information increases localised disaster risk (landslides).*

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Photographs were taken by the researcher.

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Foreword

The Asian Tsunami of 2004 and Earthquake of 2005 demonstrate that disasters are often locally unpredictable rendering centralised prevention difficult. However, the magnitude of the impact of disaster is frequently reduced where local people have become mobilized by risk awareness and disaster avoidance. One of the main lessons learnt in disasters is that the extent of impact on life can be a function of technological, social, economic and environmental factors. This demands a fundamental drive for prevention approaches that include management of locally grounded data on historical disaster events. The approach is still badly lacking globally, but particularly in Nepal which is a high-risk hazard zone.

The purpose of the DDC is to facilitate approaches to disaster and development based on the association between sustainable development and human security. This is in conjunction with the promotion of resilience at the personal, community and institutional level. Its work is entirely applied to current real world issues, theoretically, methodologically and in terms of providing guidance to policy making for long-term disaster and development solutions. This is achieved through a combination of capacity building, academic and policy based research.

Since 2003, the Disaster and Development Centre (DDC) of Northumbria University has worked in partnership with Kathmandu University Nepal with British Council support to establish an academic Disaster Management and Sustainable Development Centre in Nepal. Kathmandu University has successfully grown in strength and influence in the HE sector in Nepal since 1992 when it was founded. An initial disaster management studies programme is now in operation at this university, which has successfully networked its interests and capacity through partnerships with renowned national and international organisations. Recently, DDC has expanded its network with Ministry of Local Development, Nepal and BP Koirala Institute of Health Sciences in support of people centred hazard and vulnerability reduction programmes in Nepal.

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Awareness about the impact of disasters in Nepal is minimal. Therefore much needs to be done to create better awareness on disaster risk impact reduction. Such awareness could lead to building risk and resilience communities for sustainable development of Nepal. This research is small step to that end.

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This research would not have been completed without my father Keshav and my wife, Becci. At last thanks to my friend June Elliott for her cartographic work and design.

Komal Raj Aryal
10 May 2007

Abbreviations

CBS	Central Bureau of Statistics
CDO	Chief District Officer
CDR	Central Development Region
DDC	Disaster and Development Centre
DFID	Department for International Development
EM-DAT	Emergencies Disasters Data Base
EPIH	Epidemics Total Human Casualties
EPIT	Epidemics Total Reported
FH	Flood Total Human Casualties
FRH	Fire total Human Casualties
FRT	Fire Total Reported
FT	Flood Total Reported
FWDR	Far Western Development Region
GIS	Geographic Information Systems
GOLF	Glacial Lake Outburst Flood
GoN	Government of Nepal
HFA	Hyogo Framework for Action
ICIMOD	International Centre for Integrated Mountain Development
IDNDR	International Decade for Natural Disaster Reduction
LDCs	Least Developed Countries
LSH	Landslides Human Casualties
LST	Landslides Total Reported
MWDR	Mid Western Development Region
NPC	National Planning Commission
NSET Nepal	National Society for Earthquake Technology – Nepal)
SH	Storm Human Casualties
ST	Storm Total Reported
THC	Total Human Casualties
TR	Total Reported
UN/ISDR	United Nations International Strategy for Disaster Risk Reduction
UNDP	United Nations Development Programme
WDR	Western Development Region

1. Introduction

The historical disaster events should usually be the first factor to be considered when planning any new development project in disaster risk reduction planning. However, a comprehensive historical disaster impact analysis (using Nepalese data) has not been performed, to date. Historical loco centric disaster data plays an important role in the analysis of the vulnerability progression of any specified location and therefore is essential for development projects. In order for sustainable development planning on the national and regional, Nepal requires historical loco centric disaster risk vulnerability analyses. This research deals with the analysis of Nepalese disaster vulnerability progression based on the temporal and spatial distribution of reported historical disaster events. Prevalent Nepalese disaster types are divided into five hazards groups:

Epidemics: Cholera, dysentery, dengue fever, and Japanese encephalitis

Storms: Thunderstorm, hailstorms, snowstorms, and windstorms

Flood: Flood and heavy rain.

Landslides: Mudslides, debris flow, landslides, GLOF (glacier lake outburst floods); avalanche

Fire: House fire, forest fire, and industrial fire.

Further in this research, the progression of Disaster vulnerability in Nepal is analysed based on (1) geographical locations and (2) the five hazards groups.

2. Background

“Nepal is now in a state of crisis fundamentally rooted in a failure of productive organisation associated with its economic and political under-development” (Blaike, Cameron and Seddon, 2001 p.5). Life on Nepal is at ever-increasing risk of being wiped out by disasters such as epidemics, fire, flood, landslides, high wind, earthquake and sudden impact of global warming. Further “disasters triggered by natural hazards are killing more people over time and costing more “(O’Brien, O’Keefe, Rose and Wisner, 2006 p.64) in Nepal. An environmental disaster is a disaster that is due, at least in part, to human activity and should not be confused with natural disasters. In the case of Nepal, the impact of humans' impact on the ecosystem has led to widespread and/or long-lasting consequences. It includes the deaths of humans, animals and plant systems, and severe disruption of human life, possibly requiring migration.

Nepal is situated in a geographical area of high and multi-dimensional environmental and anthropological disaster risk (Gurung, 2006). Disproportionate population growth in hazard prone areas and migrations results in increasing numbers of Nepalese living and working without local knowledge and in harm's way (Aryal, 2004). The increased context of anthropological or political disaster (Maoist conflict and ethnic violence in the Terai) poses even more ubiquitous threats. The imperative to prepare for and protect against these threats touches every Nepalese community.

The nature of environmental disasters involves their unexpected occurrence, irrespective of human boundaries, usually causing widespread loss of human life and livelihoods. The unpredictable nature of such events renders prevention difficult. However, the magnitude of the resultant effects can be reduced if preventative measures are put in place in advance of the event. 85 percent of people, who live in under developed countries (either medium or least developed) are currently exposed to an unacceptably high risk of disasters (UNDP, 2004; EM-DAT, 2005).

Public awareness and pragmatic government policies are key to bringing about effective avoidance. In particular, recent policy debates have started to emphasise that efficacy will most likely be achieved if the government, other actors (such as donors) and the community work together (Wisner, Blaikie and Cannon, 2004; UN/ISDR, 2005). At the local level, disaster events can seriously impact on individual livelihoods and push already vulnerable groups further into poverty. The loss of income earners (through death or injury), the interruption of production such as home based workshops or access to basic amenities are examples of the ways in which disasters can affect local and household economies. Often, such impacts are cumulative, as the everyday impacts due to frequently occurring small-scale hazards erodes long term livelihood security. This is reflected in the following quote from UNDP.

> *"Disaster losses occur on all levels, from individual household losses associated with everyday environmental hazards to losses due to exceptional catastrophic events" (UNDP, 2004 p.12).*

The capacity of a household or local community to absorb the impact and recover from a major environmental event is seriously limited if already weakened by a series of smaller ones. This suggests the necessity of national and local level co-operation for disaster mitigation. International Decade for Natural Disaster Reduction (IDNDR) (1990-99) increasingly argued that disasters could be prevented through progress in community based integrated disaster risk management (DFID, 2004; UN/ISDR, 2005). The frequency and severity of environmental disasters have increased in recent years in Nepal (Aryal, 2002), and this trend is expected to continue well in the future. Further O'Brien et. al, 2006 highlights:

> *"This is a challenge for the international community. If the Millennium Development Goals (MDGs) are to be realised in a sustainable fashion then reducing the impact of disasters in an urgent priority (Middleton and O'Keefe, 2001; DFID2004; UNDP 2004; Wisner and Walker, 2005)" (cited from O'Brien et. al, 2006 p. 65)*

The hills of Nepal are twenty million years old (Dixit, 2004; Gurung, 2004). From the geological point of view they are quite young (Byers, 1987). The factors which render them particularly vulnerable to disasters such as floods and landslides (Carson, 1986; Blaikie and Brookfield,1987; Gurung, 2000) are as follows:

- soft soil,
- sensitive Himalayan environment,
- heavy monsoon rain,
- deforestation,
- over-farming,
- unscientific farming methods
- lack of reliable husbandry in animal farming and
- development works initiated without consideration of the environmental effects

Weaker geographical construction and the flow of water from north to south, cause landslide and flood in the country every year. Except in the Tsho Rolpa Glacial (Snow Lake) area there is no machinery available for early warning and flood defences systems in Nepal (Practical Action, 2006). Sometimes whole village are submerged into the floodwaters of overflowing rivers. The second biggest flood and landslide in the country was in 1989. In this incident 700 lives were lost and 6200 hectares of farming land were destroyed by flood and landslide.

In Nepal, 40% of soil erosion is caused and exacerbated by unrestrained human activity (World Bank, 2006). Districts like Okhaldhunga, Kavre, Sindhuli, Saptari, Mahottari, Nawalparasi, Surkhet, Syangja, Mustang, Makawanpur and Ramechhap are highly susceptible to soil erosion and floods, and as a result of the effects of these, also to landslides. In 2003, 52 separate districts were affected by landslide. Records covering the last century (1900-2005) show that environmental disasters resultant losses are increasing.

From a geographical perspective, Nepal is divided into three different parts and they are

- Himal (comprising of and subdivided into snow mountains and higher snow mountains),
- Mahabharat range (hills) and
- the Terai (the plain land).

83% land of the country belongs to mountain and 17% the Terai. 45.5% people live in Middle hill and Chure, 47.5% live in Terai area (Amatya and Jnawali,1994). Only 7.3% live in the high mountain hills (CBS, 2002). Among them, the Mahabaharat range is particularly susceptible to disasters (floods, landslides, fire high wind epidemics and storms).

The Mahabharata range was formed from soft soil and boulders and supports a large number of substantial communities (Pohle, 1992). More than six thousand rivers (both large and small) traverse this Mahabharata range to the Terai land (Mirza, Dixit and Nishat, 2003). As a result of melting snow on the Himal, (caused by climate change) and heavy monsoon rains, these rivers regularly burst their banks and cause widespread flooding and have been the main cause for the loss of life and property in great number every year (Watson, Zinyowera and Moss, 1997). Increased glacial run-off, resulting from climate change and heavy seasonal monsoons has changed the course of many rivers. The course of other rivers have been purposefully redirected by villagers and farmers, in order to facilitate the production of crops in the alluvial soil, rich in nutrients as it is carried down by the floodwaters from the higher and unfarmed ground (e.g. farming on the Bagmati flood plain in Kathmandu). Environmental disasters in this location are caused by the deforestation resultant from ill-considered land clearance in conjunction with the presence of water in the soil, the soft nature of the soil and the steep aspect of the land (Sharma, 1979). The disaster situation is further exacerbated by the practice of leaving land fallow. Although this is excellent farming practice under general circumstances, leaving land fallow when it is situated on very steep hillsides without the anchoring properties of trees and foliage can lead to disasters caused by landslides when the soil becomes saturated by the monsoon or by flood waters (Adhikari, 2004).

Boulders, dislodged by landslides are frequently deposited in farm land, making farming difficult and abandonment of these sites only makes re-occurrence more likely. Thus the effects of floods and landslides have turned former villages and farming communities into relative wastelands. Similarly, with the change of the course of the river facilitates the damage or destruction of many roads, irrigation canals and villages. These situation leads community more vulnerable to other disaster such as epidemics and droughts.

Nepal is located on the southern slopes of the Himalayas, in between India to the south, east and west and Tibet to the north. With an area of 147,000km^2, the topography of the country varies dramatically from the Terai situated on the Indo-Gangetic plains in the south to the highest peaks in the world in the north where the country borders the high Tibetan plateau (CBS/Nepal, 2003a). More than 6,000 rivers and streams including three major basins (namely Sapta Kosi, Karnali and the Narayani basin) drain the country (Mirza, Dixit and Nishat, 2003). The annual run off from total drained areas is estimated to be 202 billion m^3 (MoPE/Nepal, 2004). Geographically, Nepal is located on the boundary between the Indian and the Tibetan plates, along which a relative shear strain of about 2 cm per year has been estimated. The Indian plate is believed to be sub-ducting under the Tibetan plate at an estimated rate of about 3 cm per year (Dixit, 2004). The existence of the Himalayan range with the world's highest peaks is evidence of the continued tectonic activities in the earth's interior beneath the country. As a result Nepal is highly vulnerable to seismic disaster risk.

Being located in one of the geo-physically youngest mountain ranges in the world, Nepal is regarded as a country highly vulnerable to natural hazards in Asia. The densely populated south (Terai) is frequently the scene of flooding during the monsoon (June-September). Arable lands, as well as settled areas regularly sustain serious damage caused by floods in combination with water-logging and the slow run-off. In an agrarian country like Nepal with recent staggering increases in population and food demand, even a slight decline in annual food production is a matter of great concern. Although the majority of people depend on agriculture, this sector is adversely affected by the loss of top fertile soil due to soil erosion, landslides and flood. Therefore soil loss induced disaster is one of the major causes of decline in agricultural production and adversely effects sustainable rural livelihood in rural Nepal. The effects of multi hazards may further aggravate the vulnerability to disaster. Therefore in this research special attention has been focused upon visualisation of the disaster risk vulnerability scenarios in ecological zones, development regions and districts (*Appendix 5-17*).

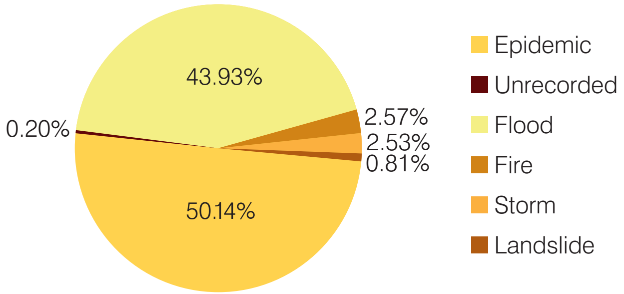
Human induced environmental disaster risk is a major concern in Nepal. Rapid population growth, changing climatic conditions, poor land use and planning, precarious settlement patterns, inadequate enforcements of building codes and inadequate communication of disaster risk information are the major factors that are helping in the progression of vulnerability to environmental disaster in Nepal.

Amongst the most at risk of Least Developed Countries (LDCs) Nepal is currently ranked second (DFID, 2006). Only Bangladesh is considered more subject to risk of environmental disaster. This risk is a function of Nepal's location in an environmentally hazardous region, where both climate and terrain combine to compound and create the risk status and through being amongst the world's poorest country. Major disasters in Nepal have been reported since 1255. Major earthquakes were recorded in the years 1408, 1681, 1810, 1833 and 1866 (NSET-Nepal, 2004). An earthquake with its epicentre in eastern Nepal and measuring 8.4 on the Richter scale was recorded in 1934; it caused more than 124,000 human casualties (based on historical news items : collected from national archives of Nepal). Two additional earthquakes in 1980 and 1988 registered 6.5 on the Rector scales and caused more than 21,000 and 180,500 human casualties respectively. Floods and landslides in 1950, 1952, 1957, 1977, 1982, 1985, 1993, 2002 and 2005 have caused more than 1,680 human casualties in every event. In the past 105 years in Nepal 13,525 disaster events were reported with 7,406,764 human casualties comprised with the following percentages

- fires 32.4%
- epidemics 23.2%
- floods 20.3%
- landslides 16.8% and
- storms 7.4%

However, the trends of their impact do not correspond to than the numbers of disaster occurrences. The highest number of human casualties by disaster is due to epidemics, which is 50.14% of the total human casualties since 1900. Epidemics are followed by floods, fires, storms and landslides in order of number of human casualties caused. Each of these disaster types account for 43.93%, 2.57%, 2.53%, and 0.81% of total human casualties respectively. The percentages of human casualties by reported disaster events since 1900 to 2005 are shown in Figure 1.

Figure 1: Depiction of cause of human casualties by disaster in Nepal (1900-2005)



In spite of the ongoing remoteness of areas and the lack of a communication of information system in Nepal, the trend of disaster events reporting and human casualties are increasing by 4.02% and 6.12% respectively every year since 1900. In spite of the country's vulnerability to various disaster risks, disaster risk management has rarely been integrated in decision-making and project cycles until the very recent past. Although a new disaster risk management strategy is about to be approved by the government including those stimulated by the Hyogo Framework for Action 2005-2015, they fail to integrate people centered disaster resilience-building strategies in Nepal due to lack of historical evidence base data (based on final draft received from NSET-Nepal).

3. Methodology

The central focus of the research is to do quantitative analysis of reported historical disaster events and the number of human casualties in Nepal. Disaster risk vulnerability at district, regional and national levels are analysed in relation to historical disaster events and the number of reported human casualties (1900-2005). Geographical Information Systems (GIS) based maps are produced to communicate disaster risk information (Appendix 5-17).

Despite the scale of hazards in Nepal, communication of historical knowledge based risk information is not yet considered to improve the community's ability to prevent disasters. However, scientific breakthroughs and advanced communication systems might be able to be applied to historical knowledge based disaster risk information.

For communication of localised risk, Geographical Information Systems could be one way of communicating risk information for different sectors of society. The link in GIS between its technical functions and applied management implications are demonstrated in the following quotes.

> *"Geographical Information Systems (GIS) are capable of acquiring spatially indexed data from a variety of sources, changing the data into useful formats, storing the data, retrieving and manupulating the data for analysis, and then generating the output required by a given user. Their great strength is based on the ability to handle large, multilayered, heterogenous databases and to query about the existence, location and properties of a wide range of spatial objects in an interactive way" (Fisher and Nijkamp,1992 p.3)*

“There are a variety of developments in hazard relevant technologies that are available to aid emergency managers in mitigation efforts. Geographical information systems (GIS) have many applications for example. GIS may be used to estimate damage to infrastructure, provide risk information to aid in community land use planning and in building planning, simulate disaster damage to aid in planning, and aid in environmental planning. Computer-mediated communication, remote sensing, decision support systems, risk analysis, all have developed rapidly and show great promise for use in disaster preparedness and mitigation planning’’ (Schneider, 2006 p.82).

The above description of GIS suggests that it could have applications as a tool in community disaster management by helping users answer various spatial questions (Dash, 2002). As such, GIS might be able to answer complex question in a simple way that is also accessible to a wider range of interest groups beyond the world of GIS and planners (MacFarlane, 1996). In support of this assertion, Chartland and Punaro (1995) argues that in order to improve community disaster risk management, an advanced-technology based information system for collection, storage and dissemination data in a simple format is needed, such is a GIS.

In a Nepalese community disaster management risk context, GIS based communication of risk information can have application in the process of determining vulnerable locations that meet certain criteria, such as which agricultural land or house are in danger from floods and landslides hazards, or which public houses, schools and government buildings are within 50 meters of specified gas station. It is also capable of dealing with the questions as to how far be the nearest health centre and how many health centres are needed in specific areas? As represented in Figure 2 below, GIS can contribute in identifying and communicating local historical knowledge based disaster risk information. It needs to be determined to what extent this can build resilience against disasters at the community level (Briggs and Beale,2002;FacFarlane, 2005)

Figure 2: Local knowledge based communication of disaster risk information system

This diagram proposes potential roles for different stakeholders in the communication of historical and local knowledge based disaster risk information.

3.1. Quantitative analysis

The quantitative data collected for this study was collected from newspaper articles and thus may be subject to journalistic enthusiasm. Put plainly, this data may be less accurate than would be hoped for in an ideal world. The accuracy of the reporting could be called into question, but on the other hand, apart from rounding the figures up or (less likely) down, there seems little reason to suspect the figures of vast discrepancy. However, it is possible that small disasters or disaster with human impact at the lower end of the scale may nor have made sufficient impact to ensure that they were reported in the national press, and for that reason it is possible that the reported figures are lower than the figures were in reality.

3.2. Total casualties per disaster reported

The fields representative of each disaster type for total human casualties recorded and total reporting of recorded disaster types per district were used to generate 6 new fields in the Nepal shape file. Each field is representative of the final data displayed on each relevant map. For example to create the data to show total human casualties caused by epidemics vs. total reporting of epidemic events between 1900 and 2005 the field for total number of deaths recorded by epidemics per district between 1900 and 2005 was divided by the total number of epidemics recorded per district between 1900 and 2005.

3.3. Disaster event density and human casualties density

This research holds that, like population density, disaster events and human casualties density (Table 4.6) are an effective index to measure the vulnerability to disaster of the individual defined areas. Disaster density can be thought of as an index to measure the pressure of human casualties by disaster on land. The number of disaster events and human casualties resulting from that disaster per square kilometre of total area functions as a measure of the disaster event density and human casualty density. The disaster events density and human casualties by disaster density by ecological zones, development regions and districts are presented here in this research.

Calculation:

Disaster event density = Total numbers of disasters events in a district A / Sq. Km (of the district A)

Human casualties density = Total numbers of human casualties in a district A /Sq. Km (of the district A)

Disaster density can be thought of as an index to measure the pressure of human casualties by disaster on land. The number of disaster events and human casualties resulting from that disaster per square kilometre of total area functions as a measure of the disaster event density and human casualty by disaster density. The disaster events density and human casualties by disaster density by ecological zones, development regions and districts are presented here.

3.4. Limitation

This research presents Nepalese disaster vulnerability scenarios based on the analysis of the historical disaster events recording in Nepalese newspapers. The analyses are based on the quantitative data collected from preserved national newspaper archives. The accuracy of the findings largely depends on how accurately the information was reported during that time in the newspapers. The disaster reports in the earlier days of the twentieth century are sparser and information is less detailed than that detailed later in the century. This clearly indicates that although Nepal has a long history of disaster events, there will be a limitation in this data in terms of reporting accuracy.

Although this study may attract criticism for the absence of earthquake data, it would not have been possible to include earthquake data in this particular study, as earthquakes (i.e. earthquakes with high numbers of human casualties) are exceptionally rare in Nepal.

4. Result and Analysis

4.1. Disaster Vulnerability: Disaster events, growth and distribution

4.1.1. Change in reported disaster events

The total number of reported disaster events and human casualties in every ten years since 1900 is presented in Table 4.1.

Even allowing for some fluctuation in reporting practice, Table 4.1 has shown that the reported human casualties declined in the 1950s and then increased. The main reasons for the decline in disaster reporting in the 1950s are unknown but may be attributed to the impact of after math of the world wars. The huge increase in human casualties evident in 1960 as compared to reporting for other periods may be attributed to the effect of the worldwide influenza epidemic at that time. On the other hand limitations in disaster events reporting may have been caused by communication limitations due to the limited technology of the period and the geographical aspect of the regions involved.

Appendix 2 graphically indicates the size of the population of Nepal recorded in the national censuses records between 1911 and 2001.

4.2. Dispersal of disasters reporting and human casualties

People gravitate towards areas with high levels of resources. This creates pressure upon the environment which can then precipitate environmental disasters. A prime example is that of landslides caused by the agricultural working of steeply sloping land previously neglected due to local knowledge of the danger of landslides in those areas. The geographical distribution of disaster events and human casualties reporting is therefore in part related to the relationship between human habitats and the environment condition. The geographical location of disasters, in relation to populated areas, is a fundamental determinant of socio economic and anthropogenic impact. Moreover, the numbers of disasters may be influenced by combinations of socio cultural, economic, environmental, historical and developmental factors. All of these factors may influence other disaster influencing factors such as population density and adhesion (or otherwise) to practices endorsed by local knowledge regarding advisable locations for habitation. To build ones family home in a location regarded by local knowledge to be inadvisable can be seen as courting disaster. Thus the relationship between human casualties, disaster distribution and local knowledge is established. The increase in disaster events increases human vulnerability. Thus, the environmental impact associated with disaster events is not only related to human casualties but also to changes in disaster location and loss of local knowledge. This concern was also highlighted in the WCDR 2005, where the emphasis is placed upon the integration of local knowledge in development processes aimed at coping with potential disaster risk.

Nepal's political geography has undergone great change since the ancient time. In the Rana Regime, Nepal was divided into 20 Hill districts, 9 Terai districts and 3 inner Terai (Bhitri Madesh) districts. However, the geographical administrative division of Nepal, which was based on the Rana Regime, was cancelled in 1961 and the country divided into 75 Districts and 14 zones. Again in 1972, the 14 Zones were grouped into four development regions. In 1980 this was increased to five development regions. The five development regions are eastern, central, western, mid western and far western. After the establishment of the multiparty system in April 1990 the zones were no longer regarded as functional administrative units. Thus, in this research the spatial distribution of disaster events reporting and human casualty analysis is focused on ecological zone, development regions and districts.

4.2.1. Disaster events recording by ecological zones

Geographically the country is divided into three ecological zones. They are Mountain, Hill and Terai. Ecological zones are defined by the prevailing climatic condition, the variation of agriculture land and other resources. The disaster events recording and human casualties in the ecological regions (1900 to 2005) are shown in Table 4.3 and in the form of disasters maps. The table and maps reveal that the highest numbers of disaster events are recorded in the hill area which covers 56.24% of Nepal's total land mass. Among the total reported disaster events in the Hill area, epidemic are reported 1,353 times, accounting for 21.63% of total reported disasters. Fire was reported 1,916 times (30.65% of all reported disasters in the Hill area), flood was reported 903 times (14.43% of all reported disasters in the Hill area), storm was reported 473 times (7.56% of all reported disasters in the Hill area) and there were 1,610 separate incidents of landslides (25.73% of all reported disasters in the Hill area).

Terai areas yielded the second highest number of recorded disaster events in the past 105 years (1900-2005). There were 5,690 disaster events reported in Terai which covers 20.13% of the total land of Nepal. Among the total reported events in Terai, fire is reported 2,139 times (37.59%) followed by flood 1,674 times (29.42%), epidemic 1,416 times (24.88%), storm 348 times (6.14%) and landslides 113 times (1.98%).

Mountain zones cover 23.74% of the total land of Nepal recorded 1,580 disaster events in 105 years (1900 to 2005). Landslides were reported 555 times (35.12%), epidemics were reported 362 times (22.91%), fire was reported 321 times (20.31%), storm was reported 179 times (11.32%) and flood was reported 163 times (10.31%) in the past 105 years.

4.2.2. Disaster casualties by disasters by ecological zones

When the number of human casualties is analysed using reported disaster events the Terai has the highest number of human casualties (6,040,168) of the three ecological zones. Of the total number 3,024,594 (50.074%) were caused by epidemic, floods caused 2,856,193 (47.28%) fire caused 126,848 (2.10%), storm caused 18,307 (0.30%) and landslides caused 14,226 (0.23%) (See Table 4.4 for details).

Initially, the Terai region was covered with dense forest and infested with malaria and other communicable diseases. Later after 1953 diseases were controlled and deforestation increased to settle disaster refugees from Hill and Mountain zones. As a result new migrants created pressure to local environmental resources being exposed to disaster risk.

In the Hill area 1,162,084 human casualties have been reported between 1900 and 2005. Among the total human casualties 585,941(50.42%) were attributed to epidemics, 388,745 (33.45%) were attributed to fire, 100,857 (8.67%) were attributed to the actions and events of storms, 54,931 (4.72%) were attributed to floods and 31,610 (2.72%) were attributed to landslides.

In Mountain zones 204,512 human casualties were recorded in the past 105 years. Among human casualties reported in the mountain zone, 103,483 (50.59%) resulted from epidemics, storms resulted in 68,369 (33.43%), landslides resulted in 14,397 (7.03%), floods resulted in 9,344 (4.56%) and fire resulted in 8,919 (4.36%).

According to historical data 81.54% of the total reported human casualties occurred in the Terai region, whereas Hill and Mountain share about 15.68% and 2.76% of total human casualties respectively.

4.2.3. Disaster events recording by development regions

The disaster events recording by development regions in Nepal are shown in Table 4.5. The central development region (5,039) and eastern (3,235) development region have observed high numbers of disaster events. The central and eastern development regions have accounted for about 37.25% and 23.91% of the total disaster events recording in past 105 years. 18.26%, 12.36% and 7.77% of total disaster events have been recorded in western, mid western and far western development regions.

Appendix 4 graphically illustrates the number of disaster events reported in each geographical region, the number of human casualties recorded due to disaster events between 1900 and 2005 and the average number of human casualties per year for this period of time.

4.2.4. Human Casualties by disasters by development regions

Disaster casualties by development regions are shown in Table 4.5. The central development region accounts for a high number of human casualties whereas the far western development region accounts only for a low number of total human casualties by reported disaster in 105 years; the central and far western development regions each contribute 65.26% and 2.26% to the total recorded number of human casualties in Nepal between 1900 and 2005.

Table 4.5 also illustrates that in the last 105 years (1900-2005), an annual average number of 50,708 human casualties was calculated from available data for the western region, central – 46,042 human casualties, eastern – 13,885 human casualties, mid western – 3,308 and far western development region – 1,599 human casualties.

4.2.5. Disaster events recording and human casualties by district

Although the village development committees are the lowest administrative units in Nepal, the district functions as a coordinating administrative unit to formulate, execute and evaluate the plans and administrative work of the lower administrative units. Therefore it is appropriate to examine the incidence of disaster events and human casualties by districts.

The number of districts has remained constant at 75 since 1971, however there have been great changes in area (acreage) and the boundaries of the districts have been re-drawn on multiple occasions between 1971 and 1982 (CBS, 2003). Although the disaster distribution (or dispersal) is not strictly comparable by district until 1983 the rate of human casualties by disaster by district and regions are shown in Table 4.6. The annual growth rate of disaster events is calculated with the number of total human casualties by disaster in 1990-1999 with the data from population census 2001.

According to Table 4.6, 14 of the 75 districts of Nepal account for than 2% of the annual human casualty rate. It is also observed that 9 of that group of 14 falls under the growth rate more than 3% of human casualties where as 5 districts comes under human casualty growth rate more than 4% per year. The five districts with the highest annual human casualty growth rates are Parsa (6.35 %), Mahottarai (5.82%) and Dhanusa (5.49%) in central Terai, Saptari (5.91%) in eastern Terai, in central Terai and Lamjung (5.34%) in western Hill.

On the other hand, the 12 districts that have the lowest average annual human casualty growth rates (less than 0.10%) are Dolpa (0.01%) in mid western mountain, Pyuthan (0.08%) in mid western Hill, Rasuwa (0.08%) in central mountain, Manang (0.08%) in western Mountain, Ilam (0.08%) in eastern Hill, Kalikot (0.07%) in mid western Mountain, Darchula (0.07%) in far western Mountain, Kaski (0.06) and Arghakanchi (0.05%) in western Hill, Lalitpur (0.06%) and Kathmandu (0.04%) in central Hill and Dopla (0.01%) in the mid western Mountain region.

4.3. Rate of variation in human casualties by disaster

4.3.1. Human casualties growth by disaster by ecological zones.

The disaster growth rate and human casualty growth rate are presented in Table 4.7. An examination of the data contained in that table indicates that the disaster rate and human casualty rate recorded in the Mountain and Hill areas have demonstrated a consistent increase throughout the period under investigation whereas the human casualty rate in Terai declined in the period between 1971 and 1981.

4.3.1.1. Human casualties growth by disasters by ecological zones and development regions

The human casualties growth rate by ecological and development regions for the time between1990-1999 is shown in Table 4.8. The annual growth rate in human casualties appears to be lowest in the western development region (0.49%) and highest in central development region (2.23%). The human casualty growth rate is also observed to be less than 1% per annum in the western, mid western and far western development regions.

Table 4.7 reveals that during the period 1990 to 1999, of the mountainous areas, four separate development regions have human casualty growth rates of less than 1% (the eastern, western, central and far western development regions), thus the mountain area of the mid western development region has the highest human casualty growth rate (1.59%). In the Hill areas, all regions have a human casualty growth rate of less than 1% with the exception of the eastern region which has a recorded human casualty growth rate of 6.04%. Of the Terai areas, only the far western development region has a human casualty growth rate of less than 1% (0.39%). Other terai areas demonstrate calculated annual human casualty growth rates of between 1.15% (recorded in the mid western development region) and 5.17% (recorded in the western development region). Thus, this data would appear to reveal that for the period 1990 to 1999, it would have been safest to live in the mountain or Hill areas of any development region (with the exception of eastern Hill areas) but that the habitation of the terai areas should have been avoided at all costs, unless the area for occupation was to the far western region.

In the hill areas, all ecological development regions have human casualty growth rate of less than one per annum except for the eastern Hill area. The eastern Hill human casualty rate by disaster (6.04%) is observed as being the highest observed rate; higher than other ecological development regions in Nepal.

Four out of the five ecological development regions in the Terai areas have reported more than 1.14 percentage of human casualty growth rate, the exception being the far western Terai which has a human casualty growth rate of 0.39%.

4.3.2. Human casualties by disasters growth rate by district

Human casualty growth rates by district are shown in Table 4.6 for the year 1990-99. From the table it can be noted that human disaster casualties are spread throughout the districts in Nepal, however wide variation is observed in disaster growth rates among the districts. The annual human casualty by disaster growth rate is highest in Parsa (6.35%) and is followed by Saptari (5.91%) and Dhanusa (5.49%). The least human casualties growth rate per annum is observed in Dolpa (0.01%) and is followed by Kathmandu (0.04%).

Table 4.8 reveals that human casualties growth rate by disaster in all mountainous districts varies between 0.01-1.99 percent per annum except in Jumla (4.82). This indicates wide variation of human casualties by disaster growth for the mountainous areas in Nepal.

Similarly in the Hill, human casualty growth rate from disaster varies between an annual rate of 0.06% and an annual rate of 5.34% in most of the districts. However 3 hill districts in Nepal have annual rates of human casualties by disaster reported in the range of 3.00% to 5.34%.

In the Terai areas, most of the human casualties rate varies between 0.09 to 6.35 percent per annum, however 1 district has accounted human casualties growth rate of less than 0.10 percentage 6 districts have reported human casualties growth rate in the range of 3.00 to6.35 percentage per annum.

From the table it can noted that more than 50% of the districts have human casualty by disaster growth rates in the range of less than 1 percent. Among the 75 districts of Nepal, 5 districts have human casualties growth rate in the range of 1.00-1.99%, 4 districts have in the range of 2.00-2.99%, 4 districts have 3.00-3.99%, 1 district has in the range of 4.00-4.99% and 5 districts are observed above 5% human casualty growth rate per annum. Eight out of nineteen districts of central development regions have annual human casualty growth rate by disaster in the range of 2.00-6.35%.

4.4. Density: Disasters events density and human casualties density

4.4.1. Disasters events density by ecological zones

The disaster density is observed to be highest in the Terai areas. This could be due to pressure in environmental resources at Terai or due to the flow of internal migration from Mountain and Hill to Terai. Table 4.6 shows the number of human casualties by disaster by square kilometre. As stated before, this is observed to be highest in Terai areas. Mountainous areas exhibit the lowest number of human casualties by disaster by square kilometre (Table 4.6).

Appendix 4 graphically illustrates the data given in Table 4.6. Thus it can be clearly seen that all but the far western Terai areas have a significantly higher disaster density than mountain and hill areas, wherever situated.

4.4.2. Disasters events density by development regions

Further examination of the data contained in table 4.6 and Appendix 4 also reveals that the disaster density is highest in the central development regions and lowest in the mid western and far western regions. All but one of the Terai areas of the development regions have disaster densities far in excess of those found in Mountain and Hill regions (the exception being that of the far western terai area). The Far Western Terai has a lower disaster density than the Eastern Hill area. Similarly, the Western Mountain area has a lower disaster density in comparison to all the development regions. The number of human casualties per square kilometre in the central Hill is observed to be higher than that of the western, mid western and far western Terai regions.

4.4.3. Disasters events density by districts

Mahottari has the highest human casualties by disaster per square kilometre followed by Dhanusa, Saptari and Parsa. All of these four highest disaster density districts fall in the Terai plain of Nepal. Most of the Mountainous districts have less than one human casualty per square kilometre with the exception of the eastern mountainous districts and Jumla (17). Solukhumbu district (where Mount Everest is located) has a human casualty rate of 4/km^2

5. Discussion

For the past 105 years (1900-2005), 13525 disasters events have been recorded in Nepal. The 105 years disaster data shows that 32.35% of the total disaster reports concerned fire events; 190698 human casualties have been reported between 1900 and 2005. An increase in disaster events increases human vulnerability to environmental disaster. Thus, the environmental impact associated with disaster events is not only related to human casualties but also to disaster location.

The central development region (5039) and eastern (3235) development region have high observed numbers of disaster events. 18.26%, 12.36% and 7.77% of total disaster events have been recorded in western, mid western and far western development regions. Among the total reported disaster events in Terai, fire was responsible for 37.59%, flood - 29.42%, epidemic - 24.88%, storm - 6.1% and landslides - 1.98%. The same data for the Hill area shows that epidemic accounted for 21.63%, fire – 30.65%, flood – 14.43%, storm – 7.56% and landslides – 25.73%. In the Mountain area disaster data landslides accounted for 35.12% of all disasters, epidemics – 22.91%, fire – 20.31%, storm – 11.32% and flood – 10.31%.

When the number of human casualties is examined via the media of reported disaster events the Terai has the highest number of human casualties (6040168) of the three ecological zones. According to historical data 81.54% of the total reported human casualties occurred in the Terai region, whereas Hill and Mountain share about 15.68% and 2.76% of total human casualties respectively. The central development region accounts for a high number of human casualties whereas the far western development region accounts only for a low number of total human casualties by reported disaster in 105 years; the central and far western development regions each contribute 65.26% and 2.26% to the total recorded number of human casualties in Nepal between 1900 and 2005.

The annual growth rate of disaster events is calculated with the number of total human casualties by disaster in 1990-1999 with the data from population census 2001. The annual growth rate in human casualties appears to be lowest in the western development region (0.49%) and highest in central development region (2.23%).

During the period 1990 to 1999, of the mountainous areas, eastern, western, central and far western development regions have human casualty growth rates of less than 1%. The Mountain area of the mid western development region has the highest human casualty growth rate (1.59%). In the Hill areas, all regions have a human casualty growth rate of less than 1% with the exception of the eastern region which has a recorded human casualty growth rate of 6.04%. Of the Terai areas, only the far western development region celebrates a human casualty growth rate of less than 1%. Other Terai areas demonstrate calculated annual human casualty growth rates of between 1.15% and 5.17%. The eastern Hill human casualty rate by disaster (6.04%) is observed as being the highest observed rate, higher than other ecological development regions in Nepal.

Mountainous areas exhibit the lowest number of human casualties by disaster per square kilometre. Human casualties' growth rate by disaster in all Mountainous districts varies between 0.01-1.99 percent per annum except in Jumla (4.82). This indicates wide variation of human casualties by disaster growth for the Mountainous areas in Nepal. Similarly in the Hill areas, the growth rate in human casualties resulting from disaster varies between an annual rate of 0.06% and an annual rate of 5.34% in most of the districts. However 3 Hill districts in Nepal have annual rates of human casualties by disaster reported in the range of 3.00% to 5.34%.

Among the 75 districts of Nepal, 5 districts have human casualties growth rate in the range of 1.00-1.99%, 4 districts have in the range of 2.00-2.99%, 4 districts have 3.00-3.99%, 1 district has in the range of 4.00-4.99% and 5 districts are observed above 5% human casualty growth rate per annum. Eight out of nineteen districts of central development regions have annual human casualty growth rate by disaster in the range of 2.00-6.35%.

6. Conclusion

Nepal is a country exposed to and affected by several types of hazards. "Centuries ago people tried to manage natural risk by avoiding endangered zones, nowadays this strategy is no longer possible" (Zimmermann,2004 p.23) in Nepal. Averages of 70,541 human casualties have annually been reported from disasters in the past 105 years. In the 2004 monsoon, 68 of the 75 districts of the country were affected by localised disasters, 192 people died and 11 were reported missing. 16,997 families were affected.

The plight of vulnerable communities and individuals in Nepal are a cause for concern. Vulnerable individuals are found to experience repeated disasters and poor management is causing the problem to snowball. Poor decision making regarding internal displaced people and environmental disasters refugee relocation sites would appear to be aggravating the situation and is likely to be a causative factor in the occurrence of further disasters and the increasing magnitude of such disasters. Further, bureaucracy prevents some of the most vulnerable people from accessing aid to which they are entitled.

Eventually, the historical disaster data needs to be entered into national development plan designed to establish people centred disaster risk management in Nepal. There is also a need for the formulation of alternative models of disaster risk reduction based on the localised risk of the communities and for these to be taught in higher education. This research is best regarded as a good start to the debate in that area.

Appendices

Appendix 1: Tables

Table 4.1: Total number of reported disasters events, human casualties and annual growth rate since 1900.

Year	Total Disaster Reporting Per Period	Disaster Reporting Change	Rate of change in Disaster Reporting (Annual Growth)	Human Casualties Reporting	Rate of change in Human Casualties reporting	Annual Growth in Rate of Change in Human Casualties
1900-09	22			156		
1910-19	53	+31	5.84	691	535	8.0
1920-29	189	+136	7.19	1,703	1,012	6.0
1930-39	324	+135	4.16	2,445	742	3.0
1940-49	565	+241	4.26	24,334	21,889	9.0
1950-59	582	+17	0.29	17,865	-6,469	-3.6
1960-69	691	+109	1.57	79,784	61,919	7.8
1970-79	1,516	+825	5.44	240,186	160,402	6.7
1980-89	2,032	+516	2.53	1,372,841	1,132,655	8.2
1990-99	4,039	+2007	4.96	4,000,768	2,627,927	6.5
2000-05	3,512	–	–	1,666,123	–	–

Table 4.2: Average percent of human casualties in total population in every 10 years (1900-2005)

Census Year	Population (millions)	Reported Human Casualties	Human Casualties as % of population
1911	5.638749	619	0.01
1920	5.573788	1,703	0.03
1930	5.532574	2,445	0.04
1940	6.283649	24,334	0.4
1950	8.256625	17,865	0.2
1961	9.412996	79,784	0.8
1971	11.555983	240,186	2.0
1981	15.022839	1372,841	9.1
1991	18.491097	4,000,768	21.6
2001	23.151423		

(Source: CBS /Nepal 2002)

Table 4.3: *Distribution of disasters events recording and human casualties by ecological zones of Nepal (1900-2005).*

Region	EPIT	EPIH	FRT	FRH	FT	FH	LST	LSH	ST	SH	TR	THC
Mountain	362	103,483	321	8,919	163	9,344	555	14,397	179	68,369	1,580	204,512
Hill	1,353	585,941	1916	54,931	903	388,745	1,610	31,610	473	100,857	6,255	1,162,084
Terai	1,416	3,024,594	2,139	126,848	1,674	2,856,193	113	14,226	348	18,307	5,690	6,040,168

Table 4.4: *Rate of distribution of human casualties by disasters by ecological zones of Nepal (1900-1999)*

	Mountain	% of Total number	Hill	% of Total number	Terai	% of Total number
EPIT	362	2.6	1,353	10	1,416	10.46
EPIH	103,483	1.39	585,941	7.91	3,024,594	40.83
FRT	321	2.37	1,916	14.49	2,139	15.81
FRH	8,919	0.12	54,931	0.74	126,848	1.71
FT	163	1.23	903	6.67	1,674	12.37
FH	9,344	0.12	388,745	5.24	2,856,193	38.56
LST	555	4.1	1,610	11.9	113	0.83
LSH	14,397	0.19	31,610	0.42	14,226	0.19
ST	179	1.32	473	3.49	348	2.57
SH	68,369	0.92	100,857	1.36	18,307	0.24

Table 4.5: *Distribution of disasters event recording and human casualties by development regions of Nepal (1900-2005).*

Development Regions	Disaster Events Reported	Human Casualties	Average Number of Human Casualties per year	Average Number of Disasters Reported per year
Western	2,527	599,286	50,708	24
Eastern	3,235	1,457,933	13,885	31
Far western	1,052	167,804	1,599	10
Mid western	1,672	347,347	3,308	16
Central	5,039	4,834,394	46,042	48

Table 4.6: Distribution of disasters resultant human casualties by disasters by district and disaster resultant human casualties growth rate and disaster density

Area	1990's		Average Annual disaster resultant human casualties growth rate (%)		
	Population (as of census 2001)	Disaster resultant human casualties (1990-99)		Area in sq.Km	Disaster Density (Number of disaster resultant human casualties/Sq.Km)
Nepal	23,151,423	2,931,846	1.26	147,181	20
Eastern DR	5,344,476	637,557	1.19	28,456	22
Eastern Mountain	401,587	26,843	0.06	10,438	3
Taplejung	134,698	7,422	0.55	3,646	2
Sankhuwasabha	159,203	6,379	0.40	3,480	2
Solukhumbu	107,686	13,042	1.21	3,312	4
Eastern Hill	1,643,246	99,358	6.04	10,749	9
Panchthar	202,056	7,911	0.39	1,241	6
Ilam	282,806	2,405	0.08	1,703	1
Dhankuta	166,479	2,869	0.17	891	3
Terhathum	113,111	1,157	0.10	679	2
Bhojpur	203,018	26,627	1.31	1,507	18
Okhaldhunga	156,702	6,226	0.39	1,074	6
Khotang	231,385	7,042	0.30	1,591	4
Udayapur	287,689	45,121	1.56	2,063	22
Eastern Terai	3,299,643	511,356	1.54	7,269	70
Jhapa	688,109	28,208	0.40	1,606	17
Morang	843,220	39,250	0.46	1,855	21
Sunsari	625,633	72,435	1.15	1,257	58
Saptari	570,282	337,116	5.91	1,363	247
Siraha	572,399	34,347	0.60	1,188	30

(continued)

Central DR	8,031,629	1,798,002	2.23	27,410	65
Central Mountain	554,817	20,976	0.37	6,277	3
Dolkha	204,229	13,194	0.64	2,191	6
Sindhupalchock	305,857	7,400	0.24	2,542	3
Rasuwa	44,731	382	0.08	1,544	0.2
Central Hill	3,542,732	240,714	0.67	11,805	20
Kavre	385,672	22,957	0.59	1,396	16
Lalitpur	337,785	2,063	0.06	385	5
Bhakthapur	225,461	1,974	0.08	119	16
Kathmandu	1,081,845	4,758	0.04	395	12
Nuwakot	288,478	5,677	0.19	1,121	5
Sindhuli	279,821	95,873	3.42	2,491	38
Ramechhap	212,408	6,043	0.28	1,546	4
Dhading	338,658	19,438	0.57	1,926	10
Makwanpur	392,604	86,931	2.21	2,426	36
Central Terai	3,934,080	1,536,312	3.90	9,328	165
Dhanusa	671,364	368,643	5.49	1,180	312
Mahottari	553,481	322,371	5.82	1,002	322
Sarlahi	635,701	200,383	3.15	1,259	159
Rautahat	545,132	133,871	2.45	1,126	119
Bara	559,135	23,049	0.41	1,190	19
Parsa	497,219	315,961	6.35	1,353	233
Chitwan	472,048	172,034	3.64	2,218	77
Western DR	4,571,013	224,646	0.49	29,398	8
Western Mountain	24,568	1,769	0.72	5,819	0.30
Manang	9,587	852	0.08	2,246	0.4
Mustang	14,981	971	0.64	3,573	0.3

(continued)

Western Hill	2,793,180	132,074	0.47	18,319	7
Gorkha	288,134	10,623	3.68	3,610	3
Lamjung	177,149	9,463	5.34	1,692	5
Tanahu	315,237	6,318	0.20	1,546	4
Syangia	317,320	25,833	0.81	1,164	22
Kaski	380,527	2,338	0.06	2,017	1
Myagdi	114,447	10,236	0.89	2,297	4
Parbat	157,826	32,565	2.06	494	66
Baglung	268,937	25,763	0.95	1,784	14
Gulmi	296,654	4,014	0.13	1,149	3
Palpa	268,558	6,080	0.22	1,373	4
Arghakhanchi	208,391	1,179	0.05	1,193	1
Western Terai	1,753,265	90,803	5.17	5,260	17
Nawalparasi	562,870	26,562	0.47	2,162	12
Rupandehi	708,419	29,243	0.41	1,360	21
Kabilbastu	481,976	34,998	0.72	1,738	20
Mid Western DR	3,012,975	234,297	0.77	42,378	5
Mid Western Mountain	309,084	49,408	1.59	21,351	2
Dolpa	29,545	307	0.01	7,889	0.03
Jumla	89,427	43,122	4.82	2,531	17
Kalikot	105,580	838	0.07	174	0.5
Mugu	43,937	1,702	0.38	3,535	0.5
Humla	40,595	3,439	0.84	5,655	1
Mid Western Hill	1,473,022	43,007	0.29	13,710	3
Pyuthan	212,484	1,724	0.08	1,309	1
Rolpa	210,004	4,734	0.22	1,879	2
Rukum	188,438	4,965	0.26	2,877	2

(continued)

Salyan	313,500	11,600	0.37	1,462	8
Surkhet	288,527	3,405	0.11	2,451	1
Dailekh	225,201	4,664	0.20	1,502	3
Jajarkot	134,868	11,915	0.88	2,230	5
Mid Western Terai	1,230,869	141,882	1.15	7,317	19
Dang	462,380	4,344	0.09	2,955	1
Banke	385,840	113,197	2.93	2,337	48
Bardiya	382,649	24,341	0.63	2,025	12
Far Western DR	2,191,330	98,874	0.45	19,539	5
Far Western Mountain	397,803	23,827	0.59	7,932	3
Bajura	108,781	6,087	0.55	2,188	3
Bajhang	167,026	16,870	1.01	3,422	5
Darchula	121,996	870	0.07	2,344	0.4
FarWestern Hill	798,931	40,231	0.50	6,762	6
Achham	231,285	11,344	0.49	1,680	7
Doti	207,066	3,776	0.18	2,025	2
Dadeldhura	126,162	3,440	0.21	1,538	2
Baitadi	234,418	21,671	0.92	1,519	14
Far Western Terai	884,596	34,816	0.39	4,845	7
Kailali	616,697	13,529	0.21	3,235	4
Kanchanpur	377,899	21,287	0.56	1,610	13

Table 4.7: Annual Human Casualties growth rates by ecological and development regions1990-1999

Development Regions	Mountain %	Hill %	Terai %
Eastern	0.06	6.04	1.54
Western	0.72	0.47	5.17
Central	0.37	0.67	3.90
Mid western	1.59	0.29	1.15
Far Western	0.59	0.50	0.39

Table 4.8: Ranking of district human casualties growth rates by ecological zones

Growth rate % per annum	Mountain	Hill	Terai
Less than 1.00	13	32	11
1.00-1.99	2	2	1
2.00-2.99		2	2
3.00-3.99		2	2
4.00-4.99	1		
5.00 and above	1	4	
Total Districts	16	39	20

Source: Table 4.6

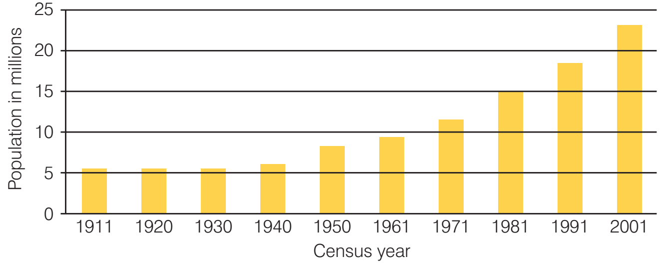
Table 4.9: Ranking of disaster casualties growth rates by development regions.

Human casualties growth rate % per annum	EDR	CDR	WDR	MWDR	FWDR
<1	11	11	13	13	8
1.00-1.99	4				1
2.00-2.99		2	1	1	
3.00-3.99		3	1		
4.00-4.99				1	
>5	1	3	1		
Total number of districts	16	19	16	15	9

Table 4.10: Disaster density by ecological zones and development regions based on human casualties by disasters in 1990-1999

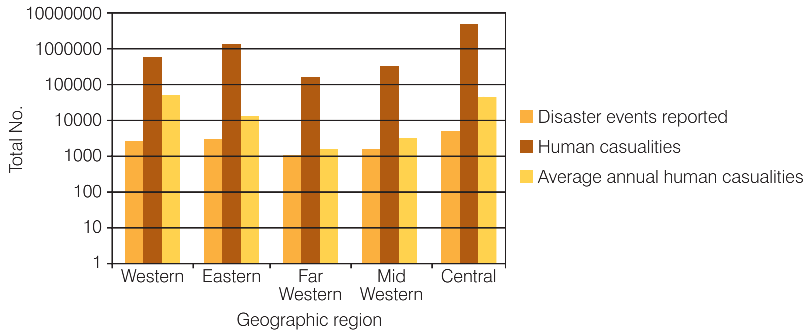
Development Regions	Mountain in no/km²	Hill in no/km²	Terai in no/km²	Total in no/km²
Eastern	3	9	70	22
Western	<1	7	17	8
Central	3	20	165	65
Mid western	2	3	19	5
Far Western	3	6	7	5

Appendix 2: Population of Nepal (1911-2001) in Millions

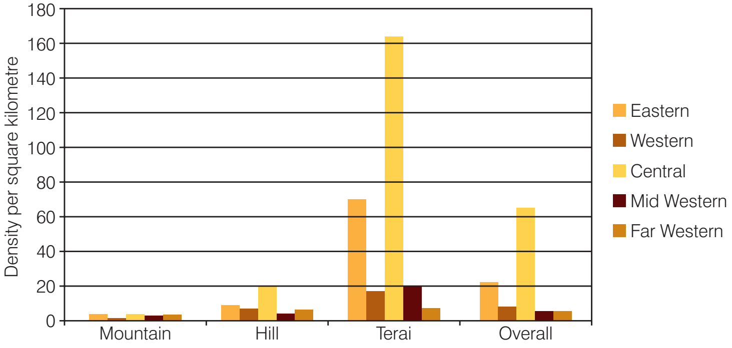


Note: This graph indicates the size of the population of Nepal recorded in the national censuses records between 1911 and 2001 (CBS, 2003).

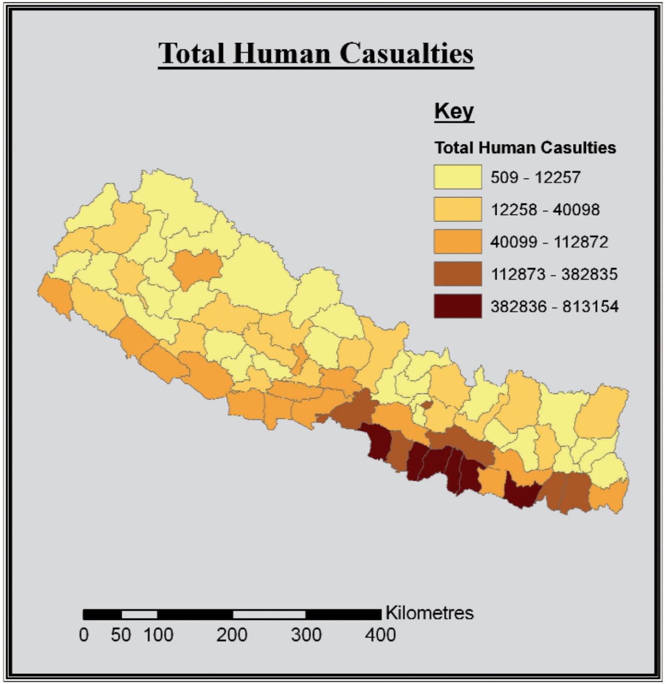
Appendix 3: Disasters events reported, total human casualties and average annual human casualties shown as a function of geographical region

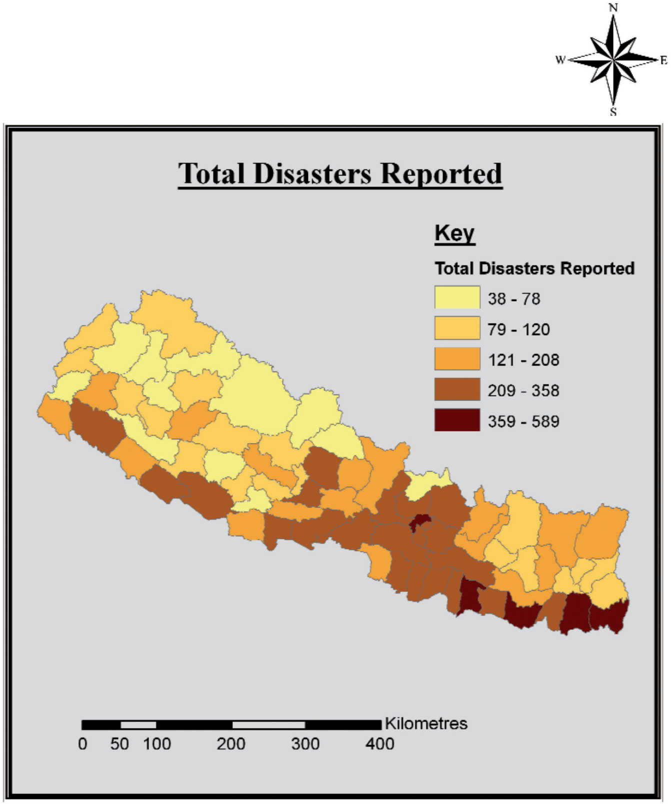


Appendix 4: Disaster density by ecological zones and development regions based on human casualties by disaster in 1990-1999



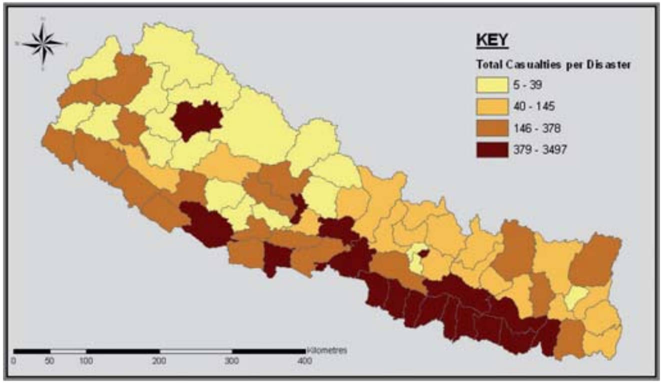
Appendix 5: Total casualties by disasters and total disasters reported between 1900-2005



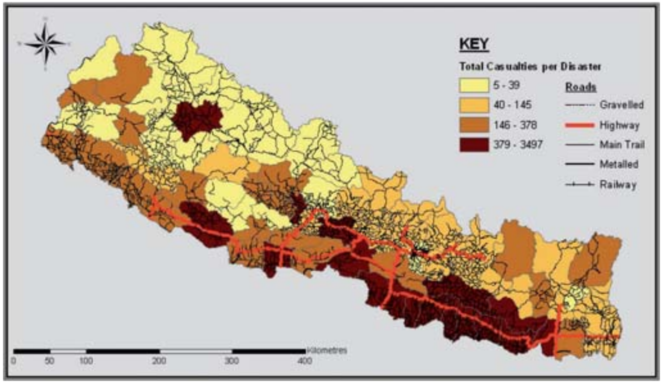


Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

Appendix 6: Total casualties per disaster reported between 1900-2005

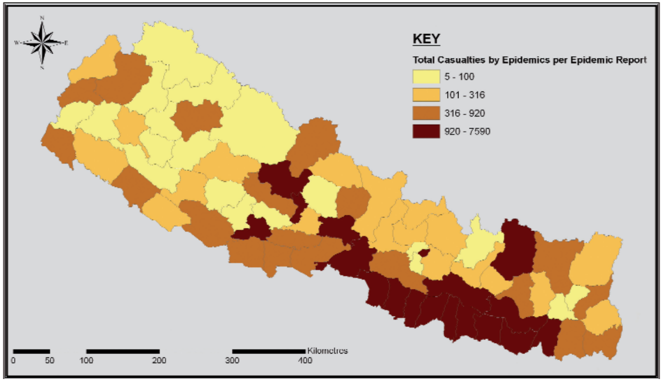


Appendix 7: Total casualties per disaster reported between 1900-2005 with road network.

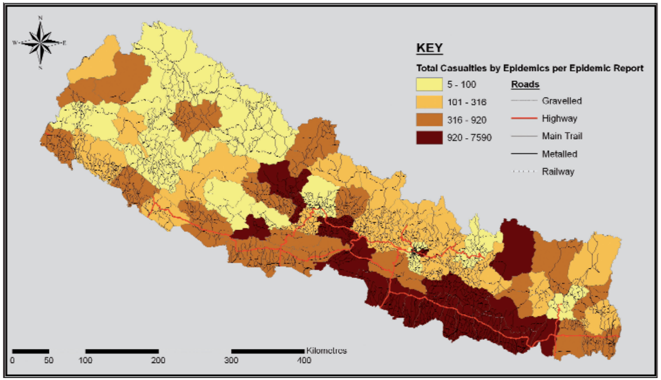


Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

Appendix 8: Total casualties by epidemics per epidemic reported between 1900-2005

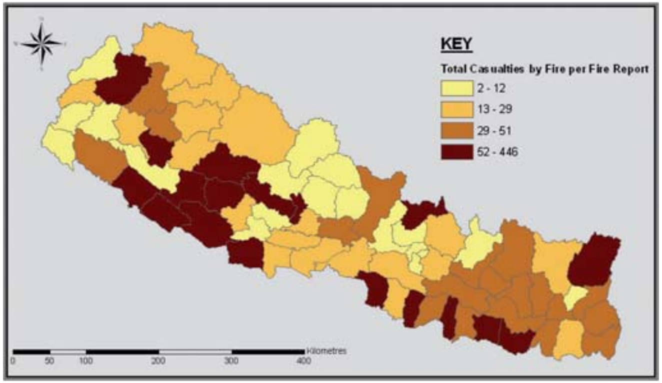


Appendix 9: Total casualties by epidemics per epidemic reported between 1900-2005 with road network

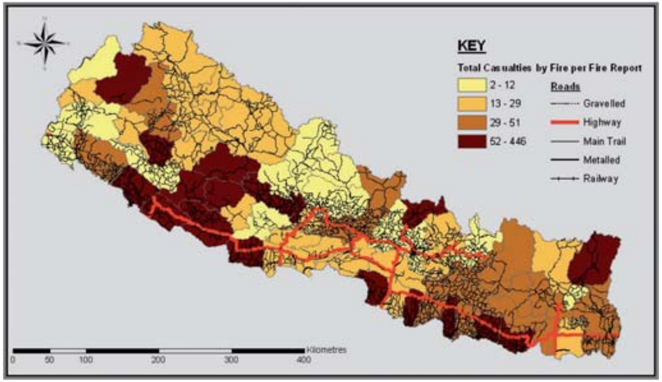


Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

Appendix 10: Total casualties by fire per fire reported between 1900-2005

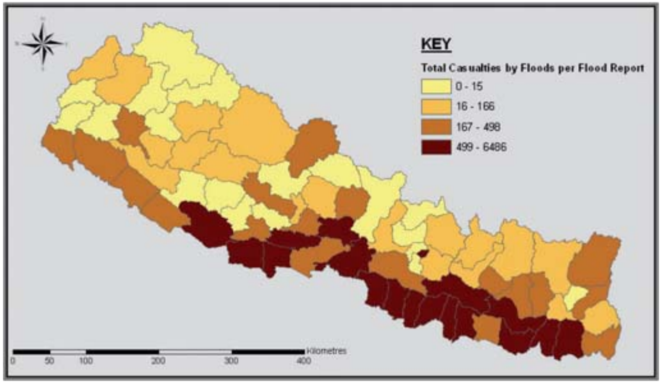


Appendix 11: Total casualties by fire per fire reported between 1900-2005 with road network

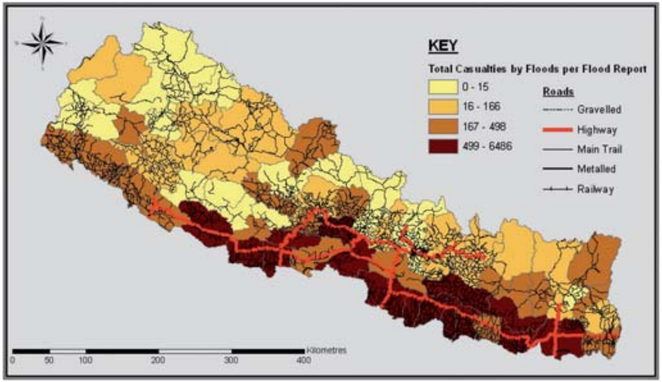


Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

Appendix 12: Total casualties by floods per flood reported between 1900-2005

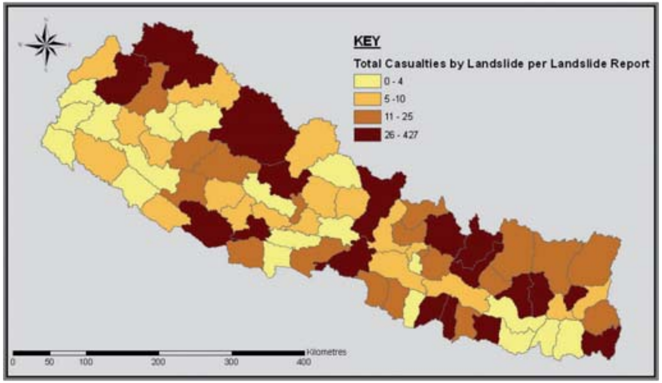


Appendix 13: Total casualties by floods per flood reported between 1900-2005 with road network

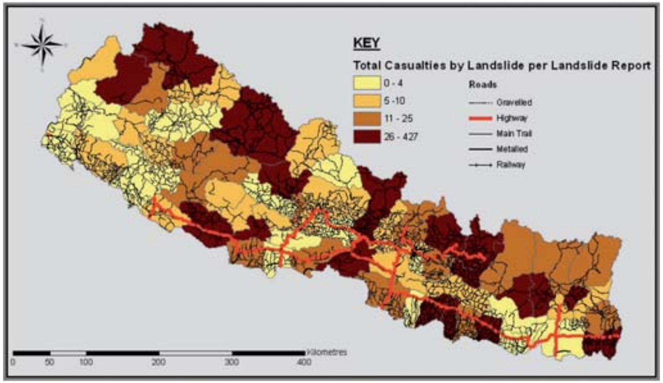


Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

Appendix 14: Total casualties by Landslides per landslide reported between 1900-2005

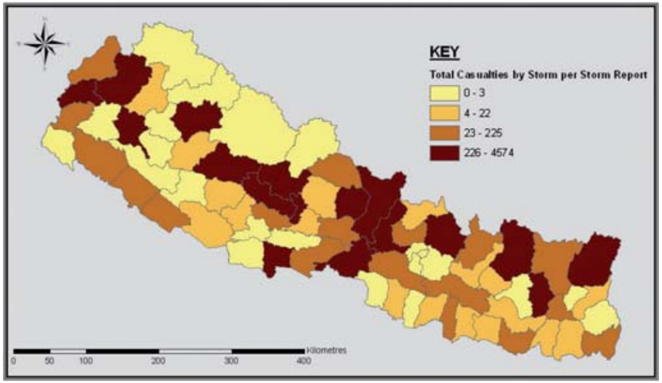


Appendix 15: Total casualties by landslides per landslide reported between 1900-2005 with road network

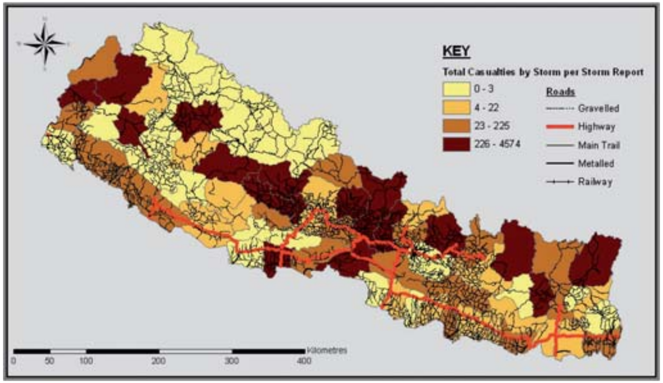


Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

Appendix 16: Total casualties by storm per storm reported between 1900-2005



Appendix 17: Total casualties by storm per storm reported between 1900-2005 with road network



Nepal base mapping, (district shape file) (C) 2000 ICIMOD (International Centre for Mountain Development)

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Staff from various parts of Northumbria University support the Centre, in particular those from the School of Applied Sciences.

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