COMPENDIUM OF

ENVIRONMENT STATISTICS

NEPAL 2015

Government of Nepal
National Planning Commission Secretariat
Central Bureau of Statistics

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Singha Durbar, Kathmandu, Nepal

Message

It is my pleasure to note that the Compendium of Environment Statistics Nepal 2015 has come out as per the guidelines of the United Nation Framework for the Development of Environment Statistics having useful data sets and analysis. Indeed, the Report is an intellectual contribution to the analysis of environment statistics of Nepal. As the country is committed to the Post 2015 global development agenda, that is achieving the Sustainable Development Goals (SDGs), this Compendium could be an important source of information to the indicators related to some of the SDGs set.

Environmental data and information play a key role in the preparation and implementation of plans, policies, programmes and projects in Nepal. This analytical report provides a comprehensive picture of the environmental situation of the country and provides an important instrument for policy integration and informed decision making.

On behalf of the National Planning Commission, I would like to extend my sincere thanks to Central Bureau of Statistics and all those who have contributed directly and indirectly in the preparation of this report.

January, 2016

Dr. Yuba Raj Khatiwada
Vice-Chairman

Government of Nepal
National Planning Commission Secretariat
Singha Durbar, Kathmandu, Nepal

Foreword

Environment is a cross cutting issue and plays an integral role in achieving sustainable development objectives. The Compendium of Environment Statistics aims to serve as reference material for policy makers and professionals in the fields of environment to increase awareness and knowledge of the environmental situation of the country. The need for improvements in the field of data and statistics to monitor progress on the Sustainable Development Goals (SDGs) and the associated need for statistical capacity building in developing countries have been highly recognized.

The environmental problems in Nepal are as diverse as its geography and climate. Priorities in addressing those problems in development planning have changed as new evidence emerged over time. The Government of Nepal has accorded high priority to environmental problems because they have profound impact on the livelihoods of millions of people who depend on ecosystem services. The government has formulated policies, strategies and programmes in each of its periodic plan to see that environmental problems are addressed.

The Compendium of Environment Statistics Nepal 2015 provides a wealth of information and analysis on environmental situation of Nepal. Nepal is committed to Post 2015 Development Agenda and the SDGs. This analytical report of the environment statistics of Nepal can be used by the government and other development stakeholders to formulate policies and programs.

I would like to thank the Central Bureau of Statistics, the authors as well as the members of the Technical Committee and many others who in various ways contributed in the preparation of the Report.

January, 2016

Suresh Man Shrestha
Secretary

Preface

Eradication of poverty and assurance of environmental sustainability are today's greatest challenges. The concept of sustainable development introduces concrete measures to bring these ambitions into balance and intends to promote sustainable development for the benefit of current and future generations.

The development of Environment Statistics is still at an infant stage in Nepal. The Central Bureau of Statistics (CBS) first published a compendium on Environment Statistics in 1994 which provided valuable insights into the importance and usefulness of the subject matter. 'A Compendium on Environment Statistics 1998 Nepal' was brought as the second publication with an attempt to analyze available data on various aspects of the environment of Nepal.

This present publication "Compendium of Environment Statistics Nepal 2015" is the third in the series of publication of the Environmental Compendium. It is not only the updated version of the previous work but an enhanced effort to present available data and textual description and analysis on various aspects of Environment as well. In this publication detailed analytical articles are contained as contributed by the experts of environment related field. This publication, by and large has followed the presentation scheme of the United Nations Framework for the Development of Environment Statistics (UNFDES).

Hope, this type of presentation of environment statistics in a single compendium may prove to be highly useful for environment management, planning, policy purposes and research works.

I would like to express my gratitude to all the authors who have contributed chapters to this compendium. I am grateful to Mr. Bikash Bista, the then Director General for his valuable comments all through the program. I would like to thank Dr. Rudra Suwal, Deputy Director General of the bureau for overall guidance to bring out this publication. Mr. Sushil Kumar Sharma, Director, Environment Statistics Section deserves special thanks for shouldering the responsibility to accomplish the whole task of compilation and bringing out this publication in time. Similarly, I would like to thank Mr. Dhundi Raj Lamichhane, Director of the Environment Statistics Section for his contribution on this publication. Statistical Officers Mr. Manohar Ghimire and Mr. Tulsi Prasad Paudel and Statistical Assistant Mr. Govinda Dumre also deserve thanks for their sincere involvement in the compilation of this publication.

Similarly, the Asian Development Bank deserves our special appreciation for providing funds for the printing of this publication.

Finally, I would like to request all users to provide invaluable suggestions and comments that would be useful for further improvement in the future publications of this kind.

January, 2016

Suman Raj Aryal
Director General
Central Bureau of Statistics

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Abbreviation

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
APF	Armed Police Force
BCN	Bird Conservation Nepal
CBD	Convention on Biodiversity
CBS	Central Bureau of Statistics
CDAF	Central Disaster Aid Fund
CDRC	Central Disaster Relief Committee
CEA	Classifications of Environmental Activities
CITES	Convention on International Trade in Endangered Spices of Wild Fauna and Flora
CPC	Central Product Classification
DDC	District Development Committee
DDRC	District Disaster Relief Committees
DHM	Department of Hydrology and Meteorology
DNPWC	Department of National Parks and Wildlife Conservation
DoF	Department of Forest
DPSRF	Driving –Force-Pressure-State-Response Framework
DRR	Disaster Risk Reduction
EIA	Environmental Impact Assessment
ENPHO	Environment & Public Health Organization
FAO	Food and Agriculture Organization of the United Nations
FY	Fiscal Year
GDP	Gross Domestic Product
GER	Gross Enrollment Ratio
GHG	Green House Gas
GLOF	Glacial Lake Outburst Flood
GoN	Government of Nepal
GTF	Global Tiger Forum
HFA	Hyogo Framework for Action
ICD	International Classification of Diseases
ICIMOD	International Centre for Integrated Mountain Development
IDNDR	International Decade for Natural Disaster Reduction
IEE	Initial Environmental Examination
IPCC	Inter-governmental Panel on Climate Change
ISIC	International Standard Industrial Classification Of All Activities
ITTA	International Tropical Timber Agreement
IUCN	International Union for the Conservation of Nature
LAPA	Local Adaptation Programme of Action
LCCS	Land Cover Classification System
LDMC	Local Disaster Management Committee
LDRC	Local Disaster Relief Committee
LRMP	Land Resource Mapping Project
MDGs	Millennium Development Goals
MEAs	Multilateral Environment Agreements
MFA	Material Flow Accounts
MoEST	Ministry of Environments Science and Technology

MoF	Ministry of Finance
MoHa	Ministry of Home Affairs
MoWR	Ministry of Water Resources
NA	Not Available
NA	Nepal Army
NAPA	National Adaptation Programme of Action
NAPDM	National Action Plan on Disaster Management
NARC	National Agriculture Research Council
NCDM	National Centre for Disaster Management
NCIDNDR	National Committee for the International Decade for Natural Disaster Reduction
NCP	Nepal Civil Police
NCRA	Natural Calamity Relief Act
NDMC	National Disaster Management Council
NEOC	National Emergency Operation Centre
NER	Net Enrollment Ratio
NGOs	Non- Governmental Organizations
NSO	National Statistical Office
NPC	National Planning Commission
NPWC	National Park and Wildlife Conservation
NSDRMN	National Strategy for Disaster Risk Management in Nepal
NTNC	National Trust for Nature Conservation
NWP	National Water Plan
OECD	Organization for Economic Co-operation and Development
PMNCAF	Prime Minister Natural Calamity Aid Fund
PSRF	Pressure-State-Response Framework
RDRC	Regional Disaster Relief Committee
SAARC	South Asian Association for Regional Cooperation
SAM	Social Accounting Matrix
SDGs	Sustainable Development Goals
SEEA	System of Economic and Environment Accounting
SNA	System of National Accounts
SSDS	System of Social and Demographic Statistics
SWM	Solid Waste Management
SWMRMC	Solid Waste Management and Resource Mobilization Center
TYP	Three Year Plans
UNEP	United Nations Environment Programme
UNFDES	United Nations Framework for the Development of Environment Statistics
UNESCAP	United Nations Economic and Social Commission for Asia and Pacific
UNSD	United Nations Statistics Division
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WHO	World Health Organization
WRS	Water Resource Strategy
WTO	World Trade Organization
WUAs	Water Users Associations

CHAPTER 1

Development of Environment Statistics in Nepal

Sushil Kumar Sharma* • Manohar Ghimire**

Environment refers to the surroundings and is roughly divided into two types, Micro environment and Macro environment. The Government of Nepal has addressed major environmental problems and issues in the periodic plans. Environment statistics describe the state and trends of the environment. Currently the Central Bureau of Statistics (CBS) is producing and compiling the environment statistics of Nepal in line with the United Nation Framework for the Development of Environment Statistics (FDES), 1984 updated in 1995. Now, the United Nation Statistical Division (UNSD) has endorsed the FDES 2013. The major challenge of CBS is to compile and produce Environment Statistics of Nepal within this guideline.

Background

The term "environment" has been derived from a French word "Environia", which means to surround. It refers to both abiotic (physical or non-living) and biotic (living) environment. The word "environment" means surroundings, in which organisms live. Environment and the organisms are two dynamic and complex components of nature. Environment regulates the life of the organisms including human beings. Human beings interact with the environment more vigorously than other living beings. Ordinarily environment refers to the materials and forces that surround the living organism.

Environment is the sum total of conditions that surrounds us at a given point of time and space. It is comprised of the interacting systems of physical, biological and cultural elements which are interlinked both individually and collectively. Environment is the sum total of conditions in which an organism has to survive or maintain its life process. It influences the growth and development of living forms.

In other words, environment refers to those surroundings that surrounds living beings from all sides and affect their lives in total. It consists of atmosphere, hydrosphere, lithosphere and biosphere. Its chief components are soil, water, air, organisms and solar energy. It has provided us all the resources for leading a comfortable life.

1. According to P. Gisbert "Environment is anything immediately surrounding an object and exerting a direct influence on it."
2. According to E. J. Ross "Environment is an external force which influences us."

Thus, environment refers to anything that is immediately surrounding an object and exerting a direct influence on it. Our environment refers to those things or agencies which though distinct from us, affect our life or activity. The environment by which human being is surrounded and affected by factors that may be natural, artificial, social, biological and psychological.

Environment mainly consists of atmosphere, hydrosphere, lithosphere and biosphere. But it can be roughly divided into two types such as Micro environment and Macro environment. It can also be divided into two other types such as physical and biotic environment.

(a) Micro environment refers to the immediate local surrounding of the organism.
(b) Macro environment refers to all the physical and biotic conditions that surround the organism externally.
(c) Physical environment refers to all abiotic factors or conditions like temperature, light, rainfall, soil, minerals, etc. It comprises of atmosphere, lithosphere and hydrosphere.
(d) Biotic environment includes all biotic factors or living forms like plants, animals, Micro-organisms.

*(Meaning, Definition and Components of Environment By Puja Mondal, Environment)

Environmental Problems

Environmental problems such as climate change, global warming, melting of snow in the Himalayas, decreasing productivity in agriculture despite technology development, etc. are not confined to any country or continent nor it is limited to the developing or the developed world. Therefore, the United Nations and other global institutions have been paying attention towards environment management since decades. It has been realized that sustainability of the development depends much upon the management of the environment and hence, the expenditure on environmental management today is in fact, a reliable investment for the safe future.

The United Nations initiated actions towards the environment by establishing United Nations Environment Programme (UNEP) in 1972 that aims to coordinate the development of environmental policy by keeping the global environment under review and bringing emerging issues to the attention of the governments and the international communities for action.

The major environmental problems of Nepal can be listed as:

- Degradation of air quality
- Degradation of drinking water
- Degradation of natural resources
- Lack of solid waste management
- Degradation of surface water quality
- Diminishing of water resources
- Release of toxic pollutants
- Loss of biodiversity
- Impacts of climate change
- Improper land use

Due to the above mentioned environmental problems, Nepal has been facing following challenges:

- Sensitizing and building awareness among all layers of the people on environmental issues,
- Compliance with Multilateral Environmental Agreements (MEAs),
- Protecting natural resources- specially halting deforestation, biodiversity conservation, and pollution control,
- Environmental Standard formulation and enforcement,
- Adapting and mitigating climate change impacts,
- Enhancing institutional capacity considering the changing global scenario,
- Effective environmental governance.

Environment Management in Periodic Plans

In the context of Nepal, policies and programs on environment management have been incorporated in the periodic plans. However, priorities varied and immediate needs are reflected in the plans. Issues relating to environment have been addressed since the sixth Five-Year Periodic Plan. Policy regarding the environmental issues has been reflected in the national and international treaties or general conventions. It has become essential to incorporate those policies followed and continued in the development plans and programs realizing the problems of climate change and environmental degradation.

In the early seventies, priorities were given to address soil erosion, flood and landslides and conserve forest resources in the policies, strategies and programs of the periodic plans. In the early eighties, emphasis was given on the policy of reducing water pollution generated by industries and urban areas. At the same time, efforts were made to manage resources through people's participation. Remarkable achievements were gained in the community forestry but problems started to emerge in urban areas and industrial estates particularly of pollution of solid waste, air, water and noise. On the other hand, rural areas continue to suffer from soil erosion, flood, landslides and reduction in the sources of water. Nevertheless, various initiatives were taken by the government, Non-Governmental Organizations (NGOs), and the private sector to address these problems. The government formulated policies and enacted Acts and Regulations such as Environment Protection Act, 1997, Environment Protection Rules, 1997, National Environmental Impact Assessment Guidelines 1993 and Ozone Depleting Substances Consumption Rules 2001, etc. Environment Impact Assessment (EIA) of development works was institutionalized and the standard related to the industrial effluents air quality were implemented. But, the outcome of these efforts was not achieved satisfactorily.

Nepal has been facing two types of environmental challenges: problems generated by the pres-

sure on natural resources and air as well as water pollution. The problems generated by climate change for which the country is not responsible but has to face it and it could even be dangerous in future. The Three Year Interim Plan (TYP) of Nepal (2010/11 - 2012/13) has mentioned the major problems of environment management such as monitoring system being not effective regarding the implementation of approved standard including as mentioned in the report on EIA, institutional capacity not strengthened as expected, coordination mechanism not strengthened amongst the inter ministries, and environment related policies and programs not adaptable with sectoral policies and programs.

In pursuing national development Three-Year Plan TYP (2013/14 – 2015/16), Nepal increasingly needs to keep in mind the goals of environmental protection and adaptation to climate change. Nepal has ratified several national and international treaties and conventions regarding these issues and has arranged for the corresponding national policies and legislative and institutional infrastructure to uphold its commitments. To minimise stress on the environment and to mitigate the impacts of climate change, Nepal has adopted the notion of green development. With the participation of the Nepal government and other governments national as well as international non-governmental agencies, efforts have been made to frame strategic program to promote national and local adaption, initiate carbon trading, and internalize and address environment-sensitive issues. The lack of institutional capacity, the absence of inter-agency relationships to handle issues relating to climate change, and the shortage of adequate means and resources are some of the problems faced by this sector. TYP (FY 2013/14 – 2015/16) has mentioned the following major policies and operating policies to be adopted in the environment sector:

- To make environmental management an integral component of development program,
- To adapt climate change and sustainably conserve and manage natural resources by pursuing disaster risk mitigation, poverty alleviation and environmental protection,
- To make meteorological services reliable, trustworthy, regular and good-quality in order to mobilize them in efforts to mitigate the impacts of climate change,
- To make new laws pertaining to environmental conservation will be drafted, and the environmental policy, existing laws, rules and mechanisms will be strengthened and updated and institutional capacities will be enhanced,
- Through the Local Adaption Program of Action, the National Adaption Program of Action will be executed at the local level and efforts to alleviate poverty will be expanded,
- To make programs to spread public awareness about protecting and preserving the environment will be carried out,
- The Ministry of Science, Technology and Environment will serve as a focal agency to execute all the activities related to environmental conservation and climate change,
- By enforcing the treaties and conventions to which Nepal is a party, and especially taking advantage of the Clean Development Mechanism under the Kyoto Protocol, the agencies concerned will be mobilized to derive maximum benefits,
- Partnerships will be forged among the donor agencies, non-government organizations, local bodies, community institutions and other agencies in order to coordinate activities related to environment and climate change,
- The development of environment-friendly, climate change-adaptive infrastructure will be emphasized,
- Inter-agency coordination in the planning and implementation of environment-friendly development measures will be strengthened,
- The concept of green economy will be integrated into all economic programs,
- Pollution levels in the rivers in Kathmandu and other metropolises will be reduced and air, land, water, and sound pollution will be controlled,
- Actions regarding hazardous waste management will be taken in coordination with the agencies concerned,
- Additional environmental standards will be framed and implemented in the areas of air, land, water, and sound pollution,
- Special programs for reducing various types of pollution will be designed and implemented in order to keep urban pollution within a certain limit and to preserve the beauty of rural areas,
- Mechanisms for the enforcement of 'the polluter pays' and 'removing pollution is good' principles

will be developed and implemented; the use of low-polluting means of transport and environment-friendly fuel will be promoted. Advanced technology will be employed to minimize the growing levels of pollution. To reconcile the sometimes conflicting demands of environmental protection and poverty alleviation, poverty alleviation programs with an environmental dimension will be effectively implemented,

- The existing weather forecasting system will be made more reliable and trustworthy,
- Early warning systems for floods will be initiated by utilizing appropriate technology,
- To improve the collection of data from the currently existing water-and-weather centres, a telemetry system will be developed and expanded,
- Provisions will be made for spending a certain portion of revenue generated from natural resources for the conservation of natural resources and environmental research and development.

Millennium Development Goals and Progress Status in Achieving the Environment Sustainability Goals in Nepal

Nepal has made significant progress in achieving its Millennium Development Goals (MDGs). In fact, given the difficult context— a decade-long armed conflict and political instability— its achievements should be considered remarkable. Its targets for the poverty and hunger, universal primary education, gender equality and women's empowerment, child mortality, and maternal health are likely to be achieved, while those for HIV/AIDs, malaria and other diseases, environmental sustainability, and global partnership are unlikely to be achieved in totality.

Environmental sustainability is not being addressed adequately, and will require much more effort and resources to achieve targets. Environment sustainability is directly related with the people's livelihoods and economic development. Nepal is highly vulnerable to the risks of climate change, although its contribution to green house gas (GHG) emissions is very low and negligible in global warming. Community based initiatives are essential for effective conservation and sustainable use of forests and biodiversity and for biodiversity loss. As the climate change became an international issue, environmental protection and conservation has gained more attention in Nepal. The Government of Nepal has given importance to poverty alleviation, food security and climate change by creating the employment opportunities through its three years' periodic plans/programs.

After climate change became an international priority, meeting the needs of a growing population for sustainable energy is one of the biggest challenges. Nepal has been facing especially in light of the need to reduce poverty and address climate change. Nepal must adopt improved and affordable energy-efficient technology if it is to reduce poverty and sustain prosperity. Its demand for energy should be increasingly met by renewable sources in order to limit the adverse impact on the environment. It should replace out-dated infrastructure and technologies gradually and invest in efficient energy usage, renewable energy sources, and minimally carbon-intensive technologies; all areas of investment which promise both financial and environmental benefits. The government is committed to phasing out inefficient fossil fuel subsidies. In embracing renewable-energy technology, it should provide targeted support, perhaps in the nature of subsidies, to poor and marginalized communities and rural areas. Providing people with access to modern and reliable energy to cook and light their homes has enormous social, economic, and environmental benefits. The government can use a combination of taxation, subsidy, regulation and partnership to encourage innovations in clean energy. Although access to safe drinking water is a basic human right, many Nepalese have access to only basic, not medium- or high quality water supply services, and continuous access is rarely guaranteed. The 2015 MDG targets focus on improving the quality of the sources of water collection and on reducing the amount of time spent collecting water. Nepal must now ensure that safe drinking water is universally accessible nearby, or at schools and homes, especially those located in slums and squatter settlements, and that tourists, too, are adequately provisioned. Investments in safe drinking water should complement investments in sanitation and hygiene so that Nepal can reduce the currently high

incidence of diarrheal diseases. The nation must expand sanitation infrastructure and offer more public services as well as establish, or strengthen, national, sub-national and local policies regarding the collection, recycling and usage of wastewater.

Monitoring and evaluation of the policies and programs are keys to the successful implementation of the plan. However, proper monitoring and evaluation has been difficult due to data and information gaps.

Environment Statistics and Indicators

Principle 10 of the United Nations Declaration on Environment and Development (Rio de Janeiro, June 1992), stated "……..each individual shall have appropriate access to information concerning the environment that is held by public authorities ……. and the opportunity to participate in the decision making process. States shall facilitate and encourage public awareness and participation by making information widely available."

Environment statistics describe human activities with a view to enumerate his/her interactions with the environment. The scope of environment statistics depends largely on the environmental problems on the political agenda; the geographic situation of a country, its state of development, and its political system taken together determine the bulk of this agenda. A tropical, densely populated country with much rain and situated on the coast envisages other problems than a sparsely populated landlocked country with a desert climate. Also, problems of sustainable agriculture and forestry, of eco-tourism, or of biodiversity conservation or of climate change are likely to be much more important to the biodiversity-rich, resource-dependent economies of the developing world. The scope generally includes the media of the natural environment (air/climate, water, land/soil), the biota found within these media, and human settlements. It therefore, describes the quality and availability of natural resources, human activities and natural events that effect the environment, the impacts of these activities and events and social responses to these impacts.

Environment Statistics is relatively a young branch and multi-disciplinary area in the field of official statistics. The sources of environmental statistics are dispersed and variety of methods are applied in their compilation. They generally provide a synthesis of data from various subject areas and sources to help in the formulation and evaluation of integrated socio-economic and environmental policies.

Objective of Environment Statistics

The objective of environment statistics is to provide information about the environment, its most important changes over time and across locations, and the main factors that influence them. Ultimately, environment statistics aim at providing high quality statistical information to improve knowledge of the environment, to support evidence-based policy and decision making, and to provide information for the general public, as well as for specific user groups.

Scope of Environment Statistics

The scope of environment statistics covers biophysical aspects of the environment and those aspects of the socio-economic system that directly influence and interact with the environment. The scope of environment, social and economic statistics overlap and it is not easy to draw a fine dividing line between these statistical areas. Social and economic statistics describing processes or activities that have a direct impact on, or interact directly with, the environment are widely used in environment statistics and they are within the scope of the FDES. Beyond 20 that, other relevant social and economic statistics are also required to put environmental issues in context and to facilitate the integrated analysis of environmental, social and economic processes. The use of consistent definitions and classifications among these fields helps their integration. When properly integrated, data and other inputs from these domains enrich the analysis of environment statistics.

Main Users and User Groups of Environment Statistics

Environment statistics serve a variety of users, including but not restricted to:

i. Policy and decision makers at all levels;
ii. The general public, including media and civil society;
iii. Analysts, researchers and academia
iv. International agencies.

Different users need environment statistics at different levels of aggregation and depths of information. They may need cross-cutting environment statistics data sets, for instance regarding climate change. In other cases they may only be interested in particular topics and themes pertaining to specific sectoral analysis and policy making. Policy and decision makers at the highest levels and the general public would tend to use environmental indicators and more aggregated statistics. Environmental administration, researchers, analysts and academia may be more inclined to look at extensive and detailed environment statistics. International agencies typically have well articulated environmental data needs based on environmental agreements or international data collection processes. Environment statistics support evidence-based policy making by enabling the identification of environmental policy issues and the objective quantification of measures and impacts of policy initiatives. They strengthen assessments through quantitative metrics, making analysis more robust through the use of timely and comparable data. The type, the level of thematic, spatial and temporal aggregation, and the format of environment statistics depend on the type of the user and the intended purpose of use. The main products of environment statistics are detailed tabulated environment statistics series and environmental indicators stored in multipurpose databases and disseminated in the form of on-line databases as well as different types of publications such as compendia, yearbooks and state of the environment reports.

Sources of Environment Statistics

Environment statistics synthesize data originating from a wide range of source types. This means that the data used for the production of environment statistics are not only compiled by many different collection techniques but also by many different institutions. Source types include:

i. Statistical surveys (e.g., censuses or sample surveys of population, housing, agriculture, enterprises, households, employment, and different aspects of environment management);
ii. Administrative records of government and non-government agencies in charge of natural resources as well as other ministries and authorities;
iii. Remote sensing (e.g., satellite imaging of land use, water bodies or forest cover);
iv. Monitoring systems (e.g., field-monitoring stations for water quality, air pollution or climate);
v. Scientific research;
vi. Special projects undertaken to fulfill domestic or international demand.

Classifications, Categories and other Groupings relevant to Environment Statistics

Statistical classifications are sets of discrete categories which may be assigned to a specific variable in a statistical survey or an administrative file and used in the production and presentation of statistics. The field of environment statistics has no single, overarching, internationally agreed classification of the environment for statistical purposes. Instead, there are a number of coexisting and emerging classifications and categorizations for specific subject areas. These include standardized statistical classifications as well as less formalized groupings or categories. Some of the classifications and categories that have been used in the environmental field have not been developed specifically for statistical purposes, and therefore have to be linked to statistical classifications. Standard economic and social-demographic statistical classifications, such as e.g., the International Standard Industrial Classification of All Economic Activities (ISIC) and the Central Product Classification (CPC), or the International Classification of Diseases (ICD) among others, are relevant for and used in environment statistics. The use of these classifications facilitates the integration of environment statistics with economic and social demographic statistics.

More recent statistical classifications as well as less-formalized categorizations which pertain to specific sub-domains of environment statistics do exist and are in use. They are UNSD, "Standard Statistical Classifications: Basic Principles" Available from http://unstats.un.org/unsd/class/family/bestprac.pdf. International Standard Industrial Classification of All Economic Activities, Rev. 4". Available from http://unstats.un.org/unsd/cr/registry/isic-4.asp. "Central Product Classification, Ver. 2". Available from http://unstats.un.org/unsd/cr/registry/cpc-2.asp. World Health Organization (WHO), "International Classification of Diseases". Available from http://www.who.int/classifications/icd/en. Classifications and categorizations developed by different international organizations and specialized agencies, intergovernmental organizations or non-governmental organizations. Examples are the Food and Agriculture Organization (FAO), Land Cover Classification System, the United Nations (UN) Framework Classification for Energy and Mineral Resources, or the groupings and classifications developed for water statistics and for energy products in the relevant UN international recommendations. Many of the aforementioned classifications have been revised, adapted and used in the System of Environmental-Economic Accounting (SEEA) Central Framework, including the Classification of Environmental Activities (CEA) which covers the classes of activities that are considered to be environment protection and resource management activities, mostly used for producing statistics of environmental protection and resource management expenditure. Other examples are the categories of solid waste or the interim classifications of land use and land cover. More work on classifications regarding ecosystems and ecosystem services is being carried out as part of the development of the SEEA Experimental Ecosystem Accounts. Additionally, there are classifications and lists of categories which do not originate in the statistical community but are used in environment statistics, such as classifications of both natural and technological disasters produced by the Centre for Research on the Epidemiology of Disasters Emergency Events Database (CRED – EM-DAT); classifications for protected areas and threatened species by the United Nations Environment Program's World Conservation Monitoring Centre (UNEP-WCMC) and the International Union for the Conservation of Nature (IUCN); the ecosystem reporting categories used by the Millennium Ecosystem Assessment; or the source categories for greenhouse gas emissions (GHGs) from the Inter-governmental Panel on Climate Change (IPCC). These classifications have been widely used by the UN ECE, the Organization for Economic Co-operation and Development (OECD), Eurostat, United Nations Statistics Division (UNSD), and various regional and national bodies for international data collection. Ensuring harmonization of the different classifications and building bridges among them are among the most important roles of environmental statisticians.

Environment Statistics for Policymaking

The demand for environment statistics is increasing in step with the continued environmental challenges faced by modern society. The recognition that human wellbeing depends on the environment has led to an increasing emphasis on environmental and sustainability concerns on which decisions and actions need to be taken. Paramount to these actions is the regular production of environment statistics of the highest possible quality to support evidence-based policymaking by enabling the identification of environmental policy issues and allowing their objective quantification. Environment statistics portray key information about the state of the environment and its most relevant changes through space and time. They strengthen assessments through quantitative techniques, making analysis more robust, timely and progressively harmonized at the international level. Environment statistics are necessary for producing environmental assessments, state of the environment reports, environmental compendia, environmental indicators, indicators of sustainable development, as well as to facilitate environmental-economic accounting. The member States of the United Nations have addressed this challenging area during the Rio+20 Conference in June 2012. The outcome document, "The Future We Want" contains various references that are relevant to the work of the UNSD in this regard. This document frequently mentions the im-

portance of data, in particular, environmental data, as well as information and indicators. The Framework for the Development of Environment Statistics (FDES 2013), including the Core Set of Environment Statistics, provides an appropriate means for addressing these information needs as they relate to the environmental dimension of sustainable development. The FDES has been recognized by the 44th session of the Statistical Commission as a useful tool to adequately respond to the increasing demand for information in the follow-up to Rio+20 and the post-2015 development agenda (including Sustainable Development Goals).

The Challenge of Producing Environment Statistics

Environment statistics cover a wide range of information and are interdisciplinary in nature. Their sources are dispersed over a variety of data producers, and similarly numerous methods are applied in their compilation. To effectively produce environment statistics, specific statistical and environmental expertise, scientific knowledge, institutional development capabilities, and adequate resources are equally necessary. Many countries still require substantial technical assistance and capacity building. Environment statistics therefore require a proper framework to guide their development, coordination and organization at all levels.

Framework for Development of Environment Statistics

Development activities now have been linked to the environmental management and accordingly, the demand for environment related information has also increased day-by-day. Therefore, efforts are being made for the development of environment statistics. The UNSD developed United Nations Framework for the Development of Environment Statistics (UNFDES) (a list of environmental indicators) in collaboration with the Inter-governmental Working Group on the Advancement of Environment Statistics.

The FDES is a multi-purpose conceptual and statistical framework that is comprehensive and integrative in nature and marks out the scope of environment statistics. It provides an organizing structure to guide the collection and compilation of environment statistics at the national level. It brings together data from the various relevant subject areas and sources. It is broad and holistic in nature, covering the issues and aspects of the environment that are relevant for policy analysis and decision making by applying it to cross-cutting issues such as climate change.

The FDES was first published in 1984 by UNSD. For almost three decades it has been a useful framework for guiding countries in the development of their environment statistics programmes. However, the combination of lessons learned during its application, along with improved scientific knowledge and emerging environmental concerns over the intervening years, strongly suggested that the FDES was ready for revision. The fourth meeting of the Working Group (Stockholm, 6 - 10 February 1995) agreed on the List of environmental and related socioeconomic indicators given below. It provides a framework for the member countries to compile and manage environmental statistics. The Statistical Commission, at its twenty-eighth session (New York, 27 February - 3 March 1995), approved this list for international compilation by UNSD. The indicators that are bolded in the list were intended for short-term compilation directly from national statistical services or from other international organizations or specialized agencies. Now, we are using this Framework for the production of Environment Statistics of Nepal (Table 1).

Again, the 44th (2013) session of Statistical Commission of UNSD endorsed the FDES 2013 and recognized it as a useful tool to adequately respond to the increasing demand for environmental information in the follow-up to Rio+20 and the post-2015 development agenda. The FDES 2013 addresses the characteristics and challenges of environment statistics by providing a conceptual foundation and organizing structure for environment statistics, identifying the scope of relevant statistics, and by indicating the availability of classifications, methodologies and the most common sources of data as well as the most relevant institutional stakeholders.

Table 1: Framework for Development of Environment Statistics (FDES) Information Categories

Agenda 21 Issues (clusters)	A. Socioeconomic activities, events (pressure /driving force)	B. Impacts and Effects events (part of state)	C. Responses to impacts events (response)	D. Inventories, stocks, background conditions events (part of state)
ECONOMIC ISSUES	Real GDP per capita growth rate Production and consumption patterns Investment share in GDP	EDP/EVA per capita Capital accumulation (environmentally adjusted)	Environmental protection expenditure as % of GDP Environmental taxes and subsidies as % of government revenue	Produced capital stock
SOCIAL/DEMO- GRAPHIC ISSUES	Population growth rate Population density Urban/rural migration rate Calorie supply per capita	% of urban population exposed to concentrations of SO_2, particulates, ozone, CO and Pb Infant mortality rate Incidence of environmentally related diseases		Population living in absolute poverty Adult literacy rate Combined primary and secondary school enrolment ratio, Life expectancy at birth Females per 100 males in secondary school
AIR/CLIMATE	Emissions of CO_2, SO_2 and NOx Consumption of ozone depleting substances	Ambient concentrations of CO, SO_2, NO_x O_3 and TSP in urban areas Air quality index	Expenditure on air pollution abatement Reduction in consumption of substances and emissions	Weather and climate conditions
LAND/SOIL	Land use change Livestock per km^2 of arid and semi-arid lands Use of fertilizers Use of agricultural pesticides	Area affected by soil erosion Land affected by desertification Area affected by stalinization and water logging	Protected area as % of total land area	Arable land per capita
WATER Fresh water resources	Industrial, agricultural and municipal discharges directly into freshwater bodies Annual withdrawals of ground and surface water Domestic consumption of water per capita Industrial, agricultural water use per GDP	Concentration of lead, cadmium, mercury and pesticides in fresh water bodies Acidification of fresh water bodies BOD and COD in fresh water bodies Water quality index by fresh water bodies	Waste water treatment, total and by type of treatment (% of population served) Access to safe drinking water (% of population served)	Groundwater reserves
Marine water resources	Industrial, agricultural and municipal discharges directly into marine water bodies	Deviation in stock from maximum sustainable yield of marine species Loading of N and P in coastal waters		
OTHER NATURAL RESOURCES				
Biological resources	Annual round wood production Fuel wood consumption per capita Catches of marine species	Deforestation rate Threatened, extinct species	Reforestation rate Protected forest area as % of total land area	Forest inventory Ecosystems inventory Fauna and flora inventory Fish stocks
Mineral (including energy) resources	Annual energy consumption per capita Extraction of other mineral resources	Depletion of mineral resources (% of proven reserves) Lifetime of proven reserves		Proven mineral reserves Proven energy reserves
WASTE	Municipal waste disposal Generation of hazardous waste Imports and exports of hazardous wastes	Area of land contaminated by toxic waste	Expenditure on waste collection and treatment Waste recycling	
HUMAN SETTLEMENTS	Rate of growth of urban population % of population in urban areas Motor vehicles in use per 1000 habitants	Area and population in marginal settlements Shelter index % of population with sanitary services	Expenditure on low-cost housing	Stock of shelter and infrastructure
NATURAL DISASTERS	Frequency of natural disasters	Cost and number of injuries and fatalities related to natural disasters	Expenditure on disaster prevention and mitigation	Human settlements vulnerable to natural disasters

The FDES 2013 Structure

There are six components in FDES 2013. All of the components are related to each other. At the centre of the FDES, it remains environmental conditions and quality. These components are multi-layered, flexible and adaptable. (Figure1)

Figure 1: The FDES 2013 Structure

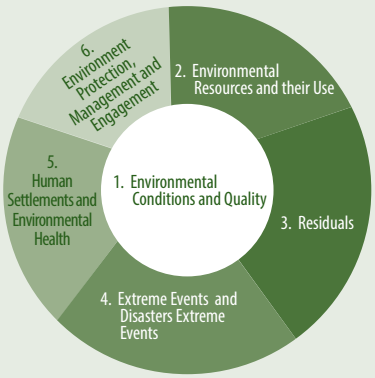
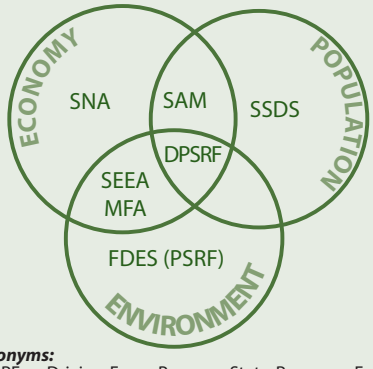


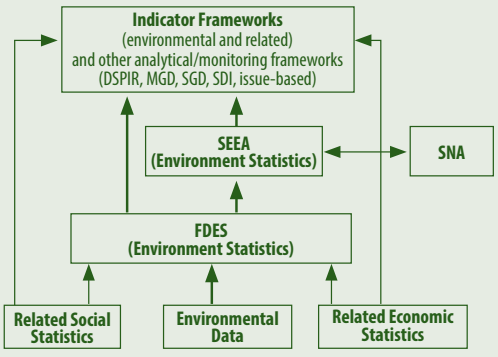
Figure 2: Links between the FDES and Social and Economic Statistics



Acronyms:

DPSRF	Driving-Force-Pressure-State-Response Framework
FDES	Framework for the Development of Environment Statistics
MFA	Material Flow Accounts
PSRF	Pressure-State-Response Framework
SAM	Social Accounting Matrix
SEEA	System for integrated Environmental and Economic Accounting
SNA	System of National Accounts
SSDS	System of Social and Demographic Statistics

Figure 3: Relationship of the FDES to other Frameworks, Systems and Indicator Sets



SEEA= System of Environment-Economic Accounting
SNA = System of National Accounts

Links between the FDES and Social and Economic Statistics

The FDES 2013 is structured in a way that allows links to economic and social domains. It seeks to be compatible with other frameworks and systems, both statistical and analytical, such as the SEEA, the Driving force – Pressure – State – Impact – Response (DPSIR) framework, or the Millennium Development Goals as well as the Sustainable Development Indicator frameworks. This compatibility allows that environment statistics from the FDES can feed into the SEEA or different indicator frameworks. It uses existing concepts and relies on existing statistical classifications (when applicable). As such, the FDES facilitates data integration within environment statistics and with economic and social statistics. (Figure 2)

We are not able to collect and publish the environmental data in the FDES 2013 format but in near future our effort will be to produce environment statistics of Nepal in this format.

Existing Status of Environment Statistics

Formally, all statistical mechanisms were geared for the production of socio economic statistics because this was the demand of the day for planning, policy purpose and decision making. The general thrust to develop and institutionalise environment statistics can be said to be of recent origin. As socio economic statistics has been developed to some extent in different areas for the last few decades, the environment statistics that can be compiled from the socio economic data sets are, more or less, available in many respects. And, side by side, various indicators, rates and ratios can be computed from that available database. But, with regard to bio- physical areas, the existing information system is not adequate enough to meet the current data needs. There are many data gaps in many respects. It was very recently i.e. starting from eighties or so, efforts were initiated to develop information system on natural environment in the process of addressing the environmental issues or undertaking the line functions of some agencies concerned with environmental aspects. Now, various agencies-governments as well as

government owned autonomous institutions have been producing environment statistics as part of their activities. Now, the major environment data producing agencies in Nepal are:

- Central Bureau of Statistics(CBS)
- Alternative Energy Promotion Centre (AEPC)
- Department of Forest (DoF)
- Department of Hydrology and Meteorology (DHM)
- Department of Livestock Services (DoLS)
- Department of National Park & Wildlife Conservation (DNPWC)
- Department of Plant Resources (DPR)
- National Agriculture Research Council (NARC)
- Water and Energy Commission Secretariat (WECS)
- Line Ministries and affiliated Departments, Divisions, Units etc.
- Development community - I/NGOs, CBOS, Clubs etc.
- Universities/Academia
- Private Sectors/Labs/Industries
- Others…….

But there are so many challenges in the development of environment statistics of Nepal, the key challenges are:

- We lack National Environmental Information System,
- Very few data in environment sector,
- Inadequate number of data generation/collection centers,
- Coordination,
- Culture of sharing data on public platforms/web,
- Organized data generation and validation mechanism,
- Accuracy, validity, reliability and timeliness,
- Standard methodologies,
- Lack of timely disseminating mechanisms,
- Data sharing policy.

The following affects are seen due to the above mentioned challenges and problems:

- Misleading information,
- Inappropriate decisions and missed targets/ problems/goals,
- No reliable baseline for research and actions,
- Monitoring and evaluation,
- Disintegration of environmental issues and fragmented actions and approaches,
- Policy gaps and constraints in implementing existing laws, policies and provisions,
- Lack in development of environmental standards, rules and guidelines,
- Unclear national picture for international negotiations and processes,
- Community ignorance and negligence of environmental issues.

To overcome these challenges we suggest the following recommendation for the development of environment statistics in Nepal:

- Designated statistical system,
- Survey clearance system,
- Inter-agency coordination mechanisms,
- Define role and scope of government and non-government organization,
- Need for compendium of environmental research,
- Establishment of data generation stations across the country,
- Environmental data sharing policy.

Role of Central Bureau of Statistics for the Development of Environment Statistics in Nepal

Central Bureau of Statistics (CBS) first published a compendium on Environment Statistics in 1994 which provided valuable insights into the importance and usefulness of the subject matter. 'A Compendium on Environment Statistics 1998 Nepal' was brought as second publication with an attempt to analyze available data on various aspect of the environment of Nepal. However, database on the environment was limited. Therefore, CBS continued attempts to bring out the environment related statistics by compiling and publishing its publication 'Environment Statistics of Nepal" since 2002. Up to now the Central Bureau of Statistics has published the following series of publications related to environment statistics of Nepal:

- A Compendium on Environment Statistics, 1994
- A Compendium on Environment Statistics, 1998
- Environment Statistics of Nepal, 2002 in the form of environment database of Nepal
- Environment Statistics of Nepal, 2003
- Environment Statistics of Nepal, 2004
- Environment Statistics of Nepal, 2005
- Environment Statistics of Nepal, 2006
- Environment Statistics of Nepal, 2008
- Environment Statistics of Nepal, 2011
- Environment Statistics of Nepal, 2013

Present Data Collection System

Environment statistics synthesize data originating from a wide range of source types. This means that the data used for the production of environment statistics are compiled by many different collection techniques (i) Statistical surveys (e.g., censuses or sample surveys of population, housing, agriculture, enterprises, households, employment, and different aspects of environment management) (ii) Administrative records of government and non-government agencies.

Now, the Central Bureau of Statistics compiles most of the environmental indicators from the secondary sources. There are several challenges to adding questions to the existing surveys conducted by the Central Bureau of Statistics: (i) there can be limited space available for additional questions in the existing surveys (ii) the survey frame and stratification of the population and sampling selection may not be ideal for environment statistics (iii) the data may need to be reorganized or reclassified in order to be used in environment statistics and (iv) respondents may not be familiar with environmental terms nor the information needed to answer environment-related questions. So, Environment-specific censuses or sample surveys are very essential.

Problem Finding

Environment statistics cuts across several disciplines and draws data from a wide range of various sources. To effectively produce environment statistics, statistical and environmental expertise, institutional development capabilities, and adequate resources are equally necessary. Within this relatively new statistical domain, methodological resources, tools and good practices are being developed and systematized progressively but in Nepal we are very weak in this matter. The major problems of Environment Statistics in Nepal are:

- Insufficient institutional development,
- Overlapping mandates and functions,
- Inadequate interagency coordination,
- Lack of skilled human resource,
- Budgetary Constraints.

So, the Central Bureau of Statistics is not compiling and publishing the environment statistics in line with the Framework for the Development of Environment Statistics (FDES) designed by United Nation Statistical Division. We face data gaps in this sector.

Way Forward

It is important for environment statistics section to have a capacity building program for their staff along with the financial resources to carry it out. Environment statistics cover several topics for which the data, whether in the form of administrative records, remote sensing, scientific measurements or survey results, are being generated by the NSOs, specialized agencies, ministries, provincial and municipal governments and scientific institutions. That necessitates the collaboration of these stakeholders, both at the strategic and technical level.

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Sustainable Development through Integrated Rural Settlement Plan in Nepal

Rudra Suwal, Ph.D.*

The chapter provides a conceptual framework for understanding sustainable development – the economic, ecological and social perspectives. Among other different approaches for sustainable development, one move towards it could be the development of integrated rural settlement in the country. The approach and practices adopted for the sustainable development of Nepal has also been subject of discussion in this paper. The concept of sustainable development through integrated rural settlement plan is introduced and elaborated using the settlement wise data collected in the latest Population and Housing Census 2011 of Nepal. More than 80 percent of rural settlements are found to be small with less than 10 households. It indicates unplanned and highly scattered settlement pattern of Nepali households, and an urgent need for integrated rural settlement planning which could be a basis for sustainable development of the country.

Introduction

Sustainable Development stands for meeting the needs of present generations without jeopardizing the ability of future generations to meet their own needs – in other words, a better quality of life for everyone, now and also for future generations. It offers a vision of progress that integrates immediate and longer-term objectives, local and global action, and regards social, economic and environmental issues as inseparable and interdependent components of human progress.

Sustainable development may not be introduced by policies only: it must be brought up by society at large as a principle guiding many choices each citizen makes every day, as well as political and economic decisions that have. This requires profound changes in thinking, in economic and social structures, living arrangements/patterns and in consumption and production behaviors.

The Concept of Sustainable Development

The essential needs of a vast number of people especially in developing countries for food, clothing, shelter, jobs - are not being met, and beyond their basic needs these people have legitimate aspirations for an improved quality of life. A world in which poverty and inequity are endemic will always be prone to ecological and other crises. Sustainable development requires meeting the basic needs of all and extending to all the opportunities to satisfy their aspirations for a better life.

Living standards that improved from the basic minimum are sustainable only if consumption standards everywhere have regard for long-term sustainability. Many needs are socially and culturally determined, and sustainable development requires the promotion of values that encourage consumption standards that are within the ecological bounds. Essential needs depend on achieving full growth potential, and sustainable development clearly requires economic growth in places where such needs are not being met. Elsewhere, it can be consistent with economic growth, provided the content of growth reflects the broad principles of sustainability and non-exploitation of others. But growth by itself is not enough. High levels of productive activity and widespread poverty can coexist, and can

endanger the environment. Hence, sustainable development requires that societies meet human needs both by increasing productive potential and by ensuring equitable opportunities for all. A society may in many ways compromise its ability to meet the essential needs of its people in the future. The direction of technological developments may solve some immediate problems but lead to even greater ones.

Despite these complications, the three principles outlined above do have resonance at a common-sense level. Thus, there is ample justification for the elucidation of a theory of sustainable development, which must have an interdisciplinary nature. Drawing on economic, ecological, and social perspectives, we can identify some of the main themes that are integral to the construction of a new paradigm:

Taken together, these observations suggest new guidelines for the development process. They also require modifications to the goal of economic growth. Economic growth in some form is required for those who lack essentials, but it must be subject to global limits and should not be the prime objective for countries already at high levels of consumption (Daly, 1996). In terms of sustainability, a moderate level of consumption, together with strong social institutions and a healthy environment, represents a better idea than ever-increasing consumption (Durning, 1992). It means that the choice of goods and technologies must be oriented to the requirements of ecosystem integrity and species diversity as well as to social goals. Elements of all three perspectives – economic, ecological, and social – are essential for understanding the requirements for sustainability.

The direction of technological developments may solve some immediate problems but lead to even greater ones.

The Economic Aspect

According to neo-classical economic theory, sustainability can be defined in terms of the maximization of welfare over time. (This is assumed to be human welfare – the claims of the non-human world arise when it is considered the ecological perspective.) Most economists simplify further by identifying the maximization of welfare with the maximization of utility derived from consumption. While this may be criticized as an oversimplification, it certainly includes many important elements of human welfare (food, clothing, housing, transportation, health and education services, etc.) and it has the analytical advantage of reducing the problem to a measurable indicator or unit.

A formal economic analysis then raises the question of whether sustainability has any validity as an economic concept. According to standard economic theory, efficient resource allocation should have the effect of maximizing utility from consumption. If we accept the use of time discounting as a method of comparing the economic values of consumption in different time periods, then sustainability appears to mean nothing more than efficient resource allocation – a concept already well established in economics.

A related issue concerns the concept of natural capital. Soils and atmospheric functions are aspects of natural capital, which consists of all the natural resources and environmental services of the planet. In the neo-classical view, there is no special reason to conserve natural capital. The 'Hartwick rule', a well-known principle derived from work by Hartwick (1977) and Solow (1986), states that consumption may remain constant, or increase, with declining non-renewable resources provided that the rents from these resources are reinvested in reproducible capital. This rule does not require maintenance of any particular stock of natural capital.

The essential assumption involved in the Hartwick/Solow approach is that of substitutability of different types of capital. If, for example, we cut down forests but build factories, we are better off provided the economic value of the new industrial plant exceeds the economic value of the lost forests. Daly's view is based on the opposite assumption, that 'man-made and natural capital are fundamentally complements and only marginally substitutes' (Daly, 1994, p. 25). If natural capital has a special and unique importance, then neo-classical economic efficiency will not suffice for sustainability.

The issue may be posed in terms of weak and strong sustainability. Even in the neo-classi-

cal perspective, the principle of weak sustainability is appropriate. In this approach, sustainability requires that the total value of manufactured plus natural capital remains constant over time. El Serafy has pointed out that in order to assess this value, there must be a full accounting for natural capital depletion (El Serafy, 1993, 1997).

A strong sustainability approach is based on the idea that substitutability between natural and manufactured capital is limited. Rather, the two are seen as complements - factors that must be used together to be productive. While it may be possible, for example, to compensate for some water pollution with purification systems, life and economic activity is essentially impossible without access to water. The strong sustainability approach implies that specific measures distinct from the ordinary market process are necessary for the conservation of natural capital. It also implies limits on macroeconomic scale. The economic system cannot grow beyond the limitations set by the regeneration and waste-absorption capacities of the ecosystem.

The distinction between weak and strong sustainability is discussed in Daly (1994). Strong sustainability is defended by Daly (1995) and criticized by Beckerman (1994, 1995), who rejects the concept of sustainability in general. A defense of weak sustainability is offered by El Serafy (1996), while Common (1996) argues that the distinction between weak and strong sustainability is invalid. Limitations of the weak sustainability concept are discussed by Gowdy and O'Hara (1997).

Costanza and Daly (1992) suggest that a minimum necessary condition for sustainability can be expressed in terms of the conservation of natural capital. This policy goal leads to two decision rules, one for renewable and the other for non-renewable resources. For renewable, the rule is to limit resource consumption to sustainable yield levels; for non-renewable the rule is to reinvest the proceeds from non-renewable resource exploitation into renewable natural capital. Following these two rules will maintain a constant stock of natural capital. To maintain a constant per capita stock of natural capital also requires a stable level of human population (Daly 1991).

Costanza and Daly suggested for natural capital conservation. Nicholas Georgescu-Roegen, whose path breaking work The Entropy Law and the Economic Process outlined the dependence of the economic system on biophysical systems and argued that it is ultimately impossible to maintain a constant stock of natural capital, since all planetary resources will eventually degrade or be used up according to the Second Law of Thermodynamics (Georgescu-Roegen 1971). But at a more practical level he proposed an approach similar to Costanza and Daly's, reasoning that 'the enormous disproportionality between the flow of solar energy and the much more limited stock of terrestrial free energy suggests a bioeconomics program emphasizing such factors as solar energy, organic agriculture, population limitation, product durability, moderate consumption, and international equity' (Georgescu-Roegen 1993; see also Cleveland and Ruth 1997).

Toman (1992) proposes that the difficulty in defining sustainability may be resolved by recognizing that some issues can be appropriately dealt with neo-classical market efficiency, while others require the application of Ciriancy-Wantrup's (1952) concept of a 'safe minimum standard' approach to protect essential resources and environmental functions. This suggests that the criteria of possible severity and irreversibility of ecological damages should be used to decide which theoretical framework is more appropriate.

The Ecology Aspect

Common and Perrings (1992) have suggested that the economic perspective of 'Solow-sustainability' needs to be complemented by an ecological approach of 'Holling-sustainability', following the work of Holling (1973, 1986) on the resilience and stability of ecosystems. Unlike economists, whose models provide no upper bound on economic growth, physical scientists and ecologists are accustomed to the idea of limits. Natural systems must exist subject to the unyielding laws of thermodynamics, and the science of population ecology has explored the

implications of these laws for living organisms. 'Two of the fundamental axioms of ecological and evolutionary biology are that organisms are exuberantly over-productive, and that limits set by time, space, and energy is inevitably encountered' (Holling, 1994). In an ecological perspective, sustainability must involve limits on population and consumption levels. These limits apply to all biological systems.

However, this simple assertion of limits does not fully capture the contribution of ecologists to the discussion of sustainability. What Holling identifies as a third axiom of ecology has even more significant implications. The third axiom 'concerns processes that generate variability and novelty' – the generation of genetic diversity and the resultant processes of evolution and change in species and ecosystems.

For the ecologist, sustainability should be defined in terms of the maintenance of ecosystem resilience. This view of sustainability is clearly different from the human-centered conceptions put forward by the World Commission on Environment and Development and the consumption-based principles proposed by economic theorists. Common and Perrings suggest that 'the concepts of Solow-sustainability and Holling-sustainability are largely disjoint. It implies that there may be no close relationship between economic efficiency and ecological sustainability' (1992). In order to achieve ecological sustainability, it is likely to be necessary to modify current consumption preferences and production techniques which, while efficient in economic terms, threaten the ecological resilience of planetary systems.

The Social Aspect

As noted above, the thought of sustainable development has regarded the social component as an essential part of the new paradigm. A 'human development' approach emphasizing issues of basic needs and equity is well grounded in the history of economic theory. Anand and Sen (1996) point out that concerns for these dimensions of economic development start with the earliest economic theorists, and contrast the human development approach to the wealth maximization approach that has dominance in development thought.

The priority for basic needs and equity in development has been the focus of the United Nations Development Programme's series of Human Development Reports. In addition to calculating the Human Development Index, which offers a different measure of development success from per capita GNP or GDP, the Human Development Reports focus each year on a different aspect of social and economic development, such as democratic governance (1993), gender inequity (1995), and poverty (1997).

HDI does not explicitly include any environmental measures. However, the 1994 report discussed the relationship between sustainability and equity, arguing that 'the concept of sustainable development raises the issue of whether present life-styles are acceptable and whether there is any reason to pass them on to the next generation. Because intergenerational equity must go hand in hand with equity, a major restructuring of the world's income and consumption patterns may be a necessary precondition for any viable strategy of sustainable development' (UNDP, 1994).

The question of environmental sustainability is linked with that of poverty and inequity. The causative relationship runs both ways – increased poverty and loss of rural livelihoods accelerates environmental degradation as displaced people put greater pressure on forests, fisheries, and marginal lands. Lipton (1997) and Scherr (1997) emphasize the relationship between population growth, social, conditions, and resource degradation. Reed (1997) notes that the social component of sustainability includes issues of distributional equity, provision of social services, gender equity, population stabilization, and political accountability and participation.

The relationship of the human development paradigm to sustainability is discussed by Haq (1995) and Chambers (1992). Interrelationships between development, population growth, and environmental sustainability are prominent in the exposition of human development concepts.

A Synthesis of Three Dimensions

From the above discussion, sustainability covers:

The conservation of natural capital is essential for sustainable economic production and intergenerational equity. Market mechanisms do not necessarily operate effectively to conserve natural capital, but may tend to deplete and degrade it.

From an ecological perspective, both population and total resource demand must be limited in scale and the integrity of ecosystems and diversity of species must be maintained.

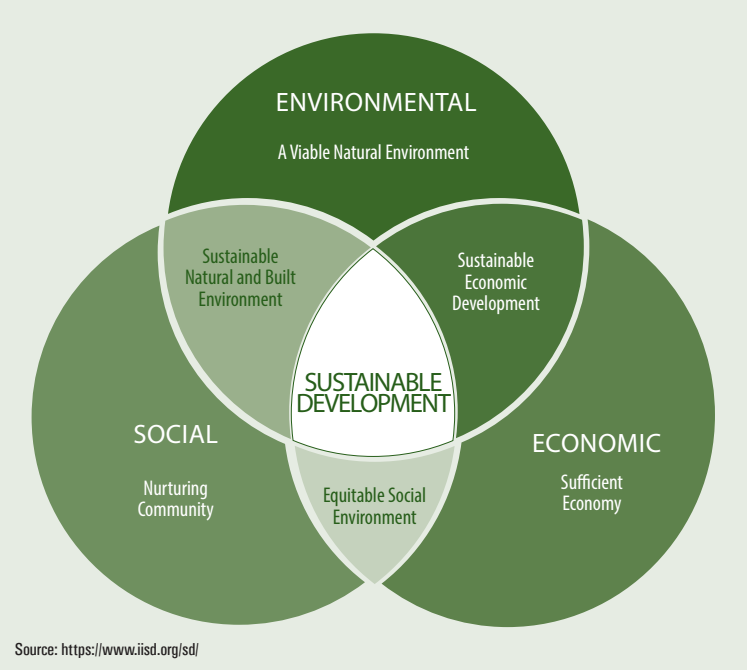
Practices consistent with sustainable development must remedy social inequities and environmental damage, while maintaining a sound economic base.

Social equity, the fulfillment of basic health and educational needs, and participatory democracy are crucial elements of development, and are interrelated with environmental sustainability.

Taken together, these principles clearly suggest new guidelines for the development process. They also require a modification of the goals of economic growth (Arrow et al., 1995). The principles of sustainability imply new goals and policies in all major areas of economic development, including:

Population: Theorists of sustainable development have generally rejected the concept of unlimited growth, whether of population or of economic production. Even if a specific carrying capacity for humans is difficult to identify, resource and environmental constraints will eventually be reached, if they have not been already. A sustainable society must ultimately imply a stable level of population. Thus, population policy must become a central element of economic development. Scherr (1997) suggests that maintaining environmental integrity depends on slowing rates of population growth in the developing world, and that policy to so require a focus on social equity.

Agriculture: The need to feed an expanding population at higher per-capita levels of consumption is straining global soil and water systems (Harris and Kennedy, 1999; Pinstrup-Andersen and Pandya-Lorch, 1998). A transition to more sustainable agricultural systems requires



Source: https://www.iisd.org/sd/

changes on both the production and consumption sides. On the production side, current high-input techniques which are leading to serious soil degradation and water pollution and overdraft must be replaced by organic soil rebuilding, integrated pest management, and efficient irrigation. This in turn implies much greater reliance on local knowledge and participatory input into the development of agricultural techniques (Pretty and Chambers, 2000).

Energy: A non-fossil energy system would be significantly more decentralized, adapted to local conditions and taking advantage of opportunities for wind, biomass, and off-grid solar power systems. This is unlikely to occur without a major mobilization of capital resources for renewable energy development in countries now rapidly expanding their energy systems (Johansson and Goldemberg, 2002).

Industry: As the scale of global industrial production increases several-fold over current levels, which themselves represent a quadrupling over 1950 levels, it is apparent that 'end-of-pipe' pollution control not be adequate. The concept of 'industrial ecology' implies the restructuring of whole industrial sectors based on a goal of reducing emissions and reusingmaterials at all stages of the production cycle (Frosch and Gallopoulos, 1989; Frosch, 1992; Ayres and Ayres,

1996). Reform and 'greening', as well as a broad cooperative effort between corporations and governments, will be needed to achieve goal.

Renewable Resource Systems: Resources of forests and water systems are severely overstressed. With even greater demands on all systems expected in the next century, all levels of institutional management must be urgently reformed. Multilateral agreements and global funding are needed to conserve global resources; national resource management systems must be shifted from goals of exploitation to conservation and sustainable harvesting; and local communities must be strongly involved in resource conservation (UNEP, 2000, 2002; UNDP et al., 2000).

Matters mentioned above poses challenges that fall under social and institutional as well as economic. Institutions of all kinds, including corporations, local and national government, and transnational organizations, will have to adapt to the requirements of sustainable development if all the problems which motivated the development of concept are not to grow worse. Democratic governance, participation, and the satisfaction of basic needs are thus an essential part of a new sustainable development synthesis.

Realizing the fact and making the goal of sustainable development applicable throughout the world, the sustainable development goals (SDGs) are a new, universal set of goals, targets and indicators that the United Nations (UN) member states will be expected to use to frame their agendas and political policies over the next 15 years.

Sustainable Development Goals Post 2015 Agenda

The proposed Sustainable Development Goals offer major improvements on the Millennium Development Goals (MDGs). The Sustainable Development Goals (SDG) framework addresses key systemic barriers to sustainable development such as inequality, unsustainable consumption patterns, weak institutional capacity, and environmental degradation that the MDGs neglected.

- The SDG framework would benefit from an overall narrative articulating how the goals will lead to broader outcomes for people and the planet. An overarching goal could be formulated, for instance in the political declaration framing the Post-2015 Development Agenda, binding together the 17 goals, thus providing a clearer means-to-end continuum.
- The current SDG framework does not identify the wide range of social groups that will need to be mobilized to deliver on the goals as agents of change alongside governments.

The Concept of Sustainable Development and Integrated Rural Settlement

Defining sustainable development for Nepal, National Planning Commission (NPC) stated " The over-arching goal of sustainable development in Nepal is to expedite a process that reduces poverty and provided to its citizens and successive generations not just the basic means of livelihood, but also the broadest of opportunities in the social, economic, political, cultural, and ecological aspects of their lives" (NPC 2003). The concept of sustainable development has been mentioned in the later planning documents-the 9th Plan, 10th Plan and millennium development goals documents.

A separate policy for land use has been promulgated in 2013 with the objectives- classification of land, protection and appropriate management of land, promotion for urbanization and management of land fragmentation, balance between development and environment, protection of the special areas of geographical, cultural, religious historical and tourism, prepare land use plan based on land use policy- , valuation of land according to utility and implement land tax system, and oversee the management of unused land for their appropriate use.

As mentioned in the earlier sections, the essential components of sustainable development are the economic, ecological and social perspectives. Within these components of development, human is the core of those all elements. The

inter-linkage of development efforts come ultimately to human development. Considering the fact, the argument of this paper has been the focus of the management of population especially in their living conditions i.e., settlements. Hence, the analysis is primarily focused on the rural settlements of Nepal where more than 80 percent population resides. It has been a general assumption that when the settlement pattern of large portion of the people improves through systematic and integrated plan approach, country's sustainable development becomes likely and realistic.

Rural settlements are found to be the oldest one in Nepal. Through history they have been changing with different pace; some at a very fast rate and others at a slow rate. Life and work in them mainly depended on natural resources and environmental conditions. Between the rural settlement (i.e. village, hamlet) on one hand and the countryside (i.e. rural area, rural landscape, rural territory, hinterland, cadastral area) on the other hand, there was always a close connection. That connection exists in the geographical location of rural settlements, their morphology, economic life and types of houses. Through history, permanent rural settlements of different types and different characteristics grew from periodical rural hamlets. In contrast to cities, towns and urban areas, rural communities have smaller population densities. Different communal improvements and utilities, such as sidewalks, water supply, tree corridors, squares and plazas, streetlights and power, and especially sewerage and solid waste management system, etc., were always on a lower development level than in urban locations. Usually, village plots have residential buildings, but also they host some other economic functions (sties for animals, food storage, storerooms for granary. This makes dwelling and work closely connected. Social and public services (i.e. schools, hospitals, and offices) are unavailable and not well developed in most of rural settlements. The definitions of "town" and "village" are a result of combined historical, administrative, population, spatial, economic and other criteria and it is often a subject of convention. Mostly, "urban settlements" are defined as such, while the rest are considered as "rural settlements". Rural settlement is a "unique form of social and economic organization of people, who are mostly engaged in agriculture production.

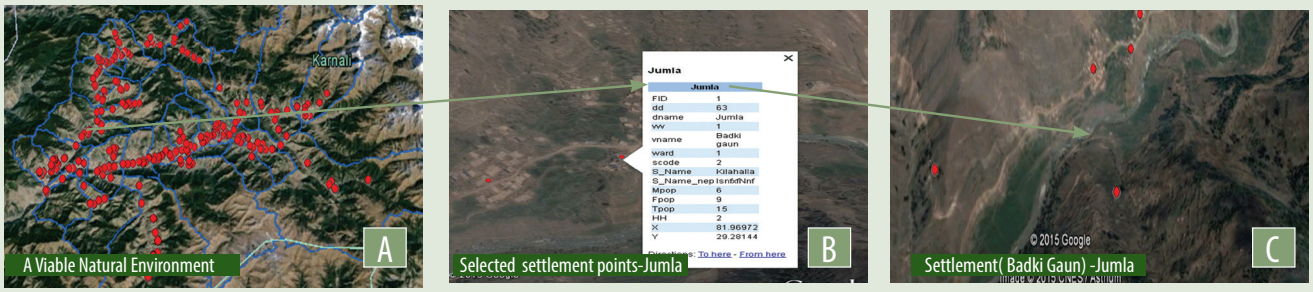
Rural settlements in Nepal lack basic life-sustaining services and economic opportunities resulting into massive migration of a large major-

BOX1: SUSTAINABLE DEVELOPMENT GOALS POST 2015 AGENDA

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

Source: United Nations Statistics Division

Map1: Geographic Coordinates (GPS) of Settlements



ity of economically active population temporarily or permanently to other parts of the country or outside the country.

The above observations are very much supported by the findings of the field surveys in the four squatter settlements – 'Kohalpur Informal Settlements' - at the proximity of Kohalpur Town in Banke District of the Mid-Western Region of Nepal. The survey findings have depicted five major categories as the basic reasons for migration to the Kohalpur area. These are: search for better employment opportunities; natural disasters like flood and landslides; looking out for better educational opportunities; political insurgency and armed conflict within the country; the other several factors lumped into 'others' category e.g. poverty, landless situation, inability to pay rent, search for better facilities and services, and socio-cultural factors (Lumanti, 2011).

Table 1: Settlement Size by Number of Households

Size of settlements	Urban	Rural	Total	Percentage
less than 10 HH	20826	129047	149873	80.6
10-20 HH	2683	17734	20417	10.98
21-30 HH	1381	6788	8169	4.39
31-50 HH	633	2135	2768	1.49
51-100 HH	329	1077	1406	0.76
101-200 HH	115	490	605	0.33
More than 200 HH	58	237	295	0.16
Not reported	475	1938	2413	1.3
	26500	159446	185946	100

Source: Population and Housing Census 2011

Natural disaster related loss of lives is another critical issue which needs to be addressed seriously. There could be a need for relocation of the whole or partial settlements from the disaster prone areas.

Nepal Population and Housing Census 2011(PHC) for the first time provides basic data on settlement. Settlements as reported in the PHC was again recoded while processing the census results. Settlements (Gaunbasti Tole) were linked with the data contained in the census questionnaire and captured geographic coordinates (GPS) later on (Map 1).

The table shows a high level of dispersed settlements throughout the country. More than 80 percent settlements have less than 10 households. Such a dispersed human settlements have hindered the access of services and facilities from the government to the public in general and made the service delivery inaccessible and inefficient. Hence, it indicates an urgent need for the identification and development of planned 'Integrated Rural Settlements (IRS)' merging those isolated and small settlements of the vicinity.

In the above satellite image maps of Jumla district, the total settlements as reported in PHC 2011 is shown in Map 'A' and selected settlements in 'B' and description of particular settlement in 'C'. The population and related data contained in the census questionnaire can be obtained by settlements as reported in the PHC 2011. The information derived from the census results could be a basis for initiating the work. Further delineation and regrouping/ merging of settlements could be the next step towards formulating IRS.

This provides an ample justification for developing compact rural settlements (CRSs) through the integration of scattered settlements in the country. This not only helps towards maximization of the benefits of investments on infrastructural facilities, but also helps to check environmental degradation and to minimize disaster risks, but also contributes towards poverty reduction and sustainable development of the country optimizing resources through scientific integrated rural settlement planning.

Proposed New Approach to Rural Planning and Development

Most rural settlements in Nepal depend directly on natural resources for their sustainability. In the last decades there is a tendency of shifting of population to areas in search of better resources. Under utilization of natural resources has been found in some cases as well as over exploitation due to unplanned and uncontrolled mobility of population from one place to another. To manage this issue, "Integrated Rural Settlement Plan", can be introduced through scientific planning following the principles of sustainable development of rural settlements.

In practice, this plan can have structural land use development proposals for the whole rural community (settlements) and detailed land use and standard regulatory building proposals for rural settlements, hamlets and other manmade and ecological territory. This allows applications of methods and techniques from disciplines such as agronomy, forestry, geodesy, geography, geology, biology, meteorology, hydrology, etc., in order to match rural development interests with the overall development. Applying methods and technique from the urban planning and design, architecture, landscape design, infrastructure planning and design, etc is as important. Classic urban planning within a rural settlement/village contents aims to stimulate infrastructure and social services development. However, if manmade areas are constructed it can destroy natural balance and the rural image can be lost. Therefore, an integrated approach for the development of rural settlements, including all three ingredients i.e. economic, ecological, and social needs to be applied and implemented.

The Scope and Process of Integrated Rural Settlement Planning

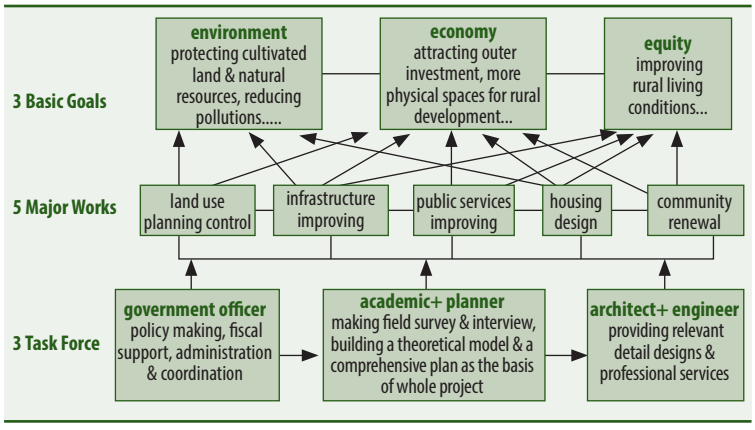
The scope and process of integrated rural plan preparation can be defined through the development of specific technical guidelines and handbooks. These documents should come out of the newest initiative for changing the existing Act. At the same time, it is necessary to co-ordinate them with similar documents from Ministries and Departments. Ministry of Land Reform and Ministry of Federal Affairs and Local Development have key role in formulating appropriate Act and to implement them effectively. The procedure for integrated rural plan preparation can keep on developing in three phases:

- Data collection and Base Line Studies investments in existing villages. It is therefore very important that the country has an efficient and appropriate approach concerning resource exploitation. The land use policy may be an appropriate basis for working towards integrated rural settlement planning

Between the mentioned phases, time and opportunities for public and professional consultations are to be included, so that plan solutions can have wide community input and professional support and fulfill numerous, most often differ-

Classic urban planning within a rural settlement/ village contents aims to stimulate infrastructure and social services development.

Table 2: Illustration of Basic Model of Integrated Rural Settlement Planning



BOX2: AREAS OF STUDY FOR PROPOSED INTEGRATED RURAL SETTLEMENTS

- Settlement location, size and boundaries
- The form and structure of settlements and built-up areas
- Natural potential, resources and physical constraints
- Urban environmental impacts and environmental quality
- Settlement population
- Settlement economy
- Existing land use, tenure and ownership
- Settlement social and community services
- Settlement infrastructure and utilities
- Settlement natural, scenic and cultural landmarks
- Environmental and other protection aspects

ent interest and expectations reconciling all those inputs received from different quarters.

Data Collection and Base Line Studies

This phase incorporates collecting, selecting and systematizing different information about natural and built-up environment, population data, as well as planning, statistical and development indicators and projections. This stage is crucial to the success of the rural integrated plan, and the planning team carrying out such a study has to review information such as: structural and detailed land use and development topics, survey detailing methodology, data collection and processing, identification of information gaps ensuring key contacts with resource people, and resource information from different government departments, local authorities, and private organizations, reviewing specific details of the rural planning project and identifying factors which might have changed after the data collection report was presented for evaluation and approval by government authorities and the rural community.

The data collection phase is a critical orientation task that should, from the onset, bring the rural community aspiration into the desired action-path. The findings from this phase will form the basis upon which the future research on the new Integrated Rural Plan document is going to be directed. Thus, this is seen as the most important task and must be allowed to take place so that problems can be solved as they arise.

For conducting feasibility research, further data collection; analysis and identification of issues are essential. This should be a distillation of the information gathered from various sources (i.e. maps, aerial photographs, satellite imagery, available digital GIS/LIS data, questionnaires, various project documentation, field surveys, meetings, etc.), and it might be published as a standalone project document, and is therefore an important milestone in the integrated rural planning process. For the planning of the development of rural settlements, detail study on the box 2 is essential.

Through this phase the rural community shall find that a major ingredient leading to a sound land use plan is an inventory of different natural, physical, environmental and manmade resources. Such an inventory provides people with information which allows better understanding of ongoing natural and man-made processes that occur within their rural area and settlement, economic opportunities for land use development, forces that might constrain better land utilization, and the problems that might result from resource use, new land use and development programmes. The survey report should describe the information collected and be made available for each of the development components in further planning phases. It is envisaged that the time scale of the report of the survey phase always has to provide for meetings with public groups and local government authorities sharing similar interdisciplinary interest. Inventories and assessments of natural and physical conditions needs to be combined with inventories and studies of economic, social, legal, manmade and built environment aspects and conditions, and will be analyzed to serve as the basis for the evaluation of future development potentials on the base of existing constraints.

The figure shows the general process of integrated rural settlement planning. The basic

components for sustainable development – economic, ecology and social (the upper portion) are fundamental. Considering the basic norms, major works (manmade) needs to be developed in a planned way utilizing the expertise of the task forces.

Conclusion

The integrated approach to planning rural communities means a combination of a general plan for rural areas and a detailed plan for rural settlements. The Integrated Rural Plan should come as a result of coordinating development interests and the possibility of using land in rural areas and rural settlements. This plan should provide time and financial compatibility in its natural surrounding and adequate community and economic conditions. A special advantage of this new approach is in the possibility of aggregation of land use data from the plot level (i.e. settlement, area, ward sub-ward) in the process of production, as well as in the process of their implementation, monitoring and review.

Countryside and villages are the parts of natural environment, which is a condition for their existence and development. Community and economic factors only reflect the tempo of that development. Because of that, it is logical that while researching and planning natural surroundings are the starting point, in which economic factors (population, produced goods, and capital) exist and make all developments possible. Planning how to use agricultural, forest and built-up land must be treated together. All planned interventions in the area (zoning, sub-division, construction, production) should be mutually coordinated and subordinated to space, community and economic development of the whole rural community (countryside and settlements) and to improvement of environmental quality and living conditions of the total rural population.

For the formation of integrated settlements, small hamlets and isolated households needs to be merged into desired level of size that contains detailed feasibility studies considering necessary geological conditions and appropriate infrastructure development of settlements. An integrated approach needs to be adopted for relating the human settlement (manmade) area with other relevant areas which are most essential components for sustainable development i.e., ecological and social. It could be an appropriate basis for the development of human settlements and ultimately a foundation for sustainable development of the nation.

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CHAPTER 3

Social and Demographic Issues

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The relationship between population dynamics and environmental change is a "complex" one. Despite several possible advantages, there are a number of reasons for a government to be concerned about population growth. For example, most of the basic resources are strained by population increase. It has an adverse effect on natural resources as well. Population of Nepal is increasing continuously since 1930s. Several demographic and social indicators for the country have also improved during the last couple of decades. In spite of this encouraging news, there are growing concerns about the worsening environmental health of the country. Population size, distribution, characteristics are some areas of concern. Population management to improve the quality of life has been the main objective of the Government policies of Nepal. The aftermath of the 2015 massive earth quake in Nepal has necessitated the Government to review its recently prepared "the first ever" population policy of the country.

Introduction

"Social/demographic issues" is one of the clusters (agenda 21)[1] identified and included in the "Framework for the Development of Environment Statistics" developed by the United Nations Statistical Division. The social and demographic issues are divided up into the following topics (as events): socioeconomic activities/events; impacts and effects events; and inventories, stocks, and background condition events.

Information categories included in the socioeconomic activities/events are: population growth rate, population density, urban/rural migration rate, and calorie supply per capita. Impacts and effects events category includes the following information categories -proportion of urban population exposed to concentration of sulphur dioxide (SO2), particulates, ozone, carbon monoxide (CO) and lead (Pb), infant mortality rate, and incidence of environmentally related diseases. Inventories, stocks, and background condition events category comprises of the following information: population living in absolute poverty, adult literacy rate, combined primary and secondary school enrollment ratio, life expectancy at birth, and females per 100 males in secondary school.

Definitions

The following is a list of definitions of the foregoing information categories specified in Box 1.

Government Policies

Nepal has realized an increasing need to protect the environment. The Government of Nepal (GoN) has ratified several national and international treaties and conventions regarding environmental issues.[2] There are several Government policies (current plan, sector policy, rules, regulations, guidelines, etc.) related to the environment and population issues in Nepal. The "environment and climate change" related objective as laid down in the current Thirteenth Plan of Nepal is: "adapt to the adverse impacts of climate change

[1] Central Bureau of Statistics, Nepal (CBS), 2014. Environment Statistics of Nepal, 2013, Introduction, p. 4.

[2] There are around two dozen conventions signed and/or ratified by the Government of Nepal (GoN). CBS, 2013, Environment Statistics of Nepal, 2013, Appendix III, p. 154.

BOX 1: DEFINITION OF INFORMATION CATEGORIES

Population growth rate – The growth rate is the rate at which a population is increasing (or decreasing) in a given year due to natural increase and net migration, expressed as a percentage of the base population. The growth rate takes into account all components of population growth: births, deaths, and migration.

Population density – Population per unit of land area; for example, persons per square kilometer of land.

Migration – The geographic movement of people across a specified boundary for the purpose of establishing a new permanent or semi-permanent residence. The concept is divided into international migration (immigration and emigration) and internal migration (in-migration and out-migration).

Calorie supply – Calorie supply per capita is amount of food available for consumption, measured in kilocalories per capita per day. It is the total available food supply for human consumption divided by the population.

Concentration of Sulphur dioxide (SO2) – Sulphur dioxide (SO2) is a colourless gas with a sharp, irritating odour. It is produced from burning of fossil fuels (like coal and oil) and smelting minerals that contain Sulphur. Concentration of SO2 in a place indicates the air quality of the place.

Concentration of particulates – "Particulate matter," also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulphates), organic chemicals, metals, and soil or dust particles.

Ozone layer – The ozone layer is a region of concentrated molecules of a form of oxygen (O3) high above the earth. Without it, there would be no life as we know it here because the ultra violet rays from the sun can be very harmful.

Carbon monoxide (CO) – Carbon monoxide (CO) is colourless, odourless and tasteless gas formed due to incomplete fuel combustion. It is toxic to humans and other warm-blooded animals. Automobile exhaust gases contain carbon monoxide. In the atmosphere, it has a role in the formation of ground-level ozone.

Lead (Pb) – Lead (Pb) is a soft, dense, naturally-occurring metal commonly used in the manufacture of building materials, lead-acid batteries, paints, ammunition, weights, medical equipment and coating for high-voltage power cables. Exposure to lead in the ambient air can be harmful to humans and animals.

Infant mortality – Infant mortality rate is the number of deaths of infants under one year of age per 1,000 live births in a given year.

Rate of incidence – The number of persons contracting a disease per 1,000 population at risk, for a given period of time.

Environment related diseases – Diseases with the largest total annual health burden from environmental factors, in terms of death, illness and disability are: diarrhea, lower respiratory infection, un-intentional injuries other than road traffic injuries, malaria, road traffic injuries, chronic obstructive pulmonary diseases, and perinatal conditions (The World Health Organization).

Absolute poverty – It refers to the poverty level using an absolute threshold, or in other words, a fixed standard of what households should be able to count on in order to meet their basic needs. (Relative poverty uses relative threshold, that is, a cutoff point in relation to the overall distribution of income or consumption in a country.)

Adult literacy rate – Percentage of persons aged 15 years and over who can read and write.

Enrollment ratio – School enrollment ratio is divided into gross and net ratios. Gross enrollment ratio is the number of children enrolled in a level (primary or secondary), regardless of age, divided by the population of the age group specified. Net enrollment ratio corresponds to the number of children enrolled in a level (primary or secondary), who belong to the age group that officially corresponds to the level (primary or secondary) schooling, divided by the total population of the same age group.

Life expectancy at birth – Life expectancy is an estimate of the average number of additional years a person could expect to live if the age-specific death rates for a given year prevailed for the rest of his or her life. Life expectancy is a hypothetical measure.

Secondary school – Secondary level of education in Nepal is divided into lower secondary and secondary levels of grades 6-8 and 9-10 respectively. [3]

[3] Education in Nepal has been structured as school education and higher education. Pre-primary includes ECD/PPCs. School education comprises Primary (grade 1-5), Lower Secondary (grade 6-8), Secondary (grade 9-10) and Higher Secondary (grade 11-12) Education. However, the proposed School Sector Reform Programme (SSRP) has proposed the school structure of Basic Education as Grade-One to Eight and Secondary Education as Grade-Nine to Twelve. (Ministry of Education, Nepal, 2010. Ministry of Education: A Glimpse, p. 10.)

by making human activities and development process environment-friendly as called under the principle of green development".[4]

One of the strategies set forth in the Thirteenth Plan is, making environmental management an integral component of development programme. Several operating policies are specified in line with the objectives and strategies. The overarching operating policy is to draft new laws pertaining to environmental conservation, and strengthen and update "environmental policy, existing laws, rules and mechanisms", and enhance institutional capacities. Other major policies related to population and demography include: to expand efforts to alleviate poverty; to carry out programmes for spreading public awareness about protecting and preserving the environment; to emphasize the development of environment-friendly, climate change adoptive infrastructure; to implement special programmes to keep urban pollution within certain limit and to preserve the beauty of rural areas; to effectively implement poverty alleviation programmes with an environmental dimension; and to improve the data collection methods.

There are several environmental issues related policies, acts and rules in the country.[5] Among them, only a select few (i.e., related to issues under consideration) are mentioned in the following. First of all, the constitution is the fundamental law of the land. The Constitution of Nepal, 2072 (2015)[6] has guaranteed every person the right to live in "a clean environment". The Constitution has also vowed to provide "basic health services free of cost from the State as provided for in the law". There is also a right to free primary and secondary education. (Box 2)

The State has also promised to make necessary arrangements to maintain the natural environment, to give priority to special protection of the environment, and rare wildlife, and prevent further damage due to physical development activities, by increasing awareness of the general public about environmental cleanliness. Other constitutionally recognized policies include - protection of the forest, vegetation and biodiversity, their sustainable use and for equitable distribution of the benefits derived from them.[8]

The Environment Protection Act, 2053 (1997) is another prominent act concerned with the environmental protection in Nepal. The act intends to minimize the adverse impacts of environmental degradation, and to protect environment for sustainable development.[9]

Nepal has formulated "Ozone Depleting Substances Consumption (Control) Rules, 2001" in order to specify the substance to be consumed as well as sold and distributed within Nepal as prescribed by the Government.

The Ministry of Science, Technology and Environment (MoSTE) aims "to achieve sustainable and broad based economic growth contributing to employment generation and poverty

BOX 2: FUNDAMENTAL RIGHTS REGARDING ENVIRONMENT, HEALTH AND EDUCATION RIGHTS

30. Rights regarding clean environment
(1) Every person has the right to live in a clean and healthy environment.

31. Education rights
(1) Every citizen shall have the right to access basic education compulsory and up to the secondary level education free from the state.

35. Health rights
(1) Every citizen shall have the right to basic health services free of cost from the state

[4] National Planning Commission, Nepal, 2013. An Approach Paper to the Thirteenth Plan (FY 2013/14 – 2015/16), pp. 116-17.
[5] The CBS publication, "Environment Statistics of Nepal 2013", has listed six instruments having environment friendly policies, 29 acts having environment friendly provisions, and 22 rules having environment friendly regulations.
[6] http://www.lawcommission.gov.np
[7] GoN, The Interim Constitution of Nepal, 2063 (2007), Part 3, Fundamental Rights, 16. Rights regarding environment and health, p. 68.
[8] Ibid, Part 4, Responsibilities, Directive Principles and Policies of the State Fundamental Rights, 35. State policies, p. 84.
[9] 7. Prevention and Control of Pollution:
(1) Nobody shall create pollution in such a manner as to cause significant adverse impacts on the environment or likely to be hazardous to public life and people's health, or dispose or cause to be disposed sound, heat radioactive rays and wastes from any mechanical devices, industrial enterprises, or other places contrary to the prescribed standards.

reduction in Nepal". Under the MoSTE, there is a separate Department of Environment (DoE) which is "primarily mandated for the implementation of the Environmental act, regulation and standards in Nepal". It is supposed to monitor the compliance of Environment Protection Act (EPA), 2053; Environment Protection Rules (EPR), 2054; and different pollution control standards set out by the Government.

The Ministry of Health and Population (MoHP) has recently launched (March 30, 2015) the country's "first ever" National Population Policy. This "overarching" policy contains nine areas of focus and 78 strategies. The policy addresses cross-cutting issues related to "social process and environment".

The Government has adopted the National Health Policy 2071 (2014) in order to address the direct relationship between "human being, environment and public health".

— Adopting environment-friendly and climate-adaptive measures by using local resources in the construction of drinking water and sanitation structures.
— Encouraging environment-friendly and climate-adaptive provisions in the construction and use of drinking water and sanitation schemes.
— Taking other measures relate to total sanitation, waste management, air pollution and climate change.

Table 1 : Select Social and Demographic Indicators, Nepal, 2000/01 - 2010/11

Indicator	2000/01	2010/11
Annual population growth rate	2.2	1.4
Life expectancy at birth (years)	60.4	66.6
Male	60.1	65.5
Female	60.7	67.9
Infant mortality rate (per 1000 live births)	64.0	40.5
Male	..	44.3
Female	..	38.9
Literacy rate (6 years of age and over)	54.1	66.6
Male	65.5	76.0
Female	42.8	57.8
Adult literacy rate (15 years of age and over)	48.6	59.6
Male	62.2	71.7
Female	34.9	48.8

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Table 3.1, p. 29; Population Monograph of Nepal, 2014, Vol. 1, Table 8.17, p. 190; Table 6.3, p. 130; Table 8.25, p. 201; Vol. II, Table 5.7, p. 202; Annex 5.2, p. 219.

Data Sources

Environment statistics are multi-disciplinary and cross-cutting in nature. As such, production of environment statistics involves "numerous stakeholders, actors and producers". Sources of environment statistics are: "censuses and sample surveys, administrative records, remote sensing, monitoring systems, and scientific research and special projects".

Population census is the major source of population and demographic data. Vital registration system of the country is another important source of such data. Demographic sample surveys are powerful tools for estimating vital rates, where vital registration system is deficient for demographic purposes.

Environment statistics is in a preliminary stage of development in Nepal. Available data related to environment in the country are sporadic; there are a few regular sources and a wide range of other are from ad-hoc sources. Most of environment data have been collected with a "particular or administrative" purpose by several agencies. These data are structured for their own specific purpose.

The Central Bureau of Statistics (CBS), Nepal, is one of the major sources of environment statistics in Nepal. The CBS first published a compendium on "Environment Statistics" in 1994. Since then the Bureau has continued its publication on environment statistics. The eighth volume in this series was compiled and published in 2013 which contains data from more than 50 agencies.[10] This publication is the major source of data for this chapter.

Select Tables

Select tables based on the "Environment Statistics of Nepal, 2013" compiled and published by the CBS are presented in the following. A few tables are derived from the other CBS publications, as well.

[10] CBS, 2013. Environment Statistics of Nepal, 2013.

A Brief Description

The following is a summary of the results presented in the foregoing tables and other basic data related to the information categories of the social and demographic issues.

Population and Households

On 22 June, 2011, there were 26,494,504 people living in Nepal, 3.3 million more than in 2001 (a 14.4 percent increase over the period of the ten-year period). The 2011 census[11] enumerated, 12,849,041 males against 13,645,463 females in the country (i.e., there were 796,422 more females than males in the country).

The number of houses recorded in the 2011 census stood at 4,767,196. The total number households in the country stood at 5,427,302 of which 5,423,297 were individual households and 4,005 were institutional households. The average household size was 4.9.

Population Distribution

The pattern of the spatial distribution of population in Nepal is very uneven. Of the 75 districts in the country, Kathmandu contained 1,744,240 persons while Manang contained only 6,538 persons in 2011. Among the five development regions, the central region had the highest number of people (36.4 percent of the total population) while the far-western region contained the lowest number (9.6 percent). More than half of the population lived in the Terai belt, 43 percent along the hills belt and 6.7 percent of the total population lived along the mountain belt.

As of 2011, Nepal had 58 designated urban areas with a total population of 4,523,820 (around 17 percent of the total population). The urban areas varied widely with respect to population – the Kathmandu metropolitan city topped the list with a population of 1,003,285 (22.2 percent of the total urban population) whereas the Dhulikhel municipality contained merely 16,263 people.

Table 2 : Population Distribution and Composition, Nepal, 1971-2011

	1971	1981	1991	2001	2011
Total population (number)	11,554,983	15,022,839	18,491,097	23,151,423	26,494,504
Population distribution (percent)					
Residence					
Rural	96	93	91	86	83
Urban	4	7	9	14	17
Ecological belt					
Mountain	9.9	8.7	7.8	7.3	6.7
Hill	52.5	47.7	45.5	44.3	43.0
Terai	37.6	43.6	46.7	48.4	50.3
Development region					
Eastern	24	24	24	23	21.9
Central	33	33	34	35	36.4
Western	21	21	20	20	18.6
Mid-western	13	13	13	13	13.4
Far western	9	9	9	9	9.6
Total	100	100	100	100	100
Population composition by sex					
Male	50.3	51.2	49.9	49.9	48.5
Female	49.7	48.8	50.1	50.1	51.5
Sex ratio	101.4	105.0	99.5	99.8	94.2

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Table 3.2, p. 30.

Table 3: Status of Calorie Consumption and Malnutrition, Nepal, 2003-04

Region	Poverty head count rate			Distribution of the poor		
	1995/96	2003/04	2010/11	1995/96	2003/04	2010/11
Nepal	41.8	30.8	25.2	100	100	100
Residence						
Urban	21.6	9.6	15.5	3.6	4.7	11.7
Rural	43.3	34.6	27.4	96.4	95.3	88.3
Ecological belt						
Mountain	57.0	32.6	42.3	10.7	7.5	11.8
Hill	40.7	34.5	24.3	41.9	47.1	42.8
Terai	40.3	27.6	23.4	47.4	45.4	45.4
Development region						
Eastern	38.9	29.3	21.4	21.0	23.4	19.8
Central	32.5	27.1	21.7	26.9	32.2	30.8
Western	38.6	27.1	22.2	18.7	16.7	16.9
Mid-western	59.9	44.8	31.7	18.5	17.7	16.4
Far western	63.9	41.0	45.6	14.8	9.9	16.0

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Table 3.4, p. 32.

[11] CBS, 2012. National Population and Housing Census 2011, National Report, Table 12, pp. 39-40.

Table 4: Status of Calorie Consumption and Malnutrition, Nepal, 2003-04

	Calorie intake shortfall (k0)	Stunting (So) < 5 age	Underweight (Uo) < 5 age	Wasting (Wo) < 5 age
Nepal	0.398	0.504	0.452	0.096
Residence				
Urban	0.416	0.368	0.335	0.078
Rural	0.395	0.522	0.467	0.980
Ecological belt				
Mountain	0.452	0.614	0.451	0.053
Hill	0.418	0.524	0.414	0.059
Terai	0.374	0.473	0.484	0.133
Development Region				
Eastern	0.376	0.476	0.434	0.091
Central	0.399	0.500	0.447	0.108
Western	0.372	0.501	0.434	0.089
Mid-western	0.443	0.539	0.490	0.088
Far-western	0.499	0.540	0.489	0.088

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Table 3.6, p. 33.

Table 5: Primary and Secondary Level Enrollment, Nepal, 2001 - 2011

	2001		2011	
Level	Girls	Boys	Girls	Boys
Pre-primary	44.5	55.5	72.1	79.6
Primary (1- 5)	44.8	55.2	50.4	49.6
Lower secondary (6 - 8)	42.2	57.8	50.5	49.5
Secondary (9 - 10)	41.4	58.6	49.7	50.3

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Table 3.7, p. 33.

Table 6: Gross and Net Enrollment Rates in Primary and Secondary Level of Schools, Nepal, 2001 – 2010

Year	Girls/Boys	Primary (1- 5)	Lower Secondary (6 - 8)	Secondary (9 - 10)
Gross enrollment ratio (GER)				
	Total	**124.7**	**63.2**	**43.8**
2001	Girls	114.7	54.0	36.0
	Boys	134.1	72.2	51.8
	Total	**135.9**	**100.0**	**70.1**
2010	Girls	141.2	104.1	71.9
	Boys	131.0	96.0	68.4
Net enrollment ratio (NER)				
	Total	**81.1**	**39.4**	**25.5**
2001	Girls	75.1	33.7	20.9
	Boys	86.9	45.0	30.2
	Total	**95.1**	**70.0**	**52.1**
2010	Girls	94.5	69.5	51.4
	Boys	95.6	70.5	52.7

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Tables 3.8 and 3.9, pp. 34-35.

Population Density

The population density in Nepal reported in 2011 was 180 people per square kilometer, an increase from 157 in 2001. Among the districts, Kathmandu was the most densely populated district (4,416 persons per sq. km) while Manang was the most sparsely populated district (3 persons per sq. km).

Out of 58 municipalities recorded in the 2011 census, the Kathmandu metropolitan city was the most crowded city (20,289 persons per sq. km) while Amargadhi municipality area was the least crowded (160 persons per sq. km).

Among the three ecological belts, Terai was the most populous as well as the most densely populated belt (392 person per sq. km). On the other, the mountain belt was the least populous with a density of 34 persons per square kilometer. Amongst the development regions, the central development region was the most densely populated (352 persons per sq. km) while the mid-western region was the most sparsely populated (84 persons per sq. km).

Population Growth

The population of Nepal is growing bigger. The population of 2011 was nearly tripled from its 1961 level. The rate of growth, however, has slowed down in recent years. The average annual growth rate of the population from 2001 to 2011 was 1.35 percent per annum, a sharp decline from the previous decade 1991 - 2001 (2.25 percent per annum). Further, the rate of growth from 2001 to 2011 was the lowest since the 1960s. If this growth rate prevailed, it will take another 51 years to double the population of Nepal.

Migration

Absent Population

There is a significant number of Nepali diaspora abroad. Estimated as of 2011, one in every four households (25.4 percent, i.e. 1.38 million households) had at least one member living abroad. The total number of absent population reported in 2011 was 1,921,494 as against 762,181 in 2001. The highest proportion of the diaspora belonged to the age group 15 – 24 years.

Population by Place of Birth

Out of the total non-institutional population recorded in 2011 (26,253,828), 25,524611 were native born, 479,625 were foreign born and for 249,592 the place of birth was not stated.

Among the foreign born population, more than 70 percent (338,460) were females. Nearly 28.7 percent were born in India. Regarding the length of stay in Nepal, 54 percent were living in the country for more than 10 years.

Internal Migration

Among the native born population, nearly 14.8 percent (3,788,070 persons) were born in districts other than where they were enumerated in 2011. Among persons having birthplace different from currently residing district (enumerated district), some 80.1 percent (3,033,574) were born in rural areas whereas 6.4 percent (241,437 persons) were born in urban areas.

Among the native born population having place of birth different from the currently residing district, 10.7 percent (406,962), 65 percent (2,460,799) and 22.2 percent (841,987) were born in the mountain, the hills, and the Terai districts respectively.

In 2011, the total number of inter-zonal life time migrants was 2,088,170. The proportion of such migrants stood at 8.2 percent of the total native born population in 2011. The hills belt was the largest area of origin while the Terai was the largest area of destination. It was the common destination of migrants from the mountains and the hills belts.[12]

Life Expectancy

Life expectancy at birth in Nepal was estimated to be 66.6 years in 2011.[13] Life expectancy of females (67.9 years) exceeded that of males (65.5 years) in 2011. Estimates of life expectancy at birth for urban and rural areas stood at 70.5 and 66.6 years respectively.

Infant Mortality Rate

From the 2011 census figures, the infant mortality rate per thousand live births was estimated at

Table 7: Inter-zonal Migrants by Sex, Nepal, 2001

Origin (place of birth)	Destination (place of enumeration)				Out-migration (percent)	Net-migration
	Mountain	Hill	Terai	Total		
Nepal						
Mountain	-	125,597	169,825	295,422	17.1	-255,103
Hill	33,895	-	1,157,035	1,190,930	68.9	-830,759
Terai	6,424	234,574	-	240,998	14	1,085,862
Total	40,319	360,171	1,326,860	1,727,350	100	
In-migration (percent)	2.3	20.9	76.8	100		
Male						
Mountain	-	57,170	84,783	141,953	16.8	-127,610
Hill	10,822	-	567,513	578,335	68.4	-400,001
Terai	3,521	121,164	-	124,685	14.8	527,611
Total	14,343	178,334	652,296	844,973	100	
In-migration (percent)	1.7	21.1	77.2	100		
Female						
Mountain	-	68,428	85,040	153,468	17.4	-127,511
Hill	23,061	-	589,528	612,589	69.4	-430,746
Terai	2,896	113,415	-	116,311	13.2	558,257
Total	25,957	181,843	674,568	882,368	100	
In-migration (percent)	2.9	20.6	76.4	100		

Source: Central Bureau of Statistics, Environment Statistics of Nepal, 2013, Table 3.11, p. 36

Table 8: Inter-zonal Migrants by Sex, Nepal, 2011

Origin (place of birth)	Destination (place of enumeration)				Out-migration (percent)	Net-migration
	Mountain	Hill	Terai	Total		
Nepal						
Mountain	-	213,714	180,587	394,301	18.9	-349,132
Hill	37,672	-	1,273,599	1,311,271	62.8	-722,456
Terai	7,497	375,101	-	382,598	18.3	1,071,588
Total	45,169	588,815	1,454,186	2,088,170	100	
In-migration (percent)	2.2	28.2	69.6	100		
Male						
Mountain	-	98,533	86,441	184,974	19.4	-171,541
Hill	9,555	-	567,368	576,923	60.5	-290,606
Terai	3,878	187,784	-	191,662	20.1	462,147
Total	13,433	286,317	653,809	953,559	100	
In-migration (percent)	1.4	30.0	68.6	100		
Female						
Mountain	-	115,181	94,146	209,327	18.4	-177,593
Hill	28,116	-	706,231	734,347	64.7	-431,849
Terai	3,618	187,317	-	190,935	16.8	609,442
Total	31,734	302,498	800,377	1,134,609	100	
In-migration (percent)	2.8	26.7	70.5	100		

Source: Central Bureau of Statistics, Population Monograph of Nepal, 2014, Table 10.3, p. 249.

[12] CBS, 2014, Population Monograph of Nepal, 2014, Volume I, p. 245-46.

[13] CBS, 2014, Population Monograph of Nepal, 2014, Volume II, Table 8.17, p. 190. One of the CBS publications has reported the figures for 2000/01 and 2010/10 as 60.8 and 68.8 years respectively (See: CBS, 2013, Environment Statistics of Nepal, 2013, Table 3.1, p. 29).

40.5. The comparable estimate in 2001 was 64 per thousand live births.

Adult Literacy Rate

According to the 2011 census, Nepal had an adult literacy rate of 59.6 percent, with a huge variation between males (71.6 percent) and females (48.8 percent).

Enrollment Ratio

Gross enrollment rates for the year 2011 were estimated to be 136 percent, 100 percent and 70 percent for primary, lower secondary and secondary schooling levels respectively. Estimates of net enrollment rates for the same year were: 95 percent (primary), 70 percent (lower secondary), and 52 percent (secondary).

Females per 100 Males in Secondary School

Ratio of girls to boys in secondary schools is the percentage of girls to boys enrolled at secondary level in public and private schools.

Ratio of girls to boys in secondary school was 0.99 in 2013. Of the total enrolment, girl's enrolment constituted 50.9 and 49.7 percent at the lower-secondary and secondary levels respectively.[14]

Calorie Supply

Calorie is a shorter form used for technically more correct term "kilocalorie". Calories are simple ways to measure the energy in food. Calorie supply is a function of food supply.

According to the Third Nepal Living Standards Survey[15], 16 percent of the respondent thought that food consumption in their households was "less than adequate" (or inadequate), while 82 percent said it was "just adequate" and the remaining 2 percent answered "more than adequate".

According to the FAO[16] report , average supply of protein during 2008 - 10 was 61 (g/cap/day) and average supply of protein of animal origin was 9 (g/cap/day). The corresponding averages for the World for the same were 79 (g/cap/day) and 31 (g/cap/day) respectively.

Inadequate access to food in terms of the depth of the food deficit for the period (2011 - 13) was 112 kcal/cap/day against 83 kcal/cap/day.

Nutritional Status of Children

According to the Third Nepal Living Standards Survey[17] , 42 percent of children under five years of age were stunted (height-for-age) and 15 percent were severely stunted. Thirty-one percent of children were underweight (weight-for-age) and 8 percent were severely underweight. Fourteen percent of children were wasted (weight-for-height) and three percent were severely wasted. These indicators among females were in general higher than among males.

Population Living in Absolute Poverty

According to the Third Nepal Living Standards Survey, 2010/11, 25.2 percent of Nepalese were living below poverty line. According to the survey report, Nepal recorded 5.6 percent decline in absolute poverty between 2003 - 04 and 2009 - 10.

Urban Air Quality

Nepal accounts for relatively low carbon dioxide (CO2) emissions compared to other countries in the region. In 2009, Nepal's total emission of CO2 was four megatons, negligible proportion of the global total of 29,837 megatons.[18]

The levels of gaseous pollutants such as oxides of nitrogen, oxides of Sulphur, and ozone have not been found to be very high in major urban areas of Nepal. However, there are possibilities that these levels may increase in the future with increasing motorization. "Environmental Pollution Index 2014" published by Yale University has ranked Nepal second last (after Bangladesh) in terms of air quality and its effect to human health. Concentration of particulate matter less than 10 microns (PM_{10}) in the Kathmandu Valley is sev-

[14] National Planning Commission/United Nations Country Team of Nepal, 2013. Nepal Millennium Development Goals Progress Report 2013, p. 31.
[15] CBS, 2011. Nepal Living Standards Survey, 2010/11, Statistical Report, Volume Two, p. 98.
[16] FAO, 2014. FAO Statistical Yearbook 2014, Asia and the Pacific Food and Agriculture, Table 12, p. 56. (www.fao.org/3/a-i3590e.pdf)
[17] CBS, 2011. Nepal Living Standards Survey, 2010/11, Statistical Report, Volume Two, pp. 119-120.
[18] NPC/UNCT, 2013, Nepal Millennium Development Goals Progress Report, p. 65.

eral times higher than the WHO safe limit. Kathmandu is one of the most polluted cities in Asia with regards to PM_{10} and PM_{25}. [19]

Nepal has formulated "Ozone Depleting Substances Consumption (Control) Rules, 2001" in order to specify the substance to be consumed as well as sold and distributed within Nepal as prescribed by the Government.

Environmentally Related Diseases

Illnesses and conditions caused by factors in the environment are collectively called environmental diseases. Pesticides, chemicals, radiation, air pollution, and water pollution, are some of the man-made hazards that are believed to contribute to human illnesses.[20]

The high incidence of diseases such as heart problems and cancer have been increasing due to changes in dietary habit, lifestyle and exposure to pollution and toxic wastes etc.

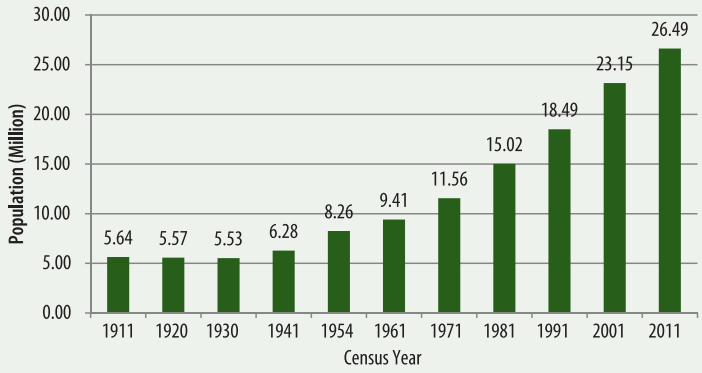
Status and Trends

The following is a short description of the current situation and a general direction in which the situation is changing. It should be noted that, the trends presented here refer to the situation before the devastating earthquake of April 25, 2015.[21]

Population Growth

To date, Nepal has seen eleven decennial population censuses. Except for the second and the third censuses, the population of the country has been increasing from one census to the other (Figure 1). The annual population growth rate was phenomenal after the fourth census. The growth rate reached the highest (2.62 percent per annum) during 1971 - 81. The rate has been undulating after 1981 and slowed down to 1.35 percent per annum in 2000 - 2011.

Figure 1: Population of Nepal, 1911 - 2011



Nepal's population took nearly 50 years to double from 5.6 million to 11.2 million. It then took only 30 years to double from 11.6 million to 23.2 million. At the latest rate of growth, it will double again in another 51 years.

Population Density

In the last 100 years (1911 – 2011), the population of Nepal grew by around 370 percent. The population has increased each decade since 1930. The first census recorded 5,638,749 people in Nepal which increased to reach 26,494,504 in 2011.

It is natural that the population density increased in tandem with the population growth. In 1911, the average number of population per square kilometer was estimated at 38. As of July 22, 2011, the density reached 180 persons per square kilometer, an increase of 142 persons per square kilometer. If the estimated growth rate (of 2001 - 2011) continued unchanged, the population density of Nepal would reach around 360 persons per square kilometer in 2061.

Rural-urban Migration

The population census of 1961 and subsequent censuses have collected information with regard to the birth place of each enumerated person. The birth place of a person was recorded in terms of the district where the person was born.

[19] Clean Air Network Nepal, 2014. Air Quality Status and Management in Kathmandu Valley Make the City Air Breathable, MaYA Fact sheet #5 (www.cen.org.np/.../AQ%20St...)

[20] http://www.humanillnesses.com/original/E-Ga/Environmental-Diseases.html#ixzz3a6ziVhNr

[21] The earthquake killed around 9 thousand people across Nepal and injured more than twice as many. More than 600 thousand houses were fully destroyed and around 300 thousand houses were partially damaged. (http://reliefweb.int/report/nepal/nepal-earthquake-weekly-situation-update-31-july-2015) According to the UN report, around 2.8 million people were displaced. Schools system in the country has been shattered. More than 5,000 schools were damaged and as many as 1,000 collapsed in the earthquake. Tomoo Hozumi, Unicef's representative in Nepal, describe the situation in the following words: "Almost one million children who were enrolled in school before the earthquake could now find they have no school building to return to. Prolonged interruption to education can be devastating for children's development and future prospects". The above numbers should be taken as indicative only. Final figures are yet to come.

Rural to urban migration from different censuses cannot be compared as the number of designated urban areas have been changing/increasing in one after another census. Estimates from the 2001 census figures indicate that the major streams of internal migration were rural-to-rural (68.2 percent), and rural-to-urban (25.5 percent). The remaining 6.3 percent was accounted by urban-to-urban and urban-to-rural migration taken together.[22]

The 2011 census estimates show that rural-to-rural migration still outweighed the other three streams. However, there is a noticeable declining trend (59 percent in 2011 compared with 68 percent in 2001). On the other, rural-to-urban migration increased from 25.5 percent in 2001 to 35.5 percent in 2011.[23] This provides a clear indication that rural-to-urban migration will gain further prominence in coming years.

Life Expectancy at Birth

Life expectancy at birth for Nepal has significantly increased over the years since 1954. Expectation of life at birth in 1954 for both sexes was estimated at 27.8 years which almost doubled in 1991 (54.3 years). It further increased and reached 66.6 years in 2011 (an increase of around 140 percent between 1954 and 2011).

Estimates of the expectation of life at birth in 1954 for males and females were 27.1 and 28.5 years respectively. The corresponding estimates for 1991 were 55 years (males) and 53.5 years (females). Estimates for 2011 were 65.5 years (males) and 67.9 years (females) respectively.[24] For 2001, the estimates were lower by 5.4 years (males) and 7.2 years (females) respectively.

Infant Mortality Rate

Childhood mortality declined significantly over the past 20 years (i.e., between 1990 and 2011). During this period, the infant mortality rate (IMR) declined from 108 to 46 per 1,000 live births.

The rate of decline for IMR (1990 – 2011) was significant, 57.4 percent. The rate of decline has, however, slowed down in recent years.[25] One in 22 children dies before the age of one (and one in 19 children dies before reaching age five).

Adult Literacy Rate

The adult literacy rate (for the population aged 15 years and over), has been increasing over the years. The overall rate was 20.6 percent in 1981 which increased and reached 33 percent (49.2 percent for males and 17.4 percent for females) in 1991. The rate increased to 48.6 percent in 2001 (62.7 percent for males and 34.9 percent for females). The 2011 population census reported a further increase: 59.6 for both sexes, 71.7 percent for males and 48.8 percent for females.[26]

School Enrollment Ratio

Overall, gross enrollment ratio (GER) for lower secondary level school in 2001 was 63.2 percent (72.2 percent for boys and 54.0 percent for girls). The ratio increased significantly over the years and reached 100.0 percent (96.0 percent for boys and 104.1 percent for girls).

At the national level, GER for secondary level school in 2001 was 43.8 percent (51.8 percent for boys and 36.0 percent for girls). The corresponding figures for 2011 were 70.1 percent for both sexes, 68.4 percent for boys and 71.9 percent for girls.

Net enrollment ratios (NER) have increased considerably during the period 2001 - 11. The NER for lower secondary level of school in 2001 was 39.4 percent for both sexes, 45.0 percent for boys and 33.7 percent for girls. In 2011, the NER for both sexes reached 70.0 percent, 70.5 percent for boys and 69.5 percent for girls.

For secondary level of schools, the NER in 2001 was 25.5 percent for both sexes (30.2 percent for boys and 20.9 percent for girls). The ratios in 2011 reached 52.1 percent for both sexes, 52.7 percent for boys and 51.4 percent for girls.

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[22] CBS, 2003. Population Monograph of Nepal, Volume II, pp. 141-143.
[23] CBS, 2014. Population Monograph of Nepal, Volume I, Population Dynamics, p. 258.
[24] CBS, 2014. Population Monograph of Nepal, Volume I, Population Dynamics, Table 8.17, p. 190.
[25] National Planning Commission/United Nations Country Team of Nepal, 2013. Nepal Millennium Development Goals Progress Report 2013, p. 39.
[26] CBS, 2014. Population Monograph of Nepal, Volume II, Social Demography, Annex 5.2, p. 219.

Females per 100 Males in Secondary School

Ratio of female to male secondary enrollment is the percentage of girls to boys at secondary level of public and private schools.

The ratio female to male secondary enrollment is increasing in favor of females in recent years. According to the World Bank portal (*http://data.worldbank.org/indicator/SE.ENR.SECO.FM.ZS*), the ratio was 97 percent in 2010 which increased to 101 percent in 2011.

Calorie Supply Per capita

The third Nepal Living Standards Survey 2010/11 used 2,200 calorie consumption (per person per day) as the threshold to measure poverty in Nepal. Using this threshold, the survey estimated that around 25 percent of the population in Nepal was living below poverty line.

According to the FAO[27], dietary energy consumption (DEC) level in Nepal is increasing over the years. The proportion of undernourished in total population, on the other, is consistently decreasing from 1999 - 2001 onwards. (Table 1).

In general, the nutritional status of children in Nepal has improved over the decade 2001 - 11. The proportion of stunted children (for whom height-for-age value is less than two standard deviations of the WHO child growth standards median) declined from 57 percent in 2001 to 41 percent in 2011 and that of underweight children (whose body weight is considered too low to be healthy), from 43 to 29 percent in the same period. Similarly, the proportion of wasted children (low weight-for-height) declined slightly, from 13 percent in 2006 to 11 percent in 2011.[28]

Population Living in Absolute Poverty

Poverty declining rate has been "impressive" in Nepal. The annual rate of decline in Nepal's poverty level increased from 1.5 percent between 1996 and 2004 to 2.5 percent between 2004 and 2011. In 1996, 42 percent of population was below the national poverty line in Nepal, which declined to 31 percent in 2004. The proportion further declined to 25 percent in 2011. According to the MDG Report 2013, between 2005 and 2013, the poverty declined by an annual average rate of one percent . If this rate is sustained, the 21 percent target for 2015 can be easily achieved.[29]

Table 9: Dietary Energy Consumption and Proportion of Undernourished Population, Nepal, 1999 - 2012

	1999 - 2001	2004 - 2006	2007 - 2009	2010 - 2012
Dietary energy consumption (DEC), kcal/person/per day	2210	2280	2340	2400
Proportion of undernourished in total population, percent	24.0	21.3	19.7	17.9

Source: FAO, Table 149 (*www.fao.org/docrep/016/i3052e/i3052e00.pdf*)

Urban Population Exposed to Concentration of Sulphur dioxide (SO_2)

Sulphur dioxide (SO_2) levels in Kathmandu and in other urban areas in Nepal were monitored in 2004. The levels in the Kathmandu valley area were much lower than in other urban areas. The 8-hour average SO_2 levels in the Kathmandu Valley area in 2004 were much lower than other urban counterparts in Nepal. These weekly 8-hour values, however, are not directly comparable to annual and 24-hour standards set for Nepal.

Incidence of Environmentally Related Diseases

During the last fifteen years (between 1996 and 2011), there have been changes in health indicators of Nepal. Several indicators show noticeable improvements. For some other indicators, however, the figures are not encouraging. Regarding the MDGs, the targets for HIV/AIDs, tuberculosis, malaria and other diseases, environmental sustainability, and global partnership are unlikely to be achieved by 2015. [30]

[27] FAO, Regional Office for Asia and the Pacific, Bangkok, 2012. Selected Indicators of Food and Agricultural Development in the Asia-Pacific Region, 2001-2011, RAP publication 2012/18, Table 149, p 211.

[28] National Planning Commission/United Nations Country Team of Nepal, 2013. Nepal Millennium Development Goals Progress Report 2013, p. 15

[29] Ibid pp. 9-10. (http://www.np.undp.org/content/nepal/en/home/library/mdg/mdg-progress-report-2013.html).

[30] Ibid, p. 92.

Recommendations

Policy implications of demographic influences on the environment are complicated. Furthermore, they can be controversial at times. Recommendations differ according to the complex issues related to social and demographic issues. The following are some of the recommendations (pertinent to the Nepalese situation) based on the overall suggestions made by Lori M. Hunter.[31]

— Inclusion of demographic factors in development policies to promote effective family planning.
— Development of plan to slow migration to the Terai region and crowded urban areas.
— Development of incentives to encourage sustainable levels of consumption and the use of efficient, cleaner technologies.
— Promotion of interdisciplinary and analytical approach in environmental research.
— Collection of new data that allow examination of the links between social and natural processes.

Nepal has its "first ever" National Population Policy endorsed by the Cabinet and unveiled on March 30, 2015 (countryoffice.unfpa.org/nepal/2015/.../first_population_policy_in_nepal). This umbrella policy "contains nine areas of focus and 78 strategies". According to the UNFPA, Nepal, "the policy, among other things, aims at improving lives of people by integrating population issues into development, ensuring reproductive health and reproductive rights of people as the fundamental human rights and promoting gender equality and inclusion in all sustainable development strategies". The policy is expected to be "a key milestone in responding the population issues and the challenges of sustainable development faced by Nepal". Further, the policy "follows a rights-based approach that will ultimately contribute to balancing the population and achieve key demographic targets in 20 years (2015-2034) in line with the proposed Sustainable Development Goals (SDGs) due to be endorsed by the UN member states in September 2015".

There is no shortage of good recommendations available in the Government documents regarding the social and demographic issues. The following are select objectives, strategies and operational policies outlined in the current Thirteenth Plan of Nepal[32]. These are pertinent (or related) to the issues considered above.

— Use of population management efforts to create an environment in which people can lead productive and good-quality lives.
— Establishment of reproductive rights as fundamental human rights by increasing public awareness.
— Implementation of programmes for targeted communities, thereby ensuring that population management programme effectively promotes gender equality and social inclusion.
— Promotion of coordination between development programmes and the population structure.
— Management of population growth by family planning, population-education, and awareness-raising interventions.
— Provision of intensive awareness, reproductive, maternal and child health, and family planning services to identified target groups in order to promote a good quality of life and small families.
— Enhancement of equal participation of men and women in population management programme.
— Implementation of the National Population Policy of Nepal.
— Encouragement of "maximum of two children per family" policy to control and manage population.
— Mobilization of youth-power, capitalising on the demographic dividend, in national development - by engaging youths in creative and productive activities.
— Regulation of immigration trend on the basis of the domiciles, number and characteristics of immigrants.
— Development of integrated settlements for rural and mirginalised areas and endangered

[31] Hunter, L. M., Population and Environment: A Complex Relationship, What should Policymakers do?
[32] National Planning Commission, Nepal, 2013. An Approach Paper to the Thirteenth Plan (FY 2013/14 – 2015/16), Kathmandu: NPC, Nepal.

groups to balance the regional distribution of population.
— Conduct a nationwide survey to identify the nature, intensity and reasons for various trends in national and international migration.
— Expansion of geriatric wards from central to zonal hospitals.
— Establishment and improvement of health institutions and provision of the resources they need, given the populations they serve, the needs of patients, and their geographical location.
— Restriction of unauthorised, uncontrolled and unorganised urbanisation and settlement development process.
— Development of safe, clean and prosperous cities with adequate infrastructure.
— Expansion of equal access to education of all levels and types, general, vocational, and technical.
— Provision of equitable access to secondary-level education, schools and access to students from all classes, communities and regions to science education.
— Expansion of alternative programmes, reservations, and scholarships to women, indigenous and ethnic communities, Madhesis, Dalits, and people with special needs to ensure access to education at all levels.
— Efforts made to increase enrollment and pass rates and to reduce dropout and repetition rates by creating child-friendly school environment.
— Focus on the promotion and use of agricultural and livestock products, in food-deficit and food-and-nutrition-insecure areas, which can be produced locally by using local resources, including materials, labour, and technology.
— Conduct awareness programmes designed to promote food-and-nutrition security.
— Necessary arrangements in food-and-nutrition-insecure areas and communities for solving the food crisis in the short and the long term.
— Improvement of the nutritional status of vulnerable citizens by implementing multi-sectoral nutrition programmes.
— Establishment of rehabilitation centers and expansion of nutrition services in central and zonal hospitals to improve child and maternal health.
— Strengthening of the existing nutrition programmes to achieve the objectives of the Multi-Sector Nutrition Plan.
— Efforts for the reduction of pollution levels in the rivers in Kathmandu and other metropolises and control of air, land, water, and sound pollution.
— Actions regarding hazardous waste management to be taken in coordination with the agencies concerned.
— Framing and implementation of additional environmental standards in the areas of air, land, water, and sound pollution.
— Designing and implementation of special programs for reducing various types of pollution in order to keep urban pollution within a certain limit and to preserve the beauty of rural areas.
— Development and implementation of mechanisms for the enforcement of 'the polluter pays' and 'removing pollution is good' principles.
— Promotion of the use of low-polluting means of transport and environment-friendly fuel.
— Adoption of advanced technology to minimise the growing levels of pollution.

Environment Friendly Measures

The Thirteenth Plan, also recommends for "environment-friendly" measures to be adopted in different sector under consideration. A few select measures recommended are as follows:
— Construction of buildings that are safe, economical, affordable, environment-friendly and earthquake resilient; and provision of housing facilities to disadvantaged sections of society.
— Development and dissemination of environment-friendly agro-technologies to minimize the adverse impacts of climate change.
— Development and expansion of research-based and environment-friendly agro technologies that reduce the adverse impacts of climate

change by protecting, promoting and using agro-biodiversity.
— Development of irrigation programmes that would ensure local environment-friendly ponds, lakes, wetlands and water source are protected in coordination with other concerned agencies.
— Technical and financial support to industries which install environment-friendly and energy-saving technology on their own initiative.
— Development of mountainous areas as a key tourism destination by making mountaineering systematic and environment-friendly.
— Implementation of environment-friendly and climate-adaptive measures by using local resources in the construction of drinking water and sanitation structures.
— Expansion of urban road networks in a manner which contributes to the management of safe, environment-friendly, hindrance free mass transportation.
— Development of good quality, sustainable, and environment-friendly local infrastructure by adopting a sector-wide approach.
— Contribution towards poverty alleviation by intensifying income generation through means such as sustainable socio-economic development, the provision of environment-friendly, good-quality local infrastructure, and efficient service delivery.
— Promotion of environment-friendly local governance by increasing people's participation in and coordination of climate change adaptation and disaster management efforts.
— Development of outlines for environment-friendly local governance that will ensure the use of environment-friendly measures while mobilizing local resources.
— Acclimatization to the adverse impacts of climate change by making human activities and development processes environment-friendly as called for under the principles of green development.
— Development of environment-friendly, climate change-adaptive infrastructure.
— Development and implementation of mechanisms for the enforcement of 'the polluter pays' and 'removing pollution is good' principles.
— Promotion of the use of low-polluting means of transport and environment-friendly fuel.
— Adoption of environment-friendly, climate change-adaptive and employment generating approaches while conducting studies of and research into and designing and implementing projects related to water-induced disaster control.
— Development and dissemination of environment-friendly agro-technologies to minimize the adverse impacts of climate change.

Conclusion

There are several economists and social scientists, who suggest a few benefits and advantages of population growth. The benefits, according to them, are - better use of country's resources, increase in size of market, generation of extra demand, and increase in labour force.

Further, possibilities of positive economic effects from population growth as suggested by Kuznets and Hirschman also deserve consideration. The positive effects include: exploitation of economies of scale, greater number of potentially creative people, and counter-pressure brought out by population pressure.[33]

Despite those possible advantages, there are a number of reasons for a government to be concerned about population growth. For example, arable land, potable water, and forest resources getting scarcer with the population growth.

There is no doubt that population increase will place increasing pressure on housing, schools, hospitals, and a host of other important aspects of life. It will have adverse effect on natural resources as well.

Exploding and unmanaged habitation of people have adverse effect on and threat to other species in the country. Also, there is an effect on

[33] Kindleberger, P. C., and Bruce Herrick, 1977, Economic Development, Third Edition, p. 249-50.

ozone layer and climate change. If public policies are not reformed, the quality of life as well as the biodiversity of our environment will suffer. Unchecked population growth without equal agricultural advancement to meet it leads to food shortages.

Many basic resources like food, water, air and fuel are strained by population increase. Overpopulation and uncontrolled urbanization bring the problems of overcrowding. Viruses are more likely to spread more easily in dense areas. Overpopulation might bring conflict over resources.[34]

The complex relationship between population dynamics and environmental issues are eloquently "synthesized" by Lori Hunter in her report.[35] Cause and effect analysis of relation between population and environment is not straight and simple as it may appear in the first sight.

Population of Nepal is increasing continuously since 1930s. Nepal added 3,343,081 people during the last decade ending in 2011. On the average, that was more than 9 hundred people per day within a physical area of 147,181 square kilometer.

Over the last couple of decades, several demographic and social changes have occurred in the country. On the whole, there is good news. Fertility and mortality rates have declined. Life expectancy has increased significantly. On average, people are healthier and better nourished than before. Urbanization is increasing rapidly.

During the same period, however, there have been growing concerns about the worsening environmental health of the country. Uneven population distribution has inspired crowding in several parts of the country. Internal migration pattern is asymmetric. There is a mass exodus from the mountain and the hill regions to the plains or the Terai and major urban centres. People are moving to the more arable lands of the Terai. In some parts of the country, the carrying capacity of the land has been pushed to the limit. Deforestation, soil erosion, flooding in the Terai are some of the consequences. In addition, this region (the Terai) is also experiencing ethnic tensions to some extent.

Unplanned urbanization has brought overcrowding and traffic problems in the major cities like the Kathmandu metropolitan area. Already existing environmental problems have begun to trigger an alarm - declining resources are under extra pressure. Influx of people in these areas in search of jobs and better livelihood have created additional pressure on existing life style. Lack of proper housing and sanitation, worsening air quality, water shortages and noise pollution have adversely affected the quality of urban life.

Nepal is experiencing massive youth migration – within and outside the country. Many of these migrants are from rural Nepal. Migration has affected both the youth migrants themselves and the young and old persons left behind. One example, there is acute scarcity of farm labour in the country. Agricultural status of the country is worsening. Nepal is becoming a food insecure country. Rural poverty is rampant with adverse impact on environment.

This is a bizarre story. Increasing population has naturally necessitated increase in food requirement. Thousands of hectares of forest are being cleared, and marginal lands are being brought into cultivation. This has increased vulnerability to natural disaster including soil degradation, soil erosion, fragmentation of land, flooding, and land slide etc.

The Government has prepared the first population policy of Nepal with due consideration to environment issues. Nepal environmental policy and action plan "sets forth a strategy for maintaining the country's natural environment, the health and safety of its population and its cultural heritage as economic development occurs". National health policy of Nepal, along with other health issues, has given priority to "environmental health" of the people.

The Thirteenth Plan (2013/14-2015/16) of Nepal[36] has accorded to prioritise the management of population in the country. The objective of the population policy is "to use population management efforts to create an environment in which people can lead productive and good-quality lives". The objec-

[34] Hinrichsen, D. and Bryant Robey, Population and the Environment: The Global Challenge, (http://www.actionbioscience.org/environment/hinrichsen_robey.html)

[35] Hunter, Lori M., Population and Environment: A Complex Relationship (www.rand.org › Published Research › Research)

[36] National Planning Commission, Nepal, 2013. An Approach Paper to the Thirteenth Plan (FY 2013/14 – 2015/16), Kathmandu: NPC, Nepal.

tives of the plan regarding the "environment and climate change" and the agricultural sector are:

Environment - Adapt to the adverse impacts of climate change by making human activities and development processes environment-friendly as called for under the principles of green development.

Agriculture - To develop and disseminate environment-friendly agro-technologies to minimize the adverse impacts of climate change.

The devastating earthquake of April 25, 2015 has claimed thousands of lives, destroyed thousands of infrastructures - thousands of buildings including many historical heritage sites have been destroyed or severely damaged. According to a preliminary estimate of the Government, economic cost to the country has been as much as "half of Nepal's economy". A lot of rebuilding is necessary in the aftermath of the earthquake.

Nepal had unveiled "it's first ever population policy" on March 30, 2015, less than one month before the massive earthquake in the country. The policy, no doubt, will be a milestone in responding to the population issues and its relation to the environmental issues faced by Nepal. What is needed in the present context is to review and implement the said policies from a different perspective in the aftermath of the quake.

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Climatic Extremities in Nepal

Keshav P. Sharma, Ph.D.*

Assessment of climatic extremities in Nepal showed that recurrent daily precipitation exceeding 100 mm is common in most of the southern parts of Nepal. Except a few isolated locations, intense precipitation was found to be less likely in the High Mountain and Himalayan areas. Most of the intense precipitation exceeding 400 mm was recorded in areas lying below 2100 m. Similarly, more than half of the precipitation events exceeding 400 mm were found to be occurring below 1000 m. Analysis of short duration extreme precipitation indicated the depth duration relationship in a logarithmic form give as:

Pe = 55+162*ln(T), where Pe is the extreme precipitation (mm) and T is the duration in hour.

The recorded precipitation depth showed one hour precipitation exceeding 77 mm and 24 hour precipitation exceeding 550 mm. Assessment of extreme precipitation probability indicated that most of the intense precipitation zones of Nepal were located in the southern parts: mainly foothills and Sivaliks. Intense precipitation in Sivaliks also indicates high sediment transport as Sivaliks are made of conglomerates and loose rocks. The recorded extreme annual precipitation in Nepal is as high as 5284 mm at Lumle to as low as 146 mm in Mustang. Recorded temperature within Nepal was found within the range of 46.4°C to -45.0oC. Assessment of climatic conditions in Nepal is, however, limited not only by limited network coverage but also by limited frequency and parameters monitored.

Introduction

Hydro-meteorological hazards triggered by weather and climatic extremes include: floods, droughts, tropical cyclones, thunderstorms, windstorm, hailstorm, cloudburst, lightening, heat waves and cold waves. Some of these hazards ultimately turn into disasters affecting people's socio-economy as well as development activities.

One of the major concerns related to climate change is the likely scenario of amplified intensity and frequency of such hydro-meteorological hazards, which could jeopardize investments in development activities. Intergovernmental Panel on Climate Change (IPCC) reports that extreme weather and climate are likely to change in terms of its frequency, intensity, extent, duration and timing in the global warming scenarios (IPCC, 2012). Increased vulnerability of societies and development activities to the climatic extremes has made it an essential aspect of research and a major challenge for scientific communities regarding its prediction (Quevauviller, 2014).

Regarding statistics, extremities related to weather, climate and water are responsible for ninety percent of the globally occurring disasters (WMO, 2006). Similarly, analysis of the greatest rainfall values are of particular significance in estimating Probable Maximum Precipitation (PMP) for design of major hydraulic structures. There has been more than 200 dam failures in the world, which are mostly linked to inadequate assessment of extreme hydrometeorological events (Rakhecha & Singh, 2009).

Temperature decreases with increase in altitude. With the variation of elevation from 61 metre at Budhanagar in Moran (Survey Department, 2012) to the Sagarmatha, the highest peak of the

world at 8848 m, Nepal provides environment for most of the possible climate of the world from sub-tropical to alpine.

Besides atmospheric circulation and moisture source, spatial pattern of precipitation is dependent on several topography-related parameters such as elevation, slope and orientation (Spreen, 1947). Topography has the key role to play in producing rainfall events in the Himalayan region; absence of topography would lead to dryness as the region lies in a geographic belt where general atmospheric circulation supports persistent subsidence (Black, 1991).

Figure 1: Spatial Distribution of Annual Average Temperature in Nepal

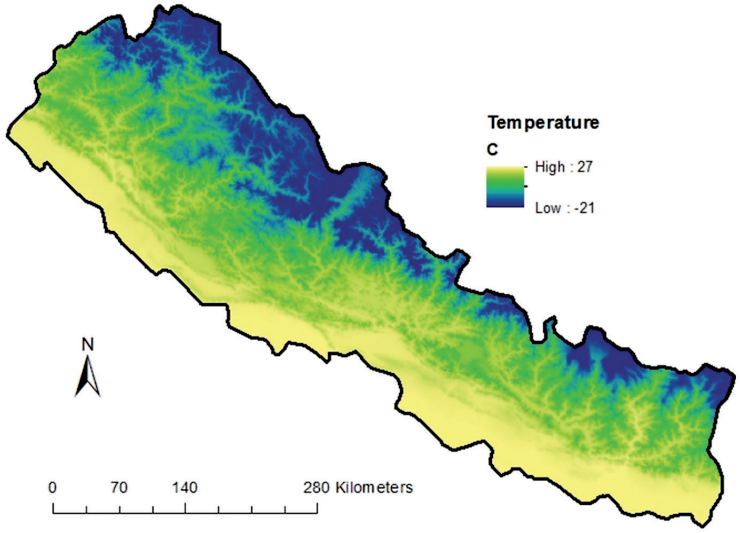
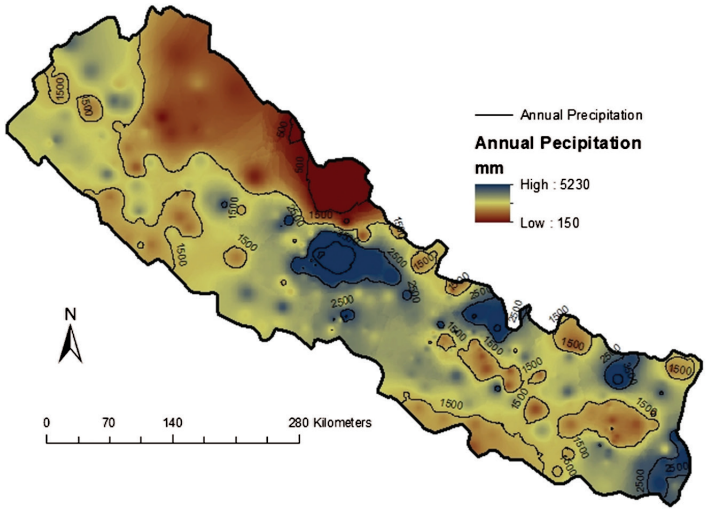


Figure 2: Spatial Distribution of Average Annual Precipitation



Background

Rainfall observations have been reported in different parts of the world since mid-eighteenth century. A rainfall station established in Calcutta in 1785 by the East India Company is the first initiation of climatic observation in South Asia. The company was also involved in recording and publishing precipitation from 1833 to 1840 for Kathmandu (Sharma, 2009). Regular climatic observations (precipitation and temperature) based on standard practices was initiated at the British Residency in Kathmandu from 1921. Temperature observation in other parts of Nepal was initiated only in the late 1950s.

Hydrological Survey Department under the Ministry of Canal and Electricity was established in 1963 as an authentic organization for monitoring hydro-meteorological information in Nepal (Sharma, 2014). Project-based hydro-meteorological information remained in a scattered manner before this period. Climatology based on a nation-wide network is, hence, possible only on the basis of data from late 1950s for precipitation and from 1970s for temperature and other meteorological variables.

The first network of precipitation station in Nepal was developed in the Koshi basin during the late 1940s. With availability of precipitation data for the spatial analysis of precipitation, assessment of one the severest floods that occurred in 1954 on the Kohsi River was made possible (Dhar & Narayanan, 1966).

General Climatology

Nepal lies in the central part of the Great Himalayas with high mountains, valleys and plains. Climatology of the Himalayan region is characterized by extreme diversity with the wettest area on earth (highest annual precipitation amount) and a few extremely dry areas. Similarly, the temperature from low lands to the peaks of the world can vary from 45°C to -45°C (Sharma, 2014).

Under the strong influence of monsoons, the annual wetness varies from wet period during the four months of southwest monsoon (June-September) to relatively dry period during rest of the year. The recorded extreme annual precipitation in Nepal is as high as 5284 mm at Lumle to as low as 146 mm in Mustang (Sharma, 2014).

About thirty percent of Nepal lies above 3000 m, which is an uninhabitable area due to harsh climatic conditions. Very few settlements are found above this level leading to inaccessibility for proper instrumentation. Network coverage for proper assessment of climate is hence limited in these areas. Most of the climatic stations in Nepal lie below 2000 m representing only sixty percent of Nepal (Sharma & Paudel, 2008). Few studies based on scientific expedition indicate higher monsoon precipitation within the elevation range of 2000 m to 3000 m, decreasing upwards (Higuchi & Ageta, 1982; WECS/DHM, 1990).

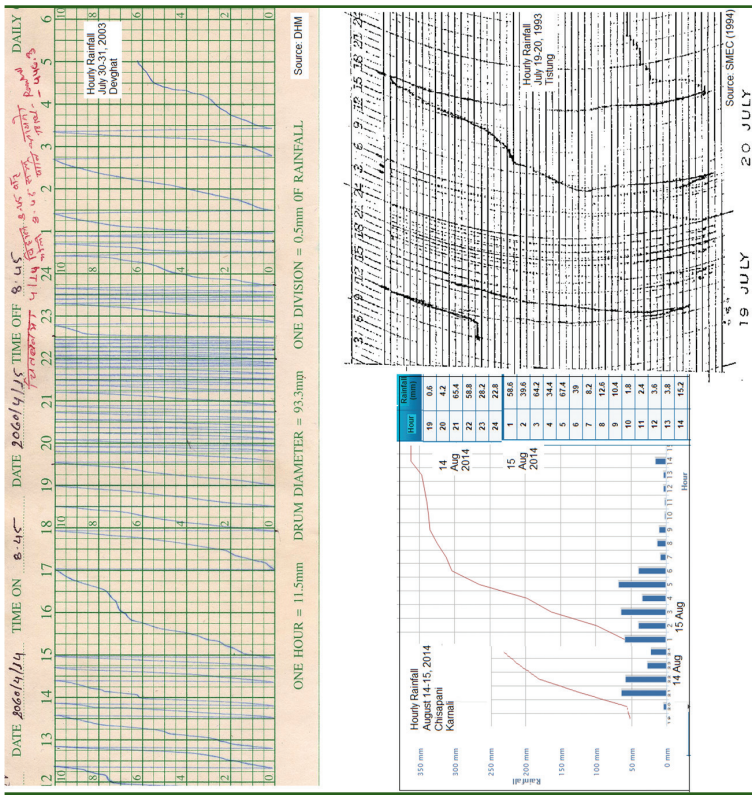
Based on the Koppen climatic classification, seventy percent of Nepal lies in the humid subtropical region with distinctly dry winter, temperature of the warmest month exceeding 22°C (Sharma, 2014). Dry winter with cool summer (temperature below 22°C) dominate in ten percent of Nepal occupied by mountainous region. Elevation between 4000 m to 6000 m, which is about nineteen percent of the area in Nepal, experiences polar type of climate, frost and snow covering the remaining area (nine percent) above 6000 m.

Extreme Temperature

Figure 1 presents the distribution of annual mean temperature over Nepal. Spatial pattern of temperature is based on the average lapse rate of temperature, which is calculated as 5.5°C/km^2, and the digital elevation model developed at 100 m resolution (Sharma, 2014). The figure shows that the annual temperature varies from 27°C in low lands to -21°C in the Himalayan region. Based on this model, the average temperature of Nepal is about 16°C.

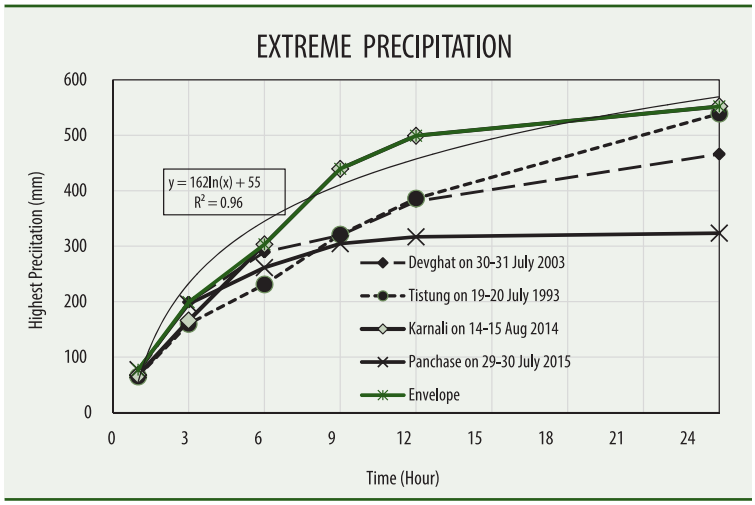
Figure 1 indicates that not only the Terai but also the mountain valleys experience relatively warm temperature. As topography is the major agent controlling temperature, spatial pattern of temperature significantly varies from one location to another.

Figure 3: Self-recorded Chart of 30-31 July 1993, 19-20 July 2003 and 14-15 August 2014 Severe Rainstorms



(Source: Department of Hydrology and Meteorology).
(The precipitation depth in one reversal on the Tistung chart is 50 mm)

Figure 4: Comparison of Three Severe Precipitation Events Maximized for Different Durations



The temperature recorded at the Sagarmatha at -45°C is considered as the lowest temperature recorded in Nepal. It is also the lowest temperature reported in in South Asia (Sharma, 2014). The records available at the Department of Hydrology and Meteorology (DHM) showed that 46.4°C, re-

Table 1: Causal Factors of Selected Severe Rainstorms in Nepal and Adjacent Areas

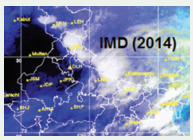
Rainstorm	Causal Factor	Reference
17-18 September 1880 storm that yielded about 271 km3 of water with 24 hour precipitation exceeding 800 mm at Nagina about 100 km west of Nainital	Re-curvature of monsoon depression	(Dhar, Rakhecha& Mandal, 1975)
23-25 August 1954 that resulted in the largest flood (24300 m3/s) recorded so far on the Kosi River.	Monsoon break	(Dhar & Narayanan, 1966)
24-hour precipitation exceeding 360 mm on 3-5 October 1968 that triggered thousands of landslides with deaths exceeding thousand in Darjeeling	Tropical cyclone	(Soja & Starkel, 2007) (Wirthmann, 2000)
Widespread rainfall in Utterakhanda area exceeding 333 mm in two days at Almora on 27-28September 1924 storm that caused more than one thousand deaths and washed away more than 240,000 houses	Re-curvature of monsoon depression to the Himalayan range	(Ramaswami, 1987)
20-21, 1993 rainstorm, the highest recorded daily rainfall (539 mm) in Nepal so far causing extensive floods and landslides resulting in the deaths of	Extended localized instability	(Sharma, 2006)
30-31 July, 2003 rainstorm in Chitwan area with daily value exceeding 446 mm.	Cloudburst: local instability	(Joshi, 2006)
Kedernath and Mahakali disaster that occurred in 2013 with a rainstorm in Mandakini and Mahakalibasins. Twenty-four hour rainfall exceeded 325 mm at Chorabari near Kedarnath. Dipayal recorded 205 mm on 18 June.	Convergence of monsoon trough and western disturbances	(Dobhal, Gupta, Mehta& Khandelwal, 2013)
More than 300 mm in Surkhet area that caused disasters related o floods on the Bheri and Babai resulting in 189 deaths.	Monsoon break	

Table 2. Daily Rainfall Exceeding 400 mm in Nepal

	Location	Region	Elevation (m)	Date	Rainfall (mm)
1	Tansen	Middle Mountain	1067	7 September 1959	409
2	Anarmanibirta	Terai	122	10 October 1959	473
3	Musikot	Middle mountain	2100	29 July 1960	503
4	Gumthang	High Mountain	2000	25 August 1968	505
5	Barahkshetra	Foothill	146	28 July 1974	405
6	Bajura	Middle Mountain	1400	12 August 1980	431
7	BeluwaGirwari	Sivalik	150	29 September 1981	446
8	Manebhanjyang	Middle Mountain	1576	30 September 1981	420
9	Tribeni	Middle Mountain	143	17 September 1984	403
10	Hetauda	Inner Valley	474	27 August 1990	453
11	Tistung	Middle Mountain	1800	21 July 1993	539
12	Sindhuligadi	Mahabharat	1463	21 July 1993	403
13	Patharkot	Foothill	275	21 July 1993	437
14	Hariharpurgadhi	Mahabharat	880	20 July 1993	482
15	Devghat	Foothill	200	31 July 2003	446
16	Surkhet	Inner Terai	720	15 August 2014	423
17	Chisapani, Karnali	Foothill	225	15 August 2014	527

(Source: Department of Hydrology and Meteorology)

corded at Ataria (Near Dhangadi) on 16 June 1995, is the highest temperature recorded in Nepal.

Extreme Precipitation

Major precipitation events causing disastrous floods are mostly associated with large-scale synoptic processes. Such processes usually develop with movement of low pressure area during monsoons, which are also known as monsoon depression. Most parts of India experience break in monsoon activities when the monsoon troughs move towards north crossing the foot hill of the Himalayan range. On the contrary, the Himalayan and sub-mountain regions receive high precipitation during such period (Dhar, Saman & Mulya, 1982). Some events are also found to be associated with the movement of tropical cyclones (Table1). Table 1 presents some causal factors associated with some of the severest rainstorms that occurred in Nepal.

Table 2 presents a list of severe rainstorm observed in Nepal. The list includes the storms with daily precipitation exceeding 400 mm. Daily precipitation is obtained from the measurements of accumulated precipitation during 24-hour period starting 03:00 UTC (08:45 Nepal Standard Time). Twenty-four hour extreme, however, can be higher that the daily maximum; but such data are not always available as most of the precipitation stations are not equipped with self-recording system.

Table 2 indicates that 539 mm measured at Tistung on 20 July 1993 was the highest daily precipitation reported for Nepal. The precipitation on 20 July 1993 was also recorded by a self-recording rain gauge established at the location (Figure 5). As presented in Figure 3, self-recorded precipitation data are also available for the second and third severest storms of Nepal.

Figure 4 presents the maximum depth-duration of the three severest rainstorms derived from the recorded charts as given in Figure 3. Table 3 provides the maximum depth-duration based on Figure 4. Some of the depth-duration values are compared with global maximum and the maximum values observed in monsoon region: India and China (Rakhecha & Singh, 2009).

The best fit equation for the data presented in Table 3 can be obtained as:

$R = 55+162*\ln(T)$,

where R is the maximum rainfall depth in mm and T is the time in hour.

Spatial pattern of 2-year and 100-year daily precipitation in Nepal is presented in Figure 5. Two-year precipitation can be considered as the annual average maximum daily precipitation, whereas 100-year maximum daily precipitation can be considered as a severe case likely to happen only once in the life-time of most of the hydraulic structures. The figure shows that the daily maximum precipitation exceeding 100 mm is likely to occur in about half portion of the southern part of Nepal. There are only a few pockets of precipitation exceeding this amount in high mountain areas. Daily maximum precipitation is less than 50 mm in Mustang and in major parts of Dolpa. Most of the extreme precipitation events are likely to occur in the Sivalik region or along the foothills where several pockets with precipitation exceeding 150 mm can be found (Figure 5). The figure also indicates that the 100-year extreme daily precipitation depth exceed 300 mm in most of the southern parts in Nepal.

The spatial patterns of extreme daily precipitation (Figure 5) is different from the annual average precipitation (Figure 2). The comparison between the spatial patterns of annual average precipitation and the maximum daily precipitation indicates that the orographic and convective precipitation is more pronounced in the Sivaliks and foothill areas compared to middle mountains.

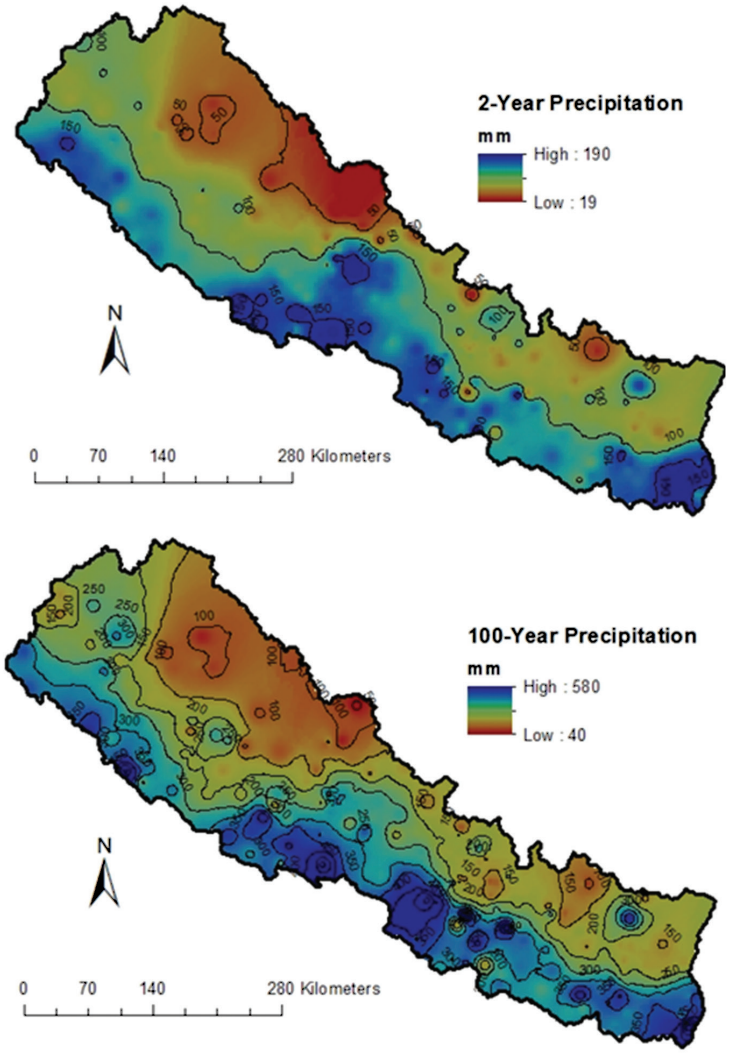
Conclusion

Daily precipitation exceeding 100 mm was common in most of the southern part of Nepal. Except a few isolated locations, intense precipitation was found to be less likely in the High Mountain and Himalayan areas. Most of the intense precipitation exceeding 400 mm was recorded in areas lying below 2100 m. Similarly, more than half of the precipitation events exceeding 400 mm were found to be occurring below 1000 m.

Table 3. Maximum Rainfall Depth-Duration Recorded in Nepal: Comparison with Global and Regional Values

Duration (Hour)	1	3	6	9	12	24
Maximum (mm)	77	199	303	439	499	552
Global Maximum (mm)			830	1087	1340	1870
Maximum in India/China (mm)	129		610			1672

Figure 5: Spatial Pattern of 2-year and 100-year Daily Precipitation in Nepal



Analyses of short duration extreme precipitation indicated the depth duration relationship in a logarithmic form (Precipitation in mm = 55 + 162*ln(Duration in hour)). The recorded precipitation depth showed one-hour precipitation exceeding 77 mm and 24-hour precipitation exceeding 550 mm.

Assessment of extreme precipitation probability indicated that most of the intense precipitation zones of Nepal were located in the southern

parts: mainly foothills and the Sivaliks. Intense precipitation in Siwaliks also indicates high sediment transport as Sivaliks are made of conglomerates and loose rocks.

Assessment of climatic conditions in Nepal is limited not only in terms of network coverage but also in term of parameters monitored. Monitoring of climatic variables, such as wind gust, wind direction, solar radiation, evaporation, etc are limited. On the other hand, monitoring of soil moisture, lightening, air chemistry, air pollution, etc does not exist. Since we have a better coverage of precipitation and temperature network over Nepal, the study is limited to the assessment of temperature and precipitation.

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CHAPTER 5

Land and Soil

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The use of land and soil is very important for human life and land is one of the most important resources in Nepal. Nepal is a mountainous country and has multiple types of land and crops due to different climatic conditions. The barren or uncultivated land is generally unsuitable for agriculture either of topography or its inaccessibility. Most of the agricultural lands are concentrated in the Terai and dun valleys. Wells and tube wells are the main sources of irrigation in Terai whereas river and canal are in the mountain and hills. The government of Nepal has amended the Land Act, 2021 B.S. focusing on land ceilings. However, new and innovative policies should be formulated to address problems in food security and proper land use management.

Introduction and Definition

Nepal has different extremes: climate ranges from subtropical to arctic and vegetation ranges from sub tropical forests to arctic like Tundra. However, Nepal has been divided into mainly 3 physiographic regions: 1. Low land (Terai); 2. Middle hills; and 3. High Mountains. More than 90% of the country's population dependent upon the land for their fulfillment of the basic need.

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (FAO/UNEP, 1999) (Adopted during the course of development of the land cover classification system, LCCS). Land use information provided the following information:

- **What:** the purpose of activities undertaken
- **Where:** the geographical location and extent of the spatial unit under consideration
- **When:** the temporal aspects of various activities undertaken
- **How:** the technologies employed
- **How much:** quantitative measures
- **Why:** the reasons underlying the current land use

Land Resources Mapping Project (LRMP, 1986) has categorized the land use as follows and Nepal government has also adopted this classifications:

- **Cultivated lands:** All lands under agricultural practices
- **No cultivated inclusion:** These are small pockets of land close to cultivated lands: too small to be mapped at a scale of 1:50000. Although these pockets are not mapped separately from cultivated areas, there are nevertheless measured as a distinct land use category. They may contain barren areas, trees, shrubs or grass
- **Grass lands:** Large flat lands covered by grasses with the minimal number of other vegetation
- **Forested lands:** Must have at least 10% crown cover but small pockets of plantation and burned areas are also included
- **Other lands:** All land areas which are not included in other categories and may include rocky areas, lakes, ponds, waterways or settlements.

However, the Central Bureau of Statistics (CBS) collected information based on the following classifications: Agricultural land and non-agricultural land. Agricultural lands are broadly classified into two categories: the crop land and the ponds. Furthermore, the crop land is classified into three categories, namely: arable lands, land under permanent crops and land under permanent meadows and pastures. Similarly, non-

agricultural lands are those lands that are part of the holding the comprise woodland or forest and all other lands.

Government Policy of the Sector related with Environment (Current plan, sector policy, rules, regulations, guidelines, etc.)

Historical Background

Nepal has a long history on land management sector from Veidic period. The land is taken as the main property of the state in the Vedas, Manusmriti, Mahabharat and Kautilya's economics. In Lichchhabi rule, the land administration was regulated by the Gaun Panchali. The Malla rule introduced the system of purchase of land, land survey and land classification on the basis of productivity. Ram Shah, the king of Gurkha Kingdom, started land record maintenance system by dividing the land type into various units like hale, kodale, mato muri, bija, mana etc. The land survey was started in 1930 B.S.

The Mal Adda was established in 1953 B.S. The Pota Registration Adda, which was established in 1978 B.S carried out the functions like, approval of written documents, namsari, dhakhil, lagat katta, collection of land revenue, allocation of budget to governmental offices and account keeping. The Survey Department and the Department of Land Revenue were established respectively in 2014 B.S and 2016 B.S. The district level land Revenue Offices were established after the political division of the Kindgdom in 75 districts. The significant works undertaken in land related sector after the dawn of democracy are given below:

- 2009 Formulated the Commission for Land Reform
- 2012 Declared 13 term Plan on Land Reformation
- 2013 Prepared Land and Land Tenancy Records Act
- 2014 Prepared Land Related Act
- 2016 Prepared Birta Unmulan Ain
- 2019 Prepared Land Survey and Measurement Act
- 2021 Prepared Land Related Act

With the commencement of Land Revenue Act, 2034, the broad land management area is opened such as collection of land Revenue, Land Registration establishment of Land Revenue Offices. After this, the Malpot Offices were gradually replaced by Land Revenue Offices. The Department of Land Revenue, which was working under the Ministry of Finance, was included under the Ministry of Land Reform and Management in 2044 B.S.

National Land Use Policy 2069 BS (2012)

Nepal government has formulated National land use Policy in 2012 to improve the current land use practices inside the country and to implement the different international treaty and understanding. This policy is very important to implement the different targets explained by the UNHABITAT. The vision, goal and objectives of this policy are as follows:

Vision:

The vision of the land use policy is to strengthen the social, economic and environmental development by utilizing optimum utilization of land.

Goal:

The main goal of the policy is to classify the land according to landform, capability, usability and necessity. To fulfil these goals, the land use plan will be carried out within 10 years within the country. However, the land use plan will be prepared for the Municipality, district headquarter and area around main roads within 5 years. The land use law will be formulated within two years to address the land use and regulations.

Objectives:

The major objectives of this policy are as follows:

- To classify the land for maximum utilization
- To promote the conservation of land and management
- To manage land division properly and promote well managed urbanization
- To maintain the balance between the development and environment
- To preserve the land which are very important

by historical, cultural, religious and touristic point of view
- To prepare the land use plan accordance with land use policy

Land Use Pattern

The land use pattern in Nepal is mostly divided in to seven categories namely cultivated land, non-cultivated land, forest, shrub land, grass land, other land and water/lake. The total area of cultivated land has been increasing from 2.9694 million hectors in 1978/79 to 3.090780 million hectors in 2001 whereas forest has been decreasing from 5.6124 million hectors in 1978/79 to 4.2682 million hectors in 2001 (Table 1).

The population density per square km is highest (4416) in Kathmandu whereas the lowest (3) in the Manang district (Table 2). This is due to rural-urban migration and the trend will increase due to increasing trend of urbanization.

Table 1: Land use Pattern by Type, Nepal, 1978/79-2001.

		1978/79*		1985/86*		2001**	
S.N.	Types of Land	Area	Percent	Area	Percent	Area	Percent
1.0	Cultivated land	2969400	20.1	3052000	20.7	3090780	21.0
2.0	Non Cultivated land	986900	6.7	998000	6.8	1030390	7.0
3.0	Forest	5612400	38.1	5518000	37.4	4268200	29.0
4.0	Shrub land	694000	4.7	706000	4.8	1560110	10.6
5.0	Grass land	1755900	11.9	1745000	11.8	1766160	12.0
6.0	Other land	2729800	18.5	2729000	18.5	2619800	17.8
7.0	Water /Lake	NA		NA		382660	2.6
	Total	**14748400**	**100.0**	**14748000**	**100.0**	**14718100**	**100.0**

Source :
*Water and Energy Commission Secretariat(Energy Sector Synopsis Report 2010),
**Department of Forest Research and Survey, 2001

Table 2: Population - Land Ratio and Population Density by District, 2011

S.N.	District	Geographical Area (sq.km.)	Holdings		Household	Population	Population Land Ratio (person per ha .)	Population Density (person per sq.km.)
			Number	Area (ha)				
1	Taplejung	3646	23444	22327.5	26509	127461	5.71	35
2	Panchthar	1241	36664	28725.5	41196	191817	6.68	155
3	Ilam	1703	57950	53394.3	64502	290254	5.44	170
4	Jhapa	1606	120538	102442.6	184552	812650	7.93	506
5	Morang	1855	126891	109943.0	213997	965370	8.78	520
6	Sunsari	1257	86650	75141.3	162407	763487	10.16	607
7	Dhankuta	891	31382	25488.7	37637	163412	6.41	183
8	Terhathum	679	19608	19102.2	22094	101577	5.32	150
9	Sankhuwasabha	3480	29983	28955.6	34624	158742	5.48	46
10	Bhojpur	1507	36832	29775.8	39419	182459	6.13	121
11	Solukhumbu	3312	21478	19116.8	23785	105886	5.54	32
12	Okhaldhunga	1074	30451	28546.9	32502	147984	5.18	138
13	Khotang	1591	40358	31349.9	42664	206312	6.58	130
14	Udayapur	2063	54919	28162.3	66557	317532	11.28	154
15	Saptari	1363	89241	73907.7	121098	639284	8.65	469
16	Siraha	1188	88527	78797.5	117962	637328	8.09	536
17	Dhanusa	1180	96006	72307.2	138249	754777	10.44	640
18	Mahottari	1002	80844	64977.2	111316	627580	9.66	626
19	Sarlahi	1259	98288	80678.4	132844	769729	9.54	611
20	Sindhuli	2491	51233	26626.3	57581	296192	11.12	119
21	Ramechhap	1546	40888	30372.4	43910	202646	6.67	131
22	Dolakha	2191	40718	26844.6	45688	186557	6.95	85
23	Sindhupalchok	2542	58998	34781.5	66688	287798	8.27	113
24	Kavrepalanchok	1396	68872	39707.3	80720	381937	9.62	274
25	Lalitpur	385	33616	9300.3	109797	468132	50.33	1,216
26	Bhaktapur	119	30631	5682.8	68636	304651	53.61	2,560
27	Kathmandu	395	51462	9595.6	436344	1744240	181.77	4,416

S.N.	District	Geographical Area (sq.km.)	Holdings		Household	Population	Population Land Ratio (person per ha .)	Population Density (person per sq.km.)
			Number	Area (ha)				
28	Nuwakot	1121	53984	32996.5	59215	277471	8.41	248
29	Rasuwa	1544	8504	4557.7	9778	43300	9.50	28
30	Dhading	1926	64517	35398.0	73851	336067	9.49	174
31	Makwanpur	2426	67111	31802.8	86127	420477	13.22	173
32	Rautahat	1126	79233	64834.9	106668	686722	10.59	610
33	Bara	1190	81292	56866.7	108635	687708	12.09	578
34	Parsa	1353	59496	48898.7	95536	601017	12.29	444
35	Chitawan	2218	88242	40631.6	132462	579984	14.27	261
36	Gorkha	3610	57671	31493.5	66506	271061	8.61	75
37	Lamjung	1692	33041	17265.8	42079	167724	9.71	99
38	Tanahu	1546	59233	29022.3	78309	323288	11.14	209
39	Syangja	1164	57613	29450.6	68881	289148	9.82	248
40	Kaski	2017	53268	23438.6	125673	492098	21.00	244
41	Manang	2246	993	473.6	1480	6538	13.81	3
42	Mustang	3573	2420	1374.8	3354	13452	9.78	4
43	Myagdi	2297	22480	12358.5	27762	113641	9.20	49
44	Parbat	494	28644	12598.9	35719	146590	11.64	297
45	Baglung	1784	51663	30686.6	61522	268613	8.75	151
46	Gulmi	1149	57705	40910.4	64921	280160	6.85	244
47	Palpa	1373	48830	29985.3	59291	261180	8.71	190
48	Nawalparasi	2162	101337	56125.2	128793	643508	11.47	298
49	Rupandehi	1360	104174	71188.0	163916	880196	12.36	647
50	Kapilbastu	1738	74770	64578.0	91321	571936	8.86	329
51	Arghakhanchi	1193	43422	31597.3	46835	197632	6.25	166
52	Pyuthan	1309	44423	25811.8	47730	228102	8.84	174
53	Rolpa	1879	40284	24853.3	43757	224506	9.03	119
54	Rukum	2877	37759	21375.2	41856	208567	9.76	72
55	Salyan	1462	42840	26684.8	46556	242444	9.09	166
56	Dang	2955	86623	61951.5	116415	552583	8.92	187
57	Banke	2337	61433	44120.1	94773	491313	11.14	210
58	Bardiya	2025	68063	47233.5	83176	426576	9.03	211
59	Surkhet	2451	56571	27241.3	72863	350804	12.88	143
60	Dailekh	1502	45079	21329.3	48919	261770	12.27	174
61	Jajarkot	2230	28546	16127.2	30472	171304	10.62	77
62	Dolpa	7889	6696	3733.4	7488	36700	9.83	5
63	Jumla	2531	17774	7010.9	19303	108921	15.54	43
64	Kalikot	1741	21528	14700.7	23013	136948	9.32	79
65	Mugu	3535	9174	6218.6	9619	55286	8.89	16
66	Humla	5655	8306	5232.1	9479	50858	9.72	9
67	Bajura	2188	22611	9413.1	24908	134912	14.33	62
68	Bajhang	3422	32446	11812.2	33786	195159	16.52	57
69	Achham	1680	44986	18488.6	48351	257477	13.93	153
70	Doti	2025	36840	16382.5	41440	211746	12.93	105
71	Kailali	3235	111662	66658.5	142480	775709	11.64	240
72	Kanchanpur	1610	70573	44352.9	82152	451248	10.17	280
73	Dadeldhura	1538	24797	11616.8	27045	142094	12.23	92
74	Baitadi	1519	43544	21326.7	45191	250898	11.76	165
75	Darchula	2322	22420	17378.5	24618	133274	7.67	57
	NEPAL	1,47,181	3831093	2525639.2	5427302	26494504	10.49	180

Source: CBS (Population Census 2011 and National Sample Census of Agriculture 2011)

Land Use Types

The total area of agricultural land has been increasing from 1.6264 million in 1961/62 to 2.36309 million hectors in 2011/2012. Table1 illustrates that the agricultural land has decreased from 2.4977 million hectors in 2001/02 to 2.36309 million hectors in 2011/2012. Similarly, arable land has been increasing from 1.5919 million hectors in 1961/61 to 2.357 million hectors in 2001/02 whereas the area has decreased in 20011/12 with 2.162 million hectors.

Moreover, Land under permanent pastures crops has been decreasing from 42.4 thousand hectors in 1981/82 to 29.3 thousand hectors in 2011/12. Similarly, non-agricultural land has also been increasing from 59 thousand hectors in 1961/62 to 161.91 thousand hectors in 2011/2012.

The forest covered area in Terai region has been significantly changing in every decade. The forest cover area has been increasing in Dang, Nawalparasi, Chitwan, Sarlahi, Mahot-

Table 3: Land Use Type in Nepal ('000 hectares), 1961/62 - 2011/12

	1961/62	1971/72	1981/82	1991/92	2001/02	2011.12
Agricultural land	1626.40	1592.3	2359.2	2392.9	2497.7	2363.09
Arable land	1591.90	1567.00	2287.50	2324.30	2357.00	2162.14
Land under temporary crops	1550.50	1537.10	2250.20	2284.70	2326.10	2123.17
Other arable land	41.40	29.9	37.3	39.7	30.9	38.97
Land under permanent crops	12.20	15.0	29.2	29.4	117.5	168.45
Land under permanent pastures crops	22.30	10.30	42.50	36.90	19.80	29.30
Ponds	n.a.	n.a.	n.a.	3.9	3.5	3.20
Non-agricultural land	59.00	61.80	104.50	205.00	156.40	161.91
Woodland and forest	13.80	4.70	15.00	108.80	37.20	54.89
Other land	45.2	57.1	89.5	96.2	119.2	107.02
Total area of holding	**1685.40**	**1654.00**	**2463.70**	**2597.40**	**2654.00**	**2522.52**
	Percentage					
Agricultural land	96.5	96.3	95.8	92.1	94.1	93.7
Arable land	94.5	94.7	92.8	89.5	88.8	85.7
Land under temporary crops	92.0	92.9	91.3	88.0	87.6	84.2
Other arable land	2.5	1.8	1.5	1.5	1.2	1.5
Land under permanent crops	0.7	0.9	1.2	1.1	4.4	6.7
Land under permanent pastures crops	1.3	0.6	1.7	1.4	0.7	1.2
Ponds	n.a.	n.a.	n.a.	0.2	0.1	0.1
Non-agricultural land	3.5	3.7	4.2	7.9	5.9	6.4
Woodland and forest	0.8	0.3	0.6	4.2	1.4	2.2
Other land	2.7	3.5	3.6	3.7	4.5	4.2
Total area of holding	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 4 : Land Use Pattern by District (area in hector)

S.N.	District	Total Forest Area	Shrub	Agricultural land/ grass	Water bodies	Barren land	Snow	Others	Total
1	Taplejung	112256	56362	70946	405	37757	60115	27496	365337
2	Panchthar	53182	14369	54078	181	326	29	0	122165
3	Ilam	72214	31649	64595	236	2873	0	0	171567
4	Jhapa	13239	1863	141795	778	6517	0	0	164192
5	Morang	43814	6040	126955	1374	4996	0	0	183179
6	Sunsari	21304	1508	91799	6262	6861	0	0	127734
7	Dhankuta	26324	14598	47350	549	982	0	0	89803
8	Terhathum	20033	12489	34917	129	494	0	0	68062

S.N.	District	Total Forest Area	Shrub	Agricultural land/ grass	Water bodies	Barren land	Snow	Others	Total
9	Sankhuwasabha	159872	48476	71335	975	23723	40825	0	345206
10	Bhojpur	61448	22207	66525	552	1284	0	0	152016
11	Solukhumbu	86002	49628	67424	571	59670	50037	19509	332841
12	Okhaldhunga	32363	15592	58858	352	729	0	0	107894
13	Khotang	61039	22571	74328	931	2020	0	0	160889
14	Udayapur	109404	15766	70005	1150	6587	0	0	202912
15	Saptari	30286	82	94397	3154	8169	0	544	136632
16	Siraha	20202	679	94268	818	4201	0	0	120168
17	Dhanusa	25773	1832	83617	1300	5158	0	0	117680
18	Mahottari	24086	1602	70897	1224	4836	0	0	102645
19	Sarlahi	21786	918	100624	488	2834	0	0	126650
20	Sindhuli	136302	25708	71842	1268	8442	0	0	243562
21	Ramechhap	48477	33076	67900	620	6149	3906	0	160128
22	Dolakha	78111	41194	54778	401	16031	22913	2985	216413
23	Sindhupalchok	92955	36017	67105	162	17404	32560	2679	248882
24	Kavre	46448	29511	67492	434	750	0	0	144635
25	Lalitpur	14620	8250	15553	125	999	0	0	39547
26	Bhaktapur	583	611	5440	1	316	0	0	6951
27	Kathmandu	12680	5219	22677	69	2375	0	0	43020
28	Nuwakot	42916	23526	48412	405	2405	1352	0	119016
29	Rasuwa	47494	15667	9443	54	8983	25138	44308	151087
30	Dhading	79205	31945	66322	745	4464	6382	0	189063
31	Makwanpur	137220	22578	75529	817	5696	0	0	241840
32	Rautahat	29076	563	78805	715	3332	0	0	112491
33	Bara	37974	1394	78480	298	1997	0	0	120143
34	Parsa	73131	922	63342	181	2513	0	0	140089
35	Chitawan	132746	6230	77280	2465	3696	0	0	222417
36	Gorkha	101158	52885	62886	497	23616	119141	0	360183
37	Lamjung	87552	22328	30999	607	9116	15162	0	165764
38	Tanahu	71949	18881	60850	1004	1410	49	0	154143
39	Syangja	51214	16685	45515	707	1293	74	0	115488
40	Kaski	89087	24881	28361	1803	10417	47308	0	201857
42	Mustang	16723	23587	285	272	78241	229295	10856	359259
43	Myagdi	67898	51574	16744	330	23035	70444	0	230025
44	Parbat	26189	7756	15371	141	735	7	0	50199
45	Baglung	91505	39702	21453	391	24612	1738	0	179401
46	Gulmi	51649	26853	36524	364	3033	80	0	118503
47	Palpa	72607	23736	44332	538	70	42		141325
48	Nawalparasi	89635	15210	104672	3260	9260	25	0	222062
49	Rupandehi	19897	3989	99894	1807	9063	0	0	134650
50	Kapilbastu	60500	2232	104141	2632	3951	0	0	173456
51	Arghakhanchi	69961	19414	24292	302	865	0	0	114834
52	Pyuthan	93042	3919	24587	526	8547	0	0	130621
53	Rolpa	150095	486	16458	67	19027	0	0	186133
54	Rukum	174725	2130	12961	130	77148	23253	0	290347
55	Salyan	143786	2610	36419	526	7337	0	0	190678
56	Dang	170124	8233	106934	1727	10343	0	0	297361
57	Banke	104269	9461	71475	1923	6296	0	0	193424
58	Bardiya	99364	5300	85809	2548	4756	0	0	197777
59	Surkhet	157687	33269	48653	1899	7556	0	0	249064

S.N.	District	Total Forest Area	Shrub	Agricultural land/ grass	Water bodies	Barren land	Snow	Others	Total
60	Dilekh	88699	20705	36341	167	8812	353	0	155077
61	Jajarkot	151306	1088	24126	489	43401	4095	0	224505
62	Dolpa	60603	3910	77	764	474881	249817	0	790052
63	Jumla	110531	1118	19819	338	98595	18566	0	248967
64	Kalikot	87165	3846	15560	0	48264	9588	0	164423
65	Mugu	87312	9387	20729	1360	139358	69568	0	327714
66	Humla	41051	21954	12584	677	112174	421759	0	610199
67	Bajura	72507	23982	31414	264	32110	63897	0	224174
68	Bajhang	92391	39713	43697	440	38826	139599	0	354666
69	Achham	99144	16967	45102	422	6219	154	0	168008
70	Doti	141848	17277	44839	311	2049	10	0	206334
71	Kailali	169708	14761	129769	2330	4715	0	0	321283
72	Kanchanpur	84420	2207	71938	1361	5680	0	0	165606
73	Dadeldhura	105937	11280	31359	212	1306	0	0	150094
74	Baitadi	72020	27751	46368	370	1229	0	0	147738
75	Darchaula	58177	31218	32902	591	30750	81568	0	235206
Total		**5599760**	**1283231**	**4061631**	**64664**	**1683493**	**1974003**	**108377**	**14775159**

The maximum forest cover area belongs to Rukum (174725 hectors) whereas the lowest belongs to Bhaktpur (583 hectors). Similarly, the maximum agricultural land belongs to Jhapa (141795 hectors) whereas the lowest belongs to Dolpa (77 hectors) (Table 4).

Table 5: Change in Forest Covered Area in Terai Districts (Excluding Protected Areas)

S.N.	District	1990/91	2000/01	Change	% Change
1	Jhapa	21274	21000	-274	-1.29
2	Morang	45718	45184	-534	-1.17
3	Sunsari	21659	21365	-294	-1.36
4	Saptari	21054	21110	56	0.27
5	Siraha	19021	18278	-743	-3.91
6	Dhanusa	28876	28323	-553	-1.92
7	Mahottari	23587	24181	594	2.52
8	Sarlahi	30037	30528	491	1.63
9	Rautahat	29472	29559	87	0.3
10	Bara	49632	49157	-475	-0.96
11	Parsa	18904	18644	-260	-1.38
12	Chitawan	61677	63586	1909	3.1
13	Nawalparasi	91026	93171	2145	2.36
14	Rupandehi	27305	26524	-781	-2.86
15	Kapilbastu	64579	62211	-2368	-3.67
16	Dang	191200	194262	3062	1.6
17	Banke	113074	110820	-2254	-1.99
18	Bardiya	35491	33719	-1772	-4.99
19	Kailali	210413	205939	-4474	-2.13
20	Kanchanpur	54546	51933	-2613	-4.79
	Total	**1158545**	**1149494**	**-9051**	**-0.78**

Source: Department of Forest, 2005, (Forest Covered Change Analysis of the Terai Districts 1990/91-2000/01)

Table 6: Estimated Coverage by Different Types of Wetlands in Nepal

S.N.	Wetland Types	Estimated Coverage	Column1
		Area (ha.)	Percent (%)
1	Rivers	395000	48.2
2	Lakes	5000	0.6
3	Reservoirs	1500	0.2
4	Ponds	7277	0.9
5	Marginal swamps	12500	1.5
6	Irrigated paddy fields	398000	48.6
	Total	**819277**	**100**

Source: Directorate of fisheries Development (2012)

Figure 1: Land Use Types Changes in Different Decades

Figure 2: Forest Cover Changes in the Different Terai District between 1990/91 to 2000/01

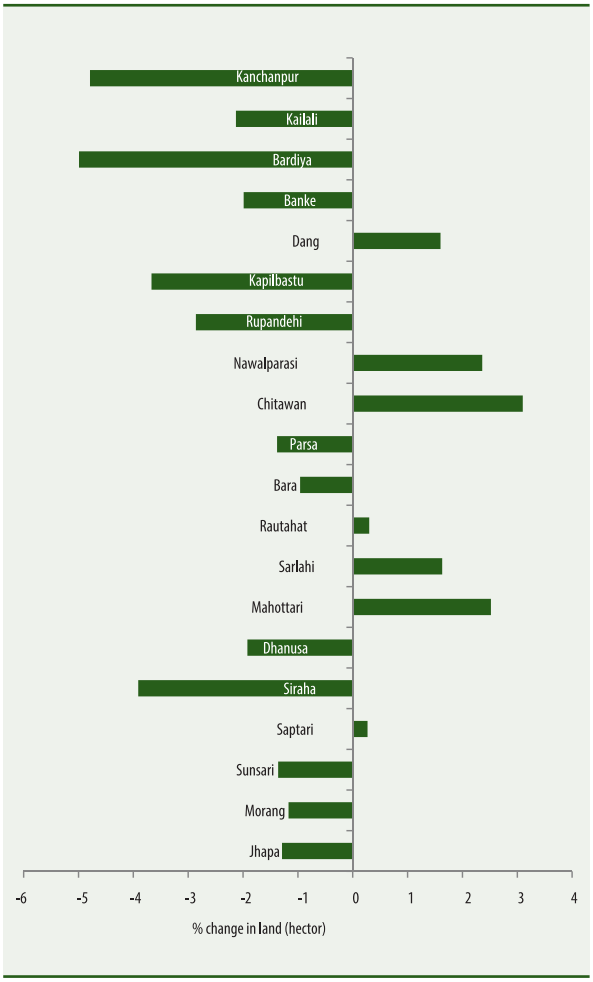
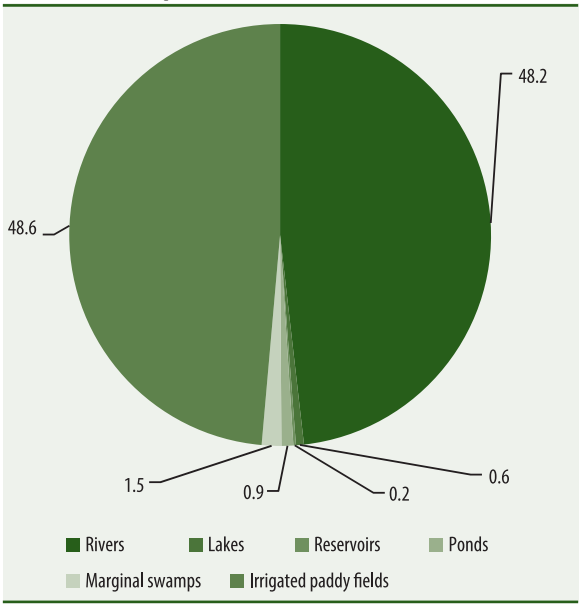


Figure 3: Estimated Coverage by Different Types of Wetlands in Nepal



tari and Saptari whereas the forest cover area has been decreasing in Kanchanpur, Kailali, Bardiya, Banke, Kapilbastu, Rupendhi, Parsa, Bara, Dhanusa, Siraha, Sunsari, Morang and Jhapa (Figure 2). The maximum forest cover area increased from 61677 to 63586 hectors in one decades in Chitwan (3.1%) whereas the maximum decreased from 35491 to 33719 hectors in Bardiya (-4.99%) in one decade (Table 5).

The total estimated coverage of wetland in the country is 819277 hectors (Table 6). Rivers and Irrigated paddy field have covered more than 96% of the wetland of country.

Figure 4: Soil Erosion due to Landslide along the Bhotekoshi River.

Land Degradation and Soil Erosion

Land degradation is the reduction in the capacity of the land to provide ecosystem goods and services and assure its functions over a period of time for the beneficiaries of these. Increased population pressures and excessive human expansion into dry lands during long wet periods leave an increasing number of people stranded there during dry periods. Almost all types of land degradation exist in Nepal. However, soil erosion, water logging and flooding are the major types of land degradation process. Land degradation in Nepal is mainly due to land clearance, quarrying of construction material, urban sprawl and commercial development, livestock including overgrazing and rural-urban migration with agricultural depletion of soil nutrients through poor farming practices (Figure 4). Due to steep slopes and intense monsoon rainfall, soil erosion mainly by water is major land degradation process prevalent in Nepal. Almost all parts of the country are affected by soil erosion resulting sediment yield in different river basin in Nepal (Table 7). Sedimentation with high flood discharge result in abrupt river channel change which may cause complete loss of fertile farm land due to deposition of eroded material or slumping of river banks and in some cases it destroy of human settlements. Every year large amount of sediment is transported by river from Himalayas to Bay of Bangal. The maximum sediment yield is

Table 7: Sediment Yield in Large Watersheds

Watersheds	Watersheds Area (sq. km)	Sediment Delivery (ton/ha/yr)
Tamor	5770	38.0 (1)
	5700	70.0 (6)
	5900	80.0 (4)
	5770	38.0 (5)
Sunkoshi	18985	21.0 (1)
	19000	65.0 (3)
	19000	45.0 (4)
Bagmati	585	45.0 (6)
Trisuli	4100	18.0 (6)
	4110	18.5 (3)
Karnali	42890	21.0 (9)
Nagmati	1388	46.0 (3)
Ganges	1076000	13.5 (8)
Saptakosi	59280	15.0 (1)
	62000	27.7 (8)
	6100	31.0 (7)
	59280	15.0 (5)
Arun	34525	7.6 (1)
	36000	16.0 (7)
	36533	(4)
	34525	7.6 (5)

Reference: Impat-1779; Sherchan-1991; Schaffner-1987; Upadhaya et al. 1991; Ries-1994; Maskey and Hoshy-1991; Karver-1995; Erl-1988; HPC-1989.
Source: Water and Energy Commission Secretariat/CIDA (Himalayan sediment, Issues and Guidelines, 2003)

Table 8: Affected Land Area from Erosion

S.N.	Degradation Type	Affected Area (million ha.)	Affected Area as % of Total Land Area of Nepal
1	Water erosion	6.7	45.4
2	Wind erosion	0.6	4
3	Chemical deterioration	0.3	1.7
4	Physical deterioration	0.2	1.3

Source: Ministry of Environment, Science and Technology, 2008.

Table 9: Estimated Soil Erosion Rate at Selected Sites in Nepal

Area	Location and Characteristics	Land Use	Erosion Rate (ton /sq. km/yr.)
Siwalik Range	Eastern Nepal, South aspect, sand stone foot hills	Different land use ranging from forest to grazing	780 - 3680
	Far Western Nepal, South aspect sand stone foot hills of Surkhet	a. Degraded land	2000
		b. Degraded forest, gullied land	4000
		c. Severely degraded heavily grazed forest, gullied land	20000
Mahabharat Lekh	Central Nepal, steep slope on Metamorphic and Sedimentary Rocks	a. Degraded forest and agriculture land	3150 - 14000
		b. Gullied land	6300 - 42000
Middle Mountain	Northern foot hills of Katmandu Valley	a. Degraded forest & shrub land	2700 - 4500
		b. Over grazed shrub land	4300
		c. Severely gullied land	12500 - 57000
	South of Katmandu	75 percent dense forest	800
	Phewa Watershed	a. Protected pasture	920
		b. Overgrazed grass land	2200 - 34700
		c. Gullied overgrazed grass land	2900

Source: Central Bureau of Statistics (A Compendium on Environment statics 1999 Nepal)

Table 10: Area of Land Made Uncultivable due to Flooding/ Soil Erosion by Ecological Belt and Development Region, Nepal between 2001/02 to 2011/2012 (area in ha.)

Area	Total Area (ha)	Affected Area (ha)	Percentage of affected area	Types of Soil Degradation		
				Soil Erosion	Chemical Degradation	Physical Degradation
ECOLOGICAL BELT						
Mountain	213931.50	3512.30	1.64	1848.60	32.10	1631.60
Hill	986073.20	18764.50	1.90	11679.60	414.90	6670.00
Terai	1325634.50	34394.90	2.59	23643.40	1485.50	9266.00
Total	2525639.20	56671.70	2.24	37171.60	1932.50	17567.60
DEVELOPMENT REGION						
Eastern	755178.00	14789.00	1.96	8407.00	294.00	6088.00
Central	716861.00	19841.00	2.77	13808.00	869.00	5164.00
Western	482547.00	8517.00	1.77	6135.00	193.00	2189.00
Midwestern	353624.00	5214.00	1.47	3791.00	129.00	1294.00
Farwestern	217430.00	8310.00	3.82	5030.00	447.00	2833.00
Total	**2525640.00**	**56671.00**	**2.24**	**37171.00**	**1932.00**	**17568.00**

Source: Central Bureau of Statistics (National Census of Agriculture, Nepal between 2001/02 to 2011/12)

Figure 5: Area of Land Made Uncultivable due to Flooding/Soil Erosion in Different Ecological Region from 2001/02 to 2011/12.

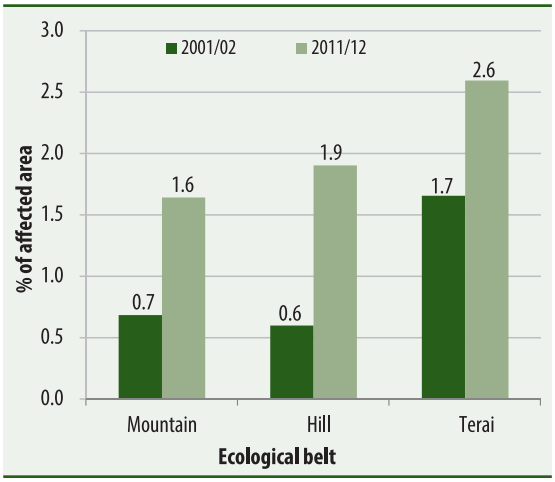
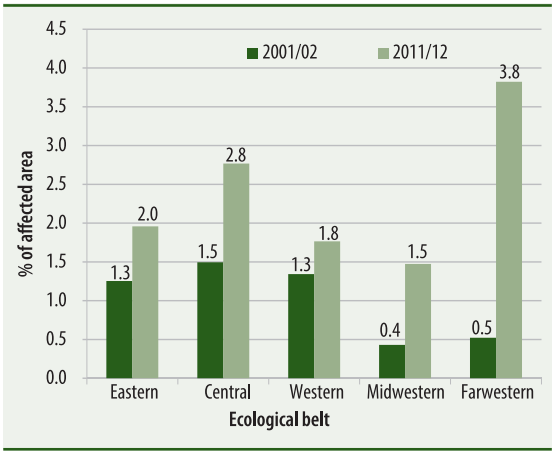


Figure 6: Area of Land Made Uncultivable due to Flooding/Soil Erosion in Different Developmental Region from 2001/02 to 2011/12.



from Tamor River which is 80 ton/hr/yr whereas minimum is in Arun River of about 7.6 ton/hr/yr (Table 7).

Soil erosion created by rain and river in hilly areas, causes landslides and floods, is one of the major problems in Nepal. However wind erosion; chemical deterioration and physical deterioration are also responsible factors for erosion in Nepal (Table 8). The maximum estimated soil erosion rate is very high in the Mahabharat Lekh (6300-4200 ton/sq.km/yr.) where metamorphic and sedimentary rocks are present. The lowest erosion rate is in the southern part of Kathmandu (800 ton/sq.km./yr.) where 75% of land is covered by forest (Table 9).

Figure 7: Type of Soil by Area of Holdings and by Development Region, Nepal, 2001/02

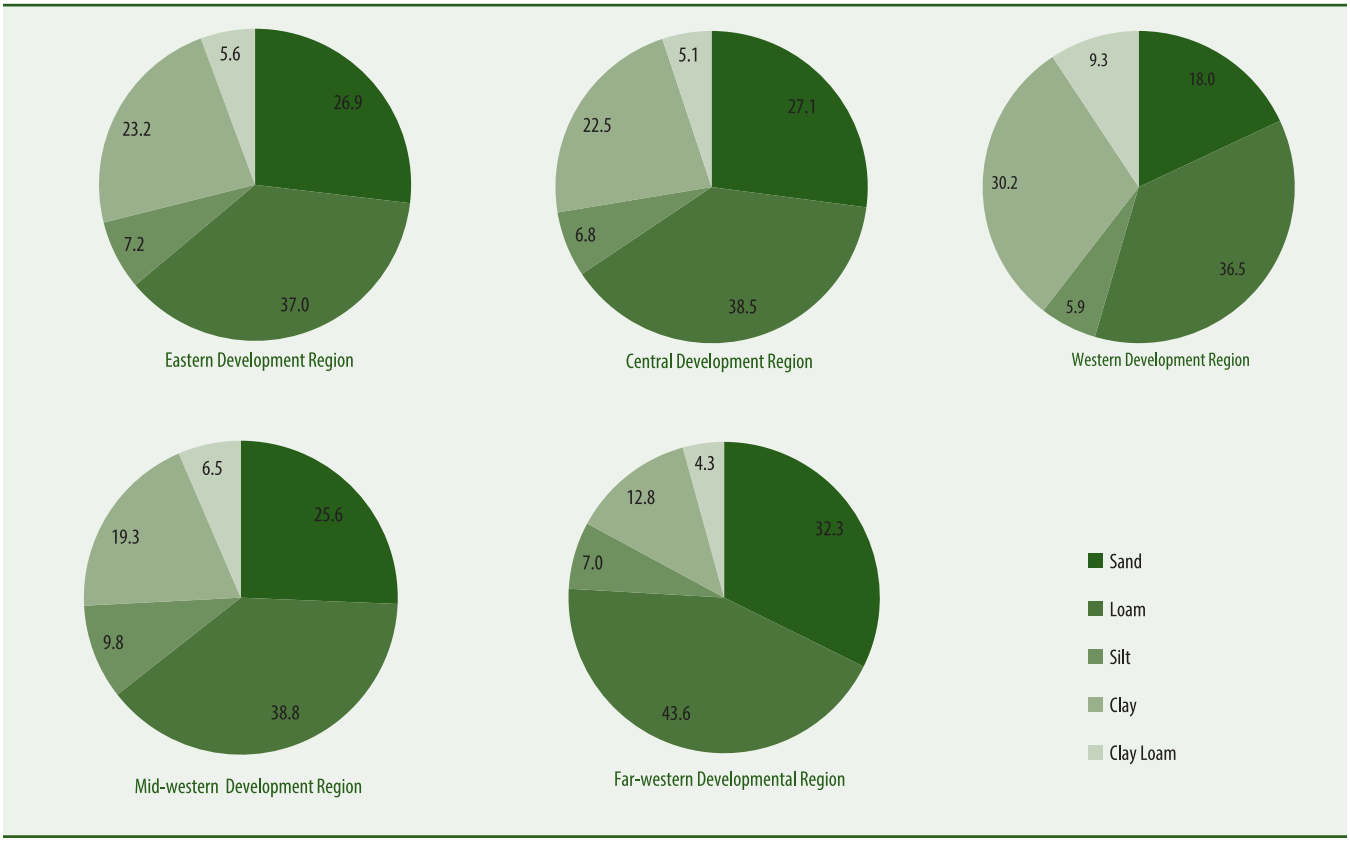
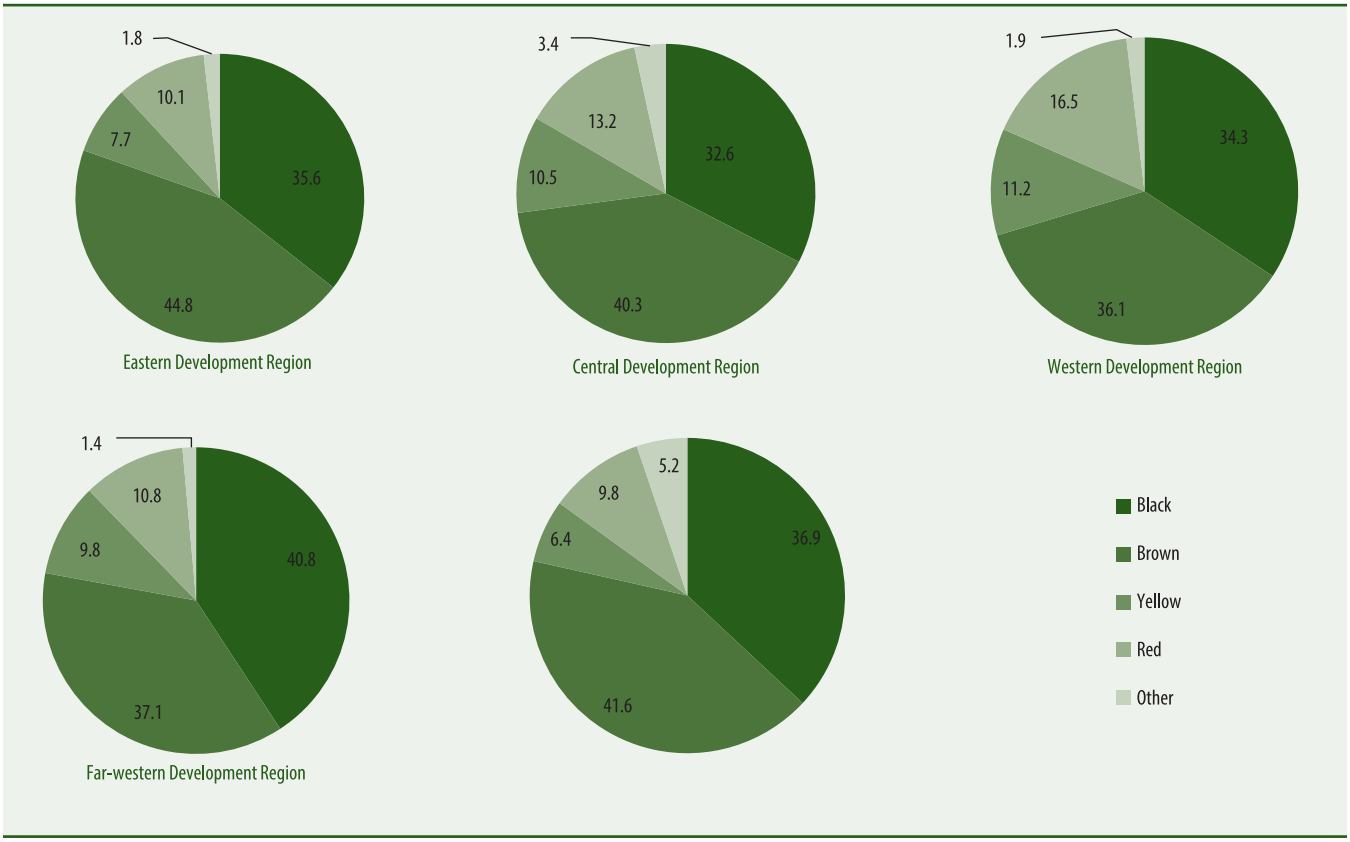


Table 11: Area of Land made Uncultivable due to Flooding/ Soil Erosion by Ecological Belt and Development Region, Nepal between 2001/02 to 2011/2012 (area in ha.)

S.N.	Type and Color of Soil	Nepal		Eastern Development Region		Central Development Region		Western Development Region		Mid -Western Development Region		Far-Western Development Region	
		Area of holding (ha)	Percent to total	Area of holding (ha)	Percent to total	Area of holding (ha)	Percent to total	Area of holding (ha)	Percent to total	Area of holding (ha)	Percent to total	Area of holding (ha)	Percent to total
Soil Type													
1	Sand	589455	25.4	198604	26.9	143885	27.1	85893	18.0	92983	25.6	68091	32.3
2	Loam	884697	38.1	273424	37.0	204719	38.5	174045	36.5	140687	38.8	91822	43.6
3	Silt	167822	7.2	53289	7.2	36094	6.8	28316	5.9	35415	9.8	14708	7.0
4	Clay	532488	22.9	171696	23.2	119527	22.5	144043	30.2	70175	19.3	27047	12.8
5	Clay Loam	145777	6.3	41692	5.6	27212	5.1	44381	9.3	23467	6.5	9025	4.3
Total		**2320239**	**100.0**	**738704**	**100.0**	**531437**	**100.0**	**476678**	**100.0**	**362727**	**100.0**	**210693**	**100.0**
Soil Color													
1	Black	825307	35.6	263073	35.6	173058	32.6	163488	34.3	147848	40.8	77841	36.9
2	Brown	939299	40.5	330750	44.8	214421	40.3	171923	36.1	134623	37.1	87583	41.6
3	Yellow	215460	9.3	57059	7.7	55618	10.5	53487	11.2	35728	9.8	13568	6.4
4	Red	283687	12.2	74556	10.1	70311	13.2	78762	16.5	39307	10.8	20751	9.8
5	Other	56485	2.4	13266	1.8	18029	3.4	9019	1.9	5221	1.4	10951	5.2
Total		**2320239**	**100.0**	**738704**	**100.0**	**531437**	**100.0**	**476678**	**100.0**	**362727**	**100.0**	**210693**	**100.0**

Source: Central Bureau of Statistics (National Sample Census of Agriculture, Nepal, 2001/02).

Figure 8: Color of Soil by Area of Holdings and by Development Region, Nepal 2001/02



The maximum percentage of land in Terai is affected due to flooding or soil erosion whereas mountain regions are less affected. (Figure 5). The land degradation is increased significantly in one decade. This might be due to low land in the Terai and high percentage of debris flow in the mountain. Soil degradation due to different factors in the country covers the area of total 566671.70 hectors. Whereas soil erosion covers 37171.60 ha and rest are from chemical degradation and physical degradation in 2001/12. Far-western developmental region is highly affected due to soil erosion between 2001/02 to 2011/2012 (Figure 6). It might be due to highest no. of flood events in the past and numbers of landslide are present in this area. Soil erosion results in huge loss of nutrients in suspension or solution, which are removed away from on replace to another, thus causing depletion or enrichment of nutrients. Moreover, subsidence of land in some areas and landslides in the hilly tracts are problems affecting highways, habitations and irrigation dams. Different kinds of soil are present in the country. Sand, loam, silt, clay and clay loam are the major types of soil. Loam soil is present throughout the country with the highest percentage (Table 11, Figure 7) followed by sand, clay, silt and clay loam. The color of soil is dissimilar in different parts of Nepal but brown color soil is present everywhere in the highest percentage followed by black, red, yellow and others (Table 11, Figure 8).

Livestock and Poultry

The country has different types of livestock and poultry. However, major types are buffalos, sheep, goats, pigs, fowls and duck. Generally, the population density of flows is very high followed by goats, buffalos, pigs and ducks (Table 12). The population/land of sheep and ducks has been decreasing whereas fowls, goats, buffalos and pigs have been increasing. This might be due to change in food

Table 12: Livestock and Poultry Population in Arid and Semi-Arid Land

	Cattle		Buffaloes		Sheep		Goats		Pigs		Fowls		Ducks	
Year	Population	p/land*	Population	p/land*	Population	p/land*	Population	p/land*	Population	p/land*	Population	p/land*	Population	p/land*
1994/95	6837913	116	3278255	56	918885	16	5649056	96	636024	11	14063581	239	403705	10
1995/96	7008420	119	3302200	56	859000	15	5783140	98	670340	11	14521100	247	416100	11
1996/97	7024775	119	3362435	57	869582	15	5921956	101	723613	12	15576525	265	415758	11
1997/98	7048660	120	3419150	58	869142	15	6080060	103	765718	13	16664730	283	416943	11
1998/99	7030698	119	3470600	59	855159	15	6204616	105	825132	14	17796826	302	421423	11
1999/00	7023166	119	3525952	60	851913	14	6325144	107	877681	15	18619636	316	425160	11
2000/01	6982660	119	3624020	62	850170	14	6478380	110	912530	15	19790060	336	411410	11
2001/02	6978690	119	3700864	63	840141	14	6606858	112	934461	16	21370420	363	408584	11
2002/03	6953584	118	3840013	65	828286	14	6791861	115	932192	16	22260700	378	408311	11
2003/04	6966436	118	3952654	67	824187	14	6979875	119	935076	16	23023979	391	405217	10
2004/05	6994463	119	4081463	69	816727	14	7153527	122	947711	16	22790224	387	391855	10
2005/06	7002916	119	4204886	71	812085	14	7421624	126	960827	16	23221439	394	392895	10
2006/07	7044279	120	4366813	74	813621	14	7847624	133	989429	17	23924630	406	394798	10
2007/08	7090714	120	4496507	76	809480	14	8135880	138	1013359	17	24665820	419	390748	10
2008/09	7175198	122	4680486	80	802993	14	8473082	144	1044498	18	24481286	416	383123	10
2009/10	7199260	122	4836984	82	801371	14	8844172	150	1064858	18	25760373	438	379753	10
2010/11	7226050	123	4995650	85	805070	14	9186440	156	1093610	19	39530540	671	378050	10
2011/12	7244944	123	5133139	87	807267	14	9512958	162	1137489	19	NA		376916	10
2012/13	7274022	124	5241873	89	809536	14	9786354	166	1160035	20	NA		375975	10

*Arid land/semi arid land= Cultivated land, Non cultivated land and Grass land/Pasture estimated area 58873.3 sq. km NA: Not Available
Source Ministry of Agriculture Developments

Table 13: Number of Livestock by Type in Nepal, 1981/82-2011/12

S.N.	Livestock type	Number of Livestock (in 'ooo)				Percentage change		
		1981/82	1991/92	2001/02	2011/12	1991/1981	2001/1991	2011/2001
1	Cattle	6501.6	7359.3	7215.2	6430.4	13.2	-2.0	-10.9
2	Chaunri	55.5	58.6	95.4	48.9	5.6	62.8	-48.8
3	Buffaloes	2379.7	3116.3	3477.7	3174.4	31.0	11.6	-8.7
4	Goats	3643.7	5515.5	6932.9	10990.1	51.4	25.7	58.5
5	Sheep	677.1	602.8	471.2	608.1	-11.0	-21.8	29.0
6	Pigs	433.6	495.8	632.6	818.5	14.3	27.6	29.4
7	Horses	NA	14.3	20.1	17.9	0.0	40.6	-11.1
8	Mules and asses	27.5	5.3	6	5.5	-80.7	13.2	-9.0
9	Rabbits	NA	NA	10.1	24.2	0.0	0.0	140.0
10	Other animals	36.8	7.3	5.9	17.1	-80.2	-19.2	189.6
11	Chickens	7368.6	12333.1	17631	26267.8	67.4	43.0	49.0
12	Ducks	142.3	280.3	393.1	429.9	97.0	40.2	9.4
13	Pigeons	830.7	1419.9	1845.2	1498.9	70.9	30.0	-18.8
14	Other poultry	20.4	9.2	57.3	52.1	-54.9	522.8	-9.1
	Total	**22117.5**	**31217.7**	**38794**	**50383.8**	**41.1**	**24.3**	**29.9**

Source: Central Bureau of Statistics (Monograph Agriculture Census Nepal,2001/02) , National Report Of National sample census of Agriculture 2011/12

Figure 9: Livestock and Poultry Population in Arid and Semi-Arid Land

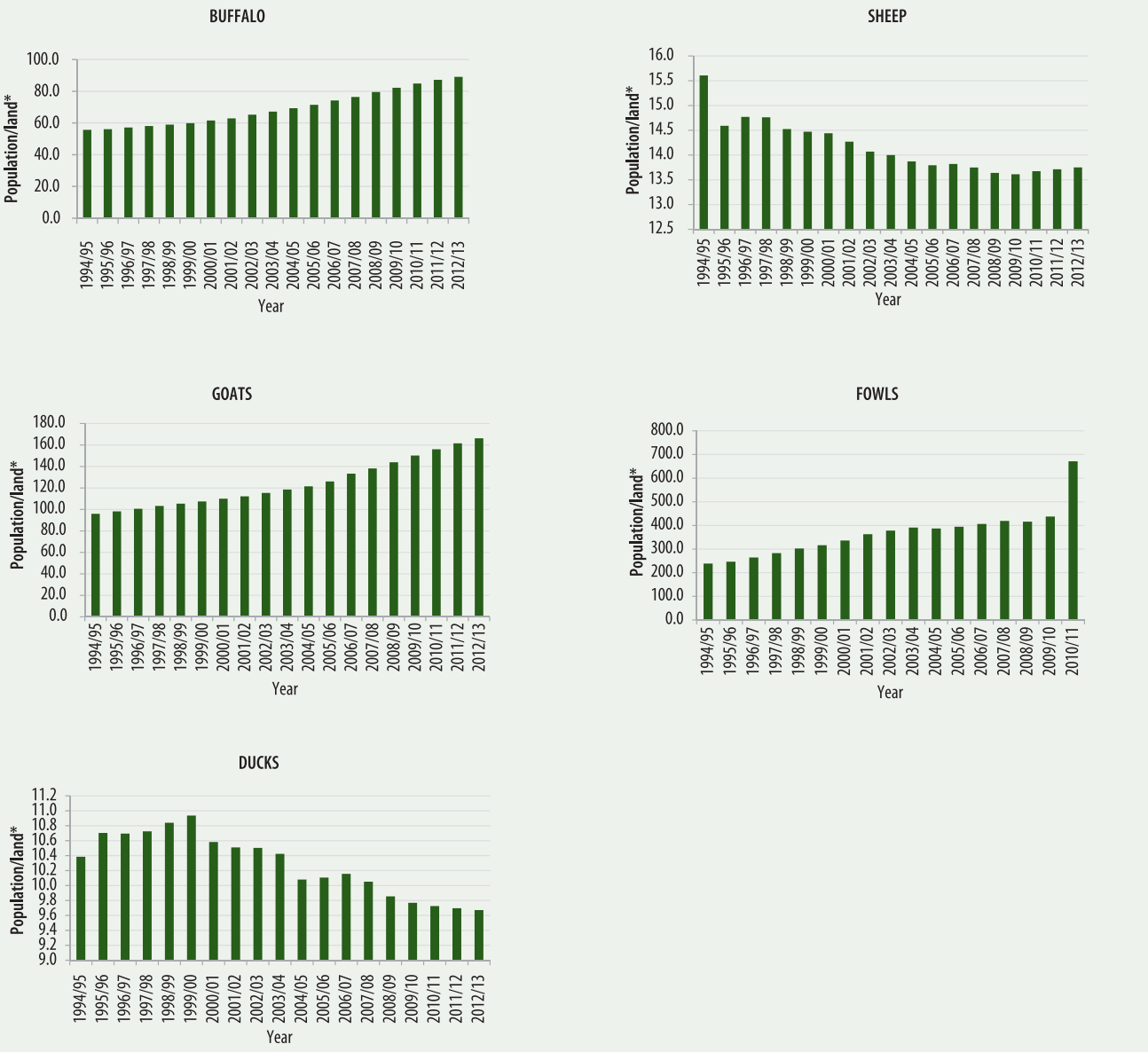


Figure 10: Livestock and Poultry Population in Arid and Semi-Arid Land

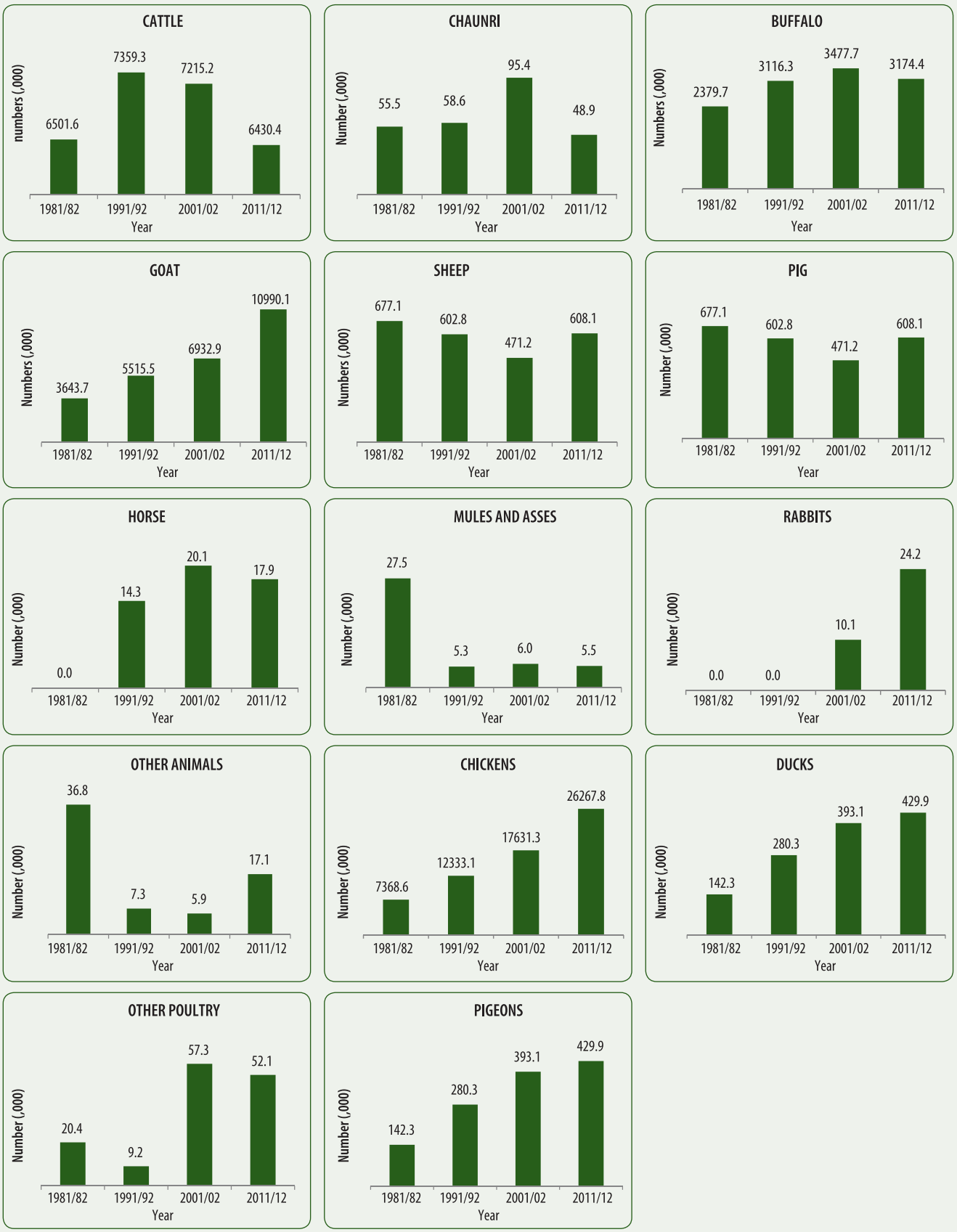


Table 14: Irrigated Land by Source of Irrigation, 2011/12

Area	Total Area (ha)	Irrigated Area (ha)	Source of Irrigation					
			River/Lake/Pond		Dam/reservoir	Tubewell/boring	Others	Mixed
			By gravity	Pumping				
ECOLOGICAL BELT								
Mountain	213.9	58.4	53.4	1.0	1.6	0.0	2.2	0.2
Hill	986.1	270.3	210.5	4.9	24.1	1.5	27.3	2.0
Terai	1325.6	984.8	250.2	107.0	182.5	390.4	26.2	28.4
Total	**2525.6**	**1313.4**	**514.1**	**113.0**	**208.1**	**391.8**	**55.7**	**30.7**
DEVELOPMENT REGION								
Eastern	755.2	394.4	181.1	18.3	41.6	132.0	15.8	5.7
Central	716.9	429.5	127.0	53.6	74.5	139.8	15.9	18.6
Western	482.5	209.8	83.3	28.7	21.4	57.3	14.8	4.3
Mid-western	353.6	152.5	56.6	6.5	55.5	27.1	6.2	0.7
Far-western	217.4	127.3	66.1	6.0	15.1	35.6	3.0	1.5
Total	**2525.6**	**1313.5**	**514.1**	**113.0**	**208.1**	**391.8**	**55.7**	**30.7**

Source: Central Bureau of Statistics (National Censuses of Agriculture, 2011/12) (number is in ,000)

habit and lifestyle (Figure 9). Moreover, the data shows that the number of mules and asses have been decreasing whereas others domestic animals have been increasing (Figure 10, Table 13) in four decades.

Irrigation

Nepal has more than 6000 rivers, which provide a dense network of rivers with steep topographic conditions. The major four river systems viz the Mahakali, Karnali, Narayani and Saptakoshi, all predate the uplift of the main Himalayan range and cut through the mountain range to form deep river valley which drain from north to south towards the Ganges. Similarly, rivers originating from the Siwalik are shallow in depth and mostly dry up during the dry season. These rivers are used by small-scale farmer-managed irrigation schemes for seasonal supplementary. Moreover, groundwater is the major water source irrigation in Nepal. The hydro-geological mapping indicates that the Terai has a tremendous potential of

Figure 11: Irrigated Land by Source of Irrigation, 2011/12

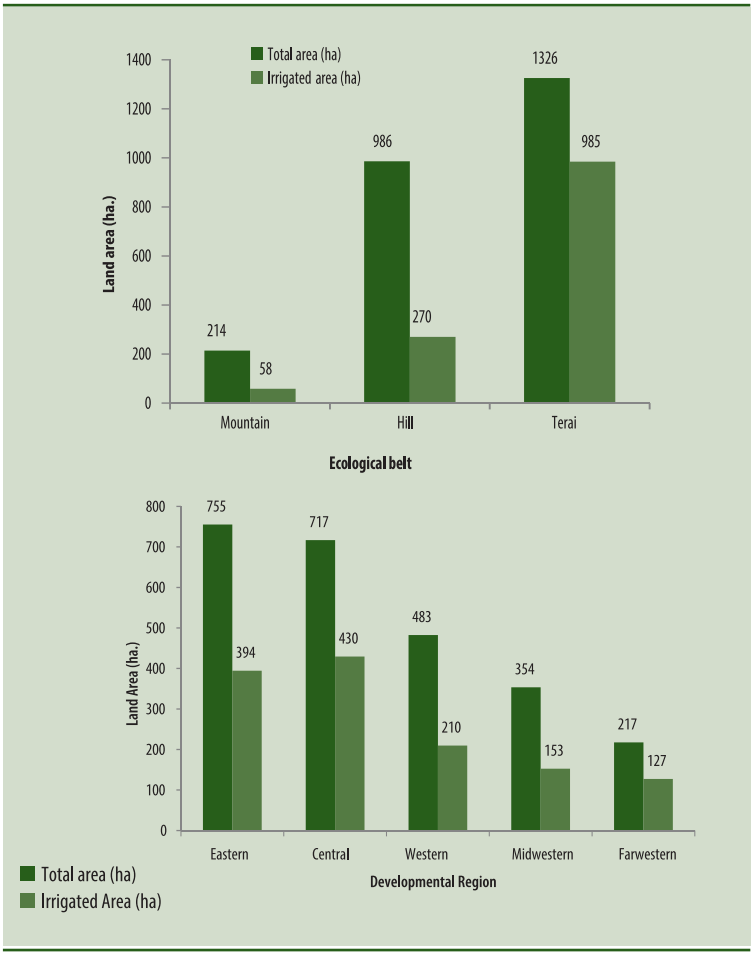


Table 15: Area under Permanent Crops

Permanent Crop	Compact area ('000 in ha.)				
	1981/82	1991/92	2001/02	2011/12	% Increase 2001-2011
Orange	0.60	2.40	3.20	5.96	86.3
Lemon	0.40	0.40	0.62	0.39	-37.0
Lime	0.40	0.20	0.29	0.21	-29.8
Junar	-	-	-	0.20	na
Sweet Oranges	0.10	-	0.23	0.11	-51.2
Other Citrus fruit	0.20	0.40	0.34	0.40	17.3
Mangoes	5.20	15.20	18.48	17.95	-2.9
Bananas	4.00	2.10	3.14	4.90	56.1
Guavas	1.10	0.40	0.48	0.39	-18.8
Jackfruit	1.80	0.60	0.68	0.43	-35.9
Pineapples	0.40	0.20	0.23	0.28	21.6
Lychees	0.10	0.30	0.78	1.38	77.7
Pears	0.20	0.10	0.35	0.25	-29.1
Apples	NA	0.60	1.38	1.71	24.0
Plums / Peach	NA	0.10	0.45	0.15	-65.7
Papayas	0.70	0.10	0.30	0.19	-38.2
Pomegranate	-	0.10	0.09	0.04	-50.2
Coconut	-	-	-	0.09	na
Walnut	-	-	-	0.18	na
Betel Nut	-	-	-	1.78	na
Other fruit	14.00	2.70	1.70	0.67	-60.7
Tea	NA	3.50	6.20	5.19	-16.3
Coffee	-	-	-	0.41	na
Black Caramon	-	-	-	14.28	na
Thatch	NA	66.40	67.60	78.99	16.8
Fodder Tree	NA	2.50	7.30	9.35	28.1
Bamboo	NA	6.00	6.30	7.23	14.8
Multiyear grass crops	-	-	-	2.49	na
Broom Grass (Amrisho)	-	-	-	12.86	na

NA: not applicable
Source: Central Bureau of Statistics (National Censuses of Agriculture) 2011/12

Table 16: Area under Selected Temporary Crops

S.N.	Selected Crops	Crop Area ('000 Ha)			
		1981/82	1991/92	2001/02	2011/12
1	Paddy	1394	3252	3423	1456
2	Wheat	389	633	794	749
3	Maize	523	769	769	674
4	Millet	154	302	251	201
5	Barley	28	46	39	26
6	Buckwheat	11	16	21	13
7	Other Cereals	NA	5	5	4
8	Legumes	335	340	379	298
9	Tubers	86	79	93	111
10	Cash Crops	86	63	61	68
11	Oilseeds	224	260	214	186
12	Spices	58	29	41	44
13	Vegetables	17	40	60	84
14	Temp. Grass Crops	NA	NA	NA	9

Source: Central Bureau of Statistics (National Sample Censuses of Agriculture, Nepal)

Figure 12: Irrigated Land by Source of Irrigation

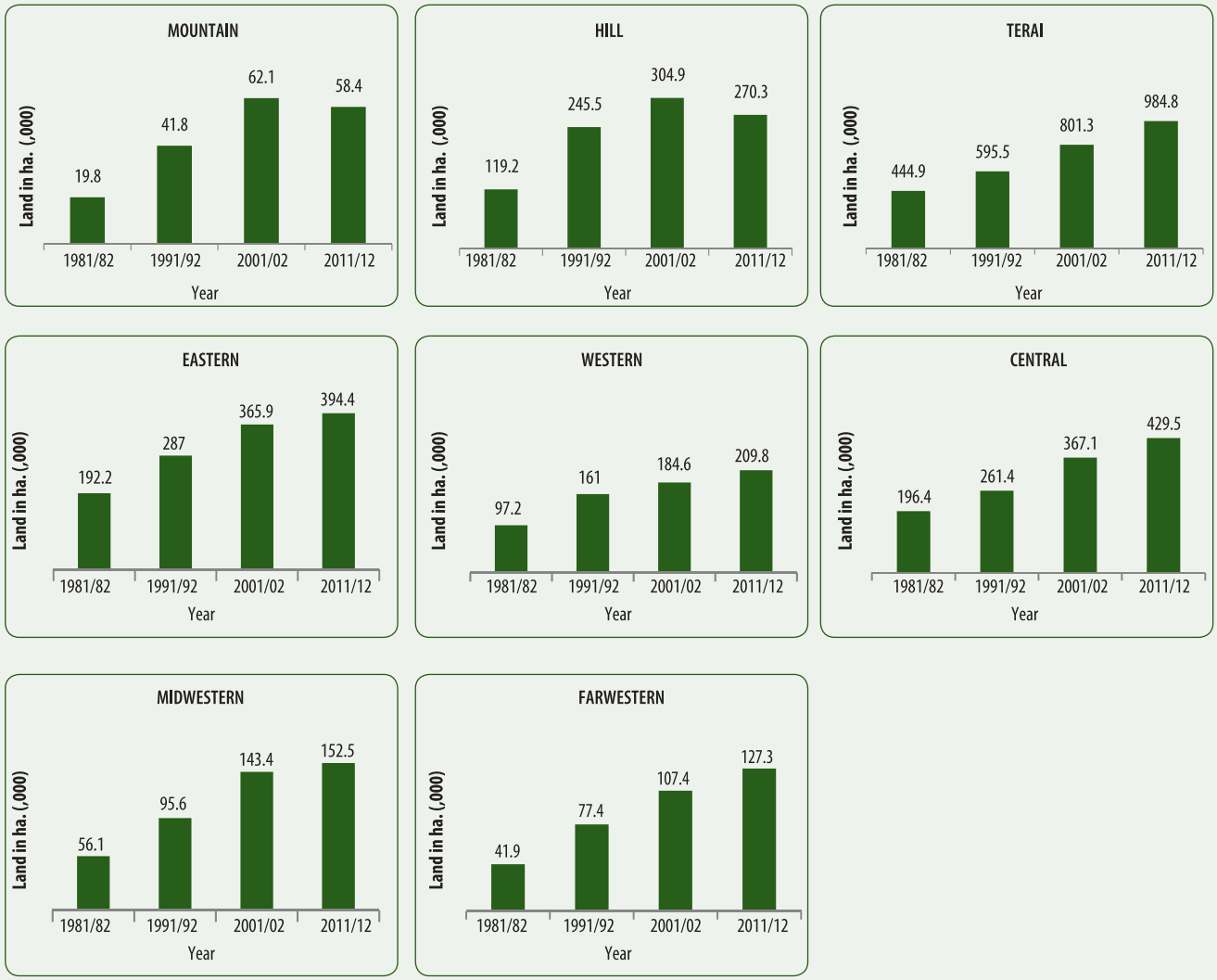


Figure 13: Area under Selected Temporary Crops between 191/82 to 2011/12

groundwater resources with a thick sequences of saturated detrital sediments of alluvial and colluvial origin. Different ecological zone has different types of irrigation system. Terai region has better irrigation system and has covered large percentage of irrigation than mountain and hill (Figure 11). Similarly, the eastern region has large area of land followed by central, western, mid-western and far-western but the ratio is similar in every development region (Figure 12).

The total land area under irrigation has gradually increased proportionally and physically since 1981/82. The irrigated lands are in different development zones. However, the irrigated lands in mountain and hills have been decreasing since 2001/02 (Figure 13). Terai belt has the highest proportion of irrigated land with irrigation relative to the total land irrigation within the belt in 2011/12 at 52.5% compared with the mountain belt of 8.5 % hill belt with 39% of the land by source of irrigation. The well/boring is dominant source of irrigation in the Terai while canal and river/lake/pond are dominant in mountain and hill.

The permanent crop yields have increased slightly in Nepal over the past 30 years. Most of the increases might have been due to development of crop varieties which respond to fertilizers. The production of orange, bananas, pineapples, lichees, fooder trees, bamboo are significantly increased from 2001/02 to 2011/12 whereas Lemon, lime, guvas, jackfruit plums, papayas and tea have decreased significantly with one decade.

The paddy is reduced more than 50% from 2001/02 to 2011/12 followed by millet, barley, buckwheat, legumes, oilseeds whereas turbers, spices and vegetable have been increasing in this decade (Table 16). The decrease in production might be due to rural-urban migration, migration aboard for labor and poor economic returns and climate change. This has created the problems of soil erosion and the destruction and disturbances to wild life habitats.

Table 17: Pesticides Registered in Nepal

		Number of Trade Name						
S.N.	Pesticide	1997*	2002+	2003+	2004+	2009	2010	2013
1	Insecticides	46	207	213	213	210	391	613
2	Herbicides (Weedicides)	9	22	23	23	24	63	120
3	Fungicides	17	71	71	71	62	170	304
4	Acaricides	1	2	2	2	–	–	12
5	Rodenticides		8	8	8	9	7	18
6	Bio- Pesticides	–	–	–	–	13	16	23
7	Bactericides						4	7
8	Molluscicide							1
9	Others	5	2	2	2	8	–	–
	Total	**78**	**312**	**319**	**319**	**326**	**651**	**1098**

*Nepal Gazette vol.47, No. (1997) + updated Registration list of the Pesticide
Source: Pesticide Registration and management section

Table 18: List of Banned Pesticides in Nepal

S.N.	Name of Pesticide	S.N.	Name of Pesticides
1	Chlordane	9	BHC
2	DDT	10	Lindane
3	Dieldrin	11	Phosphamidon
4	Endrin	12	Orano mercury fungicides
5	Aldrin	13	Methyl parathion
6	Heptachlor	14	Monocrotophos
7	Toxafen	15	Endosulphan*
8	Mirex		

Persistent Organic Pollutant; Deregistered in 2069/7/20, grace period sell and use till 2071/7/19 B.S;
Source: Pesticide Registration and Management section

Pesticides and Fertilizer

The uses of chemical fertilizers in the cultivation pattern and the users of pesticides by crop growers have been started since 1981/82. People are using different kinds of pesticides in their farming system. There are nine pesticides registered namely; insecticides, herbicides, fungicides, acaricides, rodonticides, bio-presticides, bactericides, molluscicide and others and the number is increasing day by day (Table 17).

There is a regulatory infrastructure established for the management of pesticides in Nepal. It covers all handling and using aspects of pesticides. No pesticide may be imported into the country without the appropriate certificate of importation issued by registration

Table 19: Pesticide Imported and Formulated in Nepal, 2006-2012

S.N.	Kinds of Pesticide	Quantity of Pesticides Imported																					
		2004			2005			2006/07			2007/08			2008/09			2009/10			2010/11			2011/12		
		Formulations		Total Active Ingredients (kg.)	Formulations		Total Active Ingredients (kg.)	Formulations		Total Active Ingredients (kg.)	Formulations		Total Active Ingredients (kg.)	Formulations		Total Active Ingredients (kg.)	Formulations		Total Active Ingredients (kg.)	Formulation		Total Active Ingredients (kg.)	Formulation		Total Active Ingredients (kg.)
		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)		Liquid (Ltr.)	Solid (kg.)	
1	Insecticides	55827	186754	43994	92948	180164	65113.57	85649	99460	46553.25	94234	165768	60282.42	99095.4	179051	105814.6	132278	181192	61615.8	220632	308343	96115.325	221059	326074	114717.714
1.1	Organochlorine	9922	0	2473	8846	0	3096	23470	0	8214.5	31560	0	11046	32582.6	0	11403.9	31485	0	11019.8	40059	280	14031.85	29820	0	10437
1.2	Orga-no-phospates	3354	134880	26912	40060	90270	25401	32654	70200	24682.6	15905	94749	17709.05	16415.5	95745	65838.2	42884	10765	23280.3	71925	17595	40148.42	96603	39360	60497.48
1.3	Carbamates	25	450	183.24	20	2550	1007.9	36	2780	115.4	25	7545	321.05	205.6	7654	1100.34	650	31363	1344.15	669	48233	2127.95	971.5	85800	2847.97
1.4	Synthetic Pyrethroids	33440	13727	3146.8	39083	76310	31050	22269	6626	2640.43	21852	20063	4592.66	22581.8	19941	7228.88	40634	19600	5255.65	72498	15300	9313.615	50000	3137.7	6101.7771
1.5	Botanical products	1680	0	16.8	420	0	4.2	2875	0	4.31	1430	0	2.15	0	0	0	0	0	0	0	0	0	0	0	0
1.6	Mixed Insecticides	3380	180	1235	3259	0	1147	4155	200	2290.35	10593	200	3625.25	13529.9	1276	6736.68	13760	0	7284.3	32053	450	16463.24	35515	130	18069.04
1.7	Others	4026	37517	10027	1260	11034	3407.47	190	19654	8605.66	12870	43211	22986.26	13780	54435	13506.6	2865	119464	13431.6	3428	226485	14030.25	8150	197646	16764.447
2	Herbicides	4480	11000	6386.4	11240	15850	11030	11470	0	5701.7	12523	7308	6574.05	20195.2	11956	11124.3	37452	5111	15683.1	88160	20738	46696	108478	7871.2	53476.66
3	Fungicides	1015	148817	97036	210	73290	47702	4970	103848	74368.45	5900	326005	237372.2	86874.5	324018	203392	5575	176790	129567	4590	258016	183893.02	6536	226901	166815.43
4	Rodenticides	0	3152	1135	0	4048	1457	0	2260	1808	70503	43600	37297.75	0	38617.2	31086.9	0	3085	2468	0	8310	5528.07	0	24360	8183.1066
5	Bio-Pesticides	7.2	422	4.29	0	3040	30.4	0	3850	57.58	0	3810	57.12	129.8	4293.81	30.08	2099	5134	82.08	2997	4229	78.26	7230	9823	121.687
6	Acaricides	1516	0	864.12	418	0	77.33	1290	0	238.65	5612	0	2458.06	5511	0	2080.4	220	0	38	3170	0	1085.25	7910	0	1424.1
7	Bactericides	400	0	12	0	460	13.8	0	0	0	250	0	750	45.9	20.49	6.64	0	250	25	0	16	1.6	0	0	0
8	Others	19588	4897	3244.2	0	18633	2469	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	120
Agricultural Pesticides		**82833**	**355042**	**152676**	**104816**	**295485**	**127893.1**	**103379**	**209418**	**128727.63**	**189022**	**546490**	**344791.6**	**211852**	**557957**	**353534.92**	**177624**	**371562**	**209478.98**	**319549**	**599652**	**333397.53**	**351213**	**597029**	**344858.698**
Pesticides used in Public Health		**0**	**28125**	**1406.3**	**0**	**66000**	**3377.33**	**0**	**25568**	**2556.8**	**0**	**27030**	**2703**	**0**	**28110**	**2811**	**0**	**32000**	**1600**	**0**	**45520**	**2276**	**995**	**1100**	**174**
Grand Total		**82833**	**383167**	**154082**	**104816**	**361485**	**131270.43**	**103379**	**234986**	**131284.43**	**189022**	**573520**	**347494.6**	**211852**	**586067**	**356345.92**	**177624**	**403562**	**211078.98**	**319549**	**645172**	**335673.53**	**352208**	**598129**	**345032.698**

Source: Pesticide Registration and Management section

Table 20: Chemical Fertilizer Use in Nepal, 1990/00 to 2012/2013

Year	Government Sector				Private Sector	Total Fertilizer	Nutrient mt / Cultivated Land ha*100
	Urea	DAP	Potash	Complex			
1999/00	43508	26154	308		76727	146697	4.75
2000/01	29528	15633	58		101145	146364	4.74
2001/02	17697	20645	1016		101140	140498	4.55
2002/03	34449	33331	2966		103636	174382	5.64
2003/04	7428	11377	1688		118265	138758	4.49
2004/05	10043	19436	2332		90895	122706	3.97
2005/06	1960	10857	478		78258	91553	2.96
2006/07	14985	7437	NA		65679	88101	2.85
1999/00	43508	26154	308		76727	146697	4.75
2000/01	29528	15633	58		101145	146364	4.74
2001/02	17697	20645	1016		101140	140498	4.55
2002/03	34449	33331	2966		103636	174382	5.64
2003/04	7428	11377	1688		118265	138758	4.49
2004/05	10043	19436	2332		90895	122706	3.97
2005/06	1960	10857	478		78258	91553	2.96
2006/07	14985	7437	–	2747	65679	90848	2.94
2007/08	2500	1990	–	2156	47107	53753	1.74
2008/09	5935	–	–	1198	5677	12810	0.41
2009/10	5049	2523	236	2521	NA	–	–
2010/11	85190	22001	2821	–	NA	–	–
2011/12	91500	20000	–	–	NA	–	–
2012/13	140000	40000	5000	–	NA	–	–

Note: The cultivated land (3090780) based on Department of Forest Research and Survey, 2001.
Source: Ministry of Agriculture and Cooperatives and Agriculture Inputs Company Ltd.

Table 21: Farm Population 1991/92-2011/12

Discription	Census year		
	1991/92	2001/02	2011/12
Total household*****	3328721	4253220	5427302
Total holding	2736050	3364139	3831093
Percentage of holding	82	79.1	70.6
Total Population***			
Male	9220974	11563921	12849041
Female	9270123	11587502	13645463
Total	18491097	23151423	26494504
Sex ratio	99.5	99.8	94.2
Farm population			
Male	8496843	10267646	10317681
Female	7761377	9544003	10234862
Total	16258220	19811649	20552543
Percentage of the total population			
Male	52.3	51.8	50.2
Female	47.7	48.2	49.8
Total	**87.9**	**85.6**	**77.6**
Sex ratio of farm population	109.5	107.6	100.8
Average size of farm household	5.9	5.9	5.4

*****Population census
Source: CBS

authority. Nepal government has banned the following pesticides in the country (Table 18).

The total active pesticides ingredients imported and formulated between 2006 to 2012 have been drastically increased from 128727.63 kgs to 344858.7 kgs. Which is 38% increase of the original pesticides (Table 19).

There has been an increasing trend of usage of chemical fertilizers in the cultivation of important crops in Nepal since 80's. Chemical fertilizers are distributing by both from governmental and private sectors. Urea, DAP, Potash and complex are distributed by the government.

Conclusion and Recommendation

Land use planning and management is a major challenge in a country like Nepal where land resource management priorities, action plans and policies are scattered in different ministries and institutions. Information flow is often irregular and ad hoc. Systematic and integrated land management and soil fertility management policies should be simplified and harmonized. The agricultural practices are changing day by day and therefore, the government should consider the specific problems of rainfed agriculture and sustainable use of fragmented land to overcome the food scarcity and climate change. Land use planning should be based on international standard and the human resources should be strengthened through different programs. The government should allocate budget for such kinds of activities. Policy and plans should be developed in a co-ordinated way involving all the concern stakeholders.

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Water

Narayan P. Chaulagain, Ph.D.*

Water is essential for all living beings in the world. Out of the total water available in the earth, only about 3% is fresh water and the rest 97% is stored in the seas and ocean as saline water. Nepal has more than 6000 rivers flowing from mountains to hills and plains. The rivers of Nepal are typically classified into three types depending on their source and discharge. The first one is the large river which originates from Himalayas. It consists of snowmelt component and maintain significant reliable dry season flows. The second category of river is medium type which originates in the midlands or the Mahabharat range. The third type of rivers originates from Siwalik range. These rivers are seasonal with little or no flow during the dry season, and cannot be used for year-round irrigation or hydropower generation without surface storage. There are around 5,000 lakes; 1,380 reservoirs; and 5,183 village ponds in Nepal. Likewise, there are about 3,808 glaciers with a total area of 4,212 sq km and 1466 glacial lakes with an area of 64.75 sq km in Nepal. About 20 glacial lakes have been identified as dangerous ones with the potential risk of glacial lake outburst floods. Uneven distribution of water spatially and seasonally; growing demand of water due to population growth, urbanization, migration and increased living standards; poorly planned physical infrastructures causing disruption to the sources of water as well as to the water course; lack of integrated water resources management policies and practices; lack of coordination among the institutions involved in different sub-sectors of water; lack of proper institutional and regulatory framework for sustainable and integrated water resources development in Nepal are some of the issues prevalent in the water resources sector of Nepal. Besides, climate change has created an additional but new set of issues and challenges for all the sub-sectors of water resources like hydropower, irrigation, drinking water supply, sanitation, water related industries, fisheries and tourism. The majority of the glaciers in the Himalayan region of Nepal are retreating so rapidly that even without any further warming; most of them may disappear by the end of this century. This may result in decreased melt-water contribution to total water availability, particularly during dry seasons. The hydropower and irrigation sector, which are already under stress during non-monsoon seasons, might be badly affected.

Introduction

Water is essential for all living creatures including for human being. It is estimated that around 1.4 billion cubic kilometres of water is available in the world in different forms and places (Subba, 2001). Out of the total water available in the earth only about 3% is freshwater and the rest 97% is stored in the seas and ocean as saline water. Apart from the fresh water, saline water is generally not suitable for municipal (i.e. drinking, washing etc.), agricultural and industrial use without proper treatment. Out of the available freshwater, about 68.7% is stored in icecaps and glaciers, about 30.1% as ground water, 0.3% as surface water and 0.9% in other forms. The surface water is largely available in lakes (87%), and in swamps (11%). Only about 2% of the available surface water is found in rivers. These figures tell us how little percentage of the global water is readily available for us to use compared to the total available global water resources (Table 1)

Nepal has more than 6000 rivers flowing from mountains to hills and plains. Nepal's rivers are typically classified into three types depending on their source and discharge. The first ones are the large rivers which originate in the Himalayas, they consist of snowmelt component and maintain significant reliable dry season flows. Depending upon the source and discharge, the large rivers originating from the Himalayas, which maintain their flow even during the dry seasons, consist of snowmelt component are the first type. Such as Mahakali, Karnali, Gandaki and Kosi Rivers. These rivers are perennial and offer promising water sources for irrigation and hydropower development even during the lean period (WECS, 2011). The medium types which originate in the midlands or the Mahabharat range belong to the second category. Babai, West Rapti, Bagmati, Kamala, Kankai and Mechi Rivers belong to this type, which are fed by precipitation as well as groundwater regeneration including springs. Though these rivers are perennial in nature, they are commonly characterized by a wide seasonal fluctuation in discharge. The seasonal rivers that originate from the Siwalik range fall in the third category. As there is little or no flow during the dry season, these rivers cannot be used for year-round irrigation or hydropower generation without surface storage (WECS, 2011). The rivers of Nepal are generally characterized by a wide seasonal fluctuation of flows with the monthly flows generally reaching their maximum in July-August and declining to their minimum in February-March. The rivers with smaller catchment area generally have wider flow fluctuations around the year.

Table 1: Estimated Global Water Distribution

Water source	Water volume, in cubic kilometers	Percentage of freshwater, %	Percentage of total water, %
Oceans, Seas, & Bays	1,338,000,000	--	96.5
Ice caps, Glaciers, & Permanent Snow	24,064,000	68.7	1.74
Ground water	23,400,000	--	1.69
Fresh	10,530,000	30.1	0.76
Saline	12,870,000	--	0.93
Soil Moisture	16,500	0.05	0.001
Ground Ice & Permafrost	300,000	0.86	0.022
Lakes	176,400	--	0.013
Fresh	91,000	0.26	0.007
Saline	85,400	--	0.006
Atmosphere	12,900	0.04	0.001
Swamp Water	11,470	0.03	0.0008
Rivers	2,120	0.006	0.0002
Biological Water	1,120	0.003	0.0001

Source: Shikhlomanov, 1993

Government Policy of the Sector related with Environment

The policiy/ies, acts, rules and regulations play an important role in determining the development, ownership and management mechanism of available water resources; as well as in framing the social, economic and institutional aspects of water governance and development. The provisions for the institutional arrangements and the limitations on the water sector affect how water resources are used, developed and managed. Nepal at this moment does not have a single institution or ministry dealing with the entire water resources. The different sub-sectors of water resources are being dealt with by various agencies under different ministries, e.g. irrigation sector under the Ministry of Irrigation; hydropower sector (generally large hydro) under the Ministry of Energy; micro hydropower sector under the Ministry of Science, Technology and Environment; drinking water supply sector under the Ministry of Urban Development, the Ministry of Federal Affairs and Local Development etc. Therefore, due to the fragmented mandates under different ministries, agencies and departments; the coordination and cooperation for integrated water resources management and development has become a serious bottleneck for Nepal.

Water Resource Act 1992 (2049 BS) is the umbrella Act governing water resource management. It declares the order of priority of water use (drinking, irrigation, water related enterprises and hydropower); vests the state ownership of water; provides basis for the formation of water user associations; and establishes a system of licensing and prohibits water pollution. Likewise, Water Resource Regulation 1993 (2050 BS) is the umbrella Regulation governing water resource management formed based on the Water Resources Act 1992.

The regulation sets out the procedure to register a Water User Associations and to obtain a license; establishes the District Water Resource Committee; sets out the rights and obligations of Water User Associations and license holders; and deals with the land acquisition and compensation issues.

Water Resources Strategy 2002 (WRS) has its goal of meeting water supply needs and achieving long-term sustainability. This strategy provides a systematic framework for the development of water resources and identifies action plans to avoid and resolve conflicts, and to achieve water-related development objectives for Nepal (WECS, 2002). National Water Plan 2005 (NWP) recognizes the broad objectives of the WRS and lays down short- medium- and long-term action plans for the water resources sector, including investments and human resource development. The NWP attempts to address environmental concerns, which is reflected by the incorporation of the Environmental Management Plan in the document. This Environmental Management Plan will contribute to maximizing positive impact and minimizing or mitigating adverse impacts in line with the environment sustainability concerns (WECS, 2005).

Environment Protection Act 1996 (2053 BS) and Environment Protection Regulation 1997(2054 BS) require certain persons or bodies to conduct an environmental impact assessment or initial environmental examination of water resources projects; deals with the prevention and control of water pollution; and list the water related projects required to conduct an Environmental Impact Assessment (EIA) or Initial Environmental Examination (IEE).

Local Self Governance Act 1999 (2055 BS) and Local Self Governance Regulation 1999 (2055 BS) have established a decentralised governance structure. They set out the powers, functions and duties of the village development committee (VDC), municipality and district development committee (DDC) in relation to water and sanitation, set out which natural resources are assets of local bodies and empower local bodies to levy a natural resource tax; and establish the procedure for the formulation of water related plan and project implementation.

Policies related to Drinking Water

Nepal Water Supply Corporation Act 1989 (2046 BS) establishes the Nepal Water Supply Corporation as the perpetual, autonomous government controlled corporation responsible for the supply of drinking water; and prohibits certain acts and provides penalties/punishment for violation of the Act. Drinking Water Regulation 1998 (2055 BS) regulates the use of drinking water; provides the basis for the formation of Drinking Water User Associations and sets out the procedure for registration; deals with licensing related to drinking water; deals with the control of water pollution and maintenance of quality standards for drinking water; sets out the conditions of service utilization by consumers; and provides provision for the acquisition of house and land, and compensation.

Polices related to Irrigation

Irrigation Regulation 2000 (2056 BS) deals with Irrigation Water User Associations and the transfer of projects to Irrigation. Water User Associations provides a mechanism for the joint management system by the government and Irrigation Water User Association. It deals with the Irrigation and River Control Committee sets out the conditions of service utilisation sets out the obligations of user for the irrigation and provides provision for service charges; and deals with the protection, repair and maintenance of irrigation systems.

Policies related to Hydropower

Hydropower Development Policy 1992 and 2001 facilitates the supply of electricity as per the demands of the people in urban and rural areas through the development of the high potentiality of the water resources that exists in the country; encourages the development of hydropower to meet the energy required for the industrial development in the country; and motivates the national and foreign private sector investment for the development of hydropower. The objectives

of Hydropower Development Policy 2001 are to generate electricity at low cost by utilizing the water resources available in the country; to extend reliable and qualitative electric service throughout the country at a reasonable price; to tie-up electrification with the economic activities; to render support to the development of rural economy by extending the rural electrification; and to develop hydropower as an exportable commodity (MoWR, 2001).

Water Resources Strategy 2002 provides a systematic framework for hydropower development and identifying action plans to avoid and resolve conflicts, and achieve the hydropower-related development objectives of Nepal for meeting its hydropower needs and achieving long-term sustainability (WECS, 2002). National Water Plan 2005 (NWP) recognizes the broad objectives of the WRS related to hydropower development and lays down short-, medium- and long-term action plans for the hydropower sector, including investments and human resources development (WECS, 2005). Electricity Act 1992 (2049 BS) and Electricity Regulation 1993 (2050 BS) govern the use of water for hydropower production; establish a system of licensing; set out the powers, functions and duties of a licence holder; provide certain financial incentives for licence holders; and set out the powers of the government.

Thirteenth Three Year Plan (2013-2016) on Water Sector

The ongoing Thirteenth Three Year Plan (2013-2016) has defined its long-term vision as to upgrade Nepal from a least developed to a developing country by 2022; its objective as to bring a direct positive change in the living standards of the general public by reducing the economic and human poverty prevalent in the nation; and its main goal is to reduce the proportion of the population living below the poverty line to 18 percent (NPC, 2014). Increase access to drinking water from 85% to 96.25%; access to sanitation from 62% to 90.5%; grid connected electricity generation from 758 MW to 1426 MW; access to electricity from 67.3% to 87%; irrigation facilities from 1.3 million ha to 1.5 million ha of irrigable land. The Plan has the following objectives related to water sector for the set period:

- To provide the basic services of drinking water and sanitation facilities to all population
- To increase access to reliable and quality electricity service to general public by encouraging the hydropower generation
- To emphasize the promotion and development of micro hydropower in the areas not yet connected with central grid of electricity as well as to reduce the dependency of traditional and imported energy
- To assist the development of agricultural sector by multipurpose and sustainable development of irrigation sector through appropriate use of water resources available in the country

Water Resources in Nepal: Data and Information

General Information on Water Resources of Nepal

There are more than 6000 rivers in Nepal. There are 33 rivers having their drainage areas exceeding 1000 sq km (WECS, 2011).Total drainage area of all the rivers in Nepal is about 194,471 sq km out which 147,181 sq km lies in Nepal and rest in China and India. The annual average discharge of the Nepalese rivers is about 7124 cubic metre per second including the total basin area and about 5479 cubic metre per second excluding the area outside Nepal (CBS, 2013).

Rivers and Lakes in Nepal

Rivers of Nepal can be broadly classified into three types, in accordance to their origins. The first category comprises of the four major river systems of the country, namely Koshi, Gandaki, Karnali and Mahakali originating from glaciers and snow-fed lakes. These rivers are perennial and have good potential for irrigation and hydropower development. The medium sized rivers, which originate from the mid-hills or the Mahabharat range, such as Babai, West Rapti, Bagmati, Kamala, Kankai and Mechi belong to the second type. These riv-

ers are fed by precipitation as well as groundwater regeneration (including springs). Though these rivers are perennial in nature, they are commonly characterized by a wider seasonal variation in flows. Besides the large and medium categories of the rivers, there are also a large number of small rivers in Nepal, mostly in the Terai, which generally originate in the Siwalik range and are seasonal with little or no flow during the dry season making them unsuitable for year-round irrigation or hydropower generation without seasonal storage. The rivers of this category cause flash floods during monsoon rains and remain with very little or no flow during the dry season.The surface water available in the country is estimated to be about 225 billion cubic metres per annum, equivalent to an average flow of 7,124 cubic metres per second (m^3/s) (Table 2).

Physiographic characteristics and climatic factors affect the distribution of river flows spatially and seasonally (CBS, 1998). The amount of available water resources has been unevenly distributed in space and time in Nepal. About 78% of the average flow in Nepal is available in four major river basins, 9 % in the medium basins and 13% in the smaller southern rivers of the Terai. The southern slopes of the Mahabharat range, the Himalayan range and the eastern two-third of Nepal receive the highest amount of precipitation and there is relatively higher contribution of flows of the rivers within the catchments of these areas. About 74 % of the total annual surface flow occurs in four months of June – September (WECS, 2011).

There are around 5,000 lakes; 1,380 reservoirs; and 5,183 village ponds in Nepal. Likewise, there are 163 wetlands in the Terai, and 79 in the hills and mountains (NTNC, 2009). There are about 132 lakes with the individual surface area of more than 10 sq km covering a total area of about 80 sq km (JVS/GWP Nepal, 2014). There are 12 major lakes in Nepal with a total area of 34 sq km (Table 3).

A glacial lake is defined as a water body with a sufficient amount of water and extending with a free surface in, under, beside and/or in front of a glacier. It is originated by glacier activities and/or retreating processes of a glacier. All lakes in contact with or near a glacier, or formed by recent glacial morphological activities are referred to as glacial lakes (Mool et. al, 2001). Generally, the area higher than 5,000 metres above sea level (masl) in Nepal Himalayas is mostly covered by snow and ice throughout the year. The glaciers and glacial lakes are the sources of the headwaters of many great rivers in Nepal. Most of the glacial lakes are located in the down valleys close to the glaciers. They are formed by the accumulation of large amount of water from the melting of snow

Table 2: River Water Runoff from Nepal

S.N.	River	Length (km)	Drainage Area (sq km)		Estimated Runoff (m3/sec)	
			Total	Nepal	From all Basins	From Nepal
1	Mahakali	223	15260	5410	698	247
2	Karnali	507	44000	41890	1441	1371
3	Babai	190	3400	3400	103	103
4	West Rapti	257	6500	6500	224	224
5	Narayani	332	34960	28090	1753	1409
6	Bagmati	163	3700	3700	178	178
7	SaptaKoshi	513	60400	31940	1658	878
8	Kankai	108	1330	1330	68	68
9	Other rivers		24921	24921	1001	1001
Total			**194471**	**147181**	**7124**	**5479**

Source: CBS, 2013

Table 3: Major Lakes in Nepal

Name	Elevation, masl	Area, sq km	Max depth, m	Volume, 106 m3
Rara	3060	8.00	167	
Phewa	742	4.10	20	30.5
Phoksundo	3620	4.94	145	409.0
Begnas	650	3.28	10	29.0
Jagadishpur	197	2.25	-	-
Gosaikunda	4397	0.12	18	0.8
Ghodaghodi	205	0.59	-	-
Gajedi		4.50	-	-
Gokyo	4700	0.43	43	-
Rupa		1.35	6	3.3
Maipokhari	1910	0.90	-	-
Tilicho	4917	3.54	-	-

Source: modified after JVS/GWP Nepal, 2014

and ice cover and by blockage of end-moraines at the glacier terminus due to the recent retreating processes of glaciers. The sudden break of a moraine may discharge the large volumes of water and debris causing devastating floods commonly known as glacial lake outburst floods (GLOF).

Mool et al (2001) had earlier reported that there were about 3252 glaciers with a surface area of 5324 sq km and an ice reserve of 481.32 cu. km in Nepal. Similarly, there were 2323 glacial lakes a total surface area 75.64 sq km based on the same inventory (Table 4). Recent study carried out in 2009 has revealed that there are 1466 glacial lakes with an area of 64.75 sq km in Nepal (Ives et al., 2010). The level of risks of GLOF of these glacial lakes was defined critical, if they have large lake size and rapid growth in area; if there is an increase in lake-water level; if there is an activity of supra-glacial lakes at different times. The position of the lakes in relation to moraines and associated glacier; supporting dam condition; glacier condition; and physical conditions of surroundings also define the GLOF risk level of the glacial lakes. Based on these criteria, 20 glacial lakes are considered as potentially dangerous of GLOF (Table 4)

Some glacial lakes in Nepal have been relatively known and better studied because of their potential threats of GLOF, past GLOF records or some other reasons, e.g. Lower Barun, Imja, Tsho Rolpa, Thulagi, Dig Tsho, Tam Pokhari etc. (Table 5)

Table 4: Summary of Glaciers, Glacial Lakes, and Lakes identified as Potentially Dangerous in Nepal

River basin	Glaciers			Glacial Lakes		
	Number	Area (sq. km)	Ice reserves (cu. km)	Number	Area (sq. km)	Potentially dangerous
Koshi River	779	1410	152.06	1062	25.09	16
Gandaki River	1025	2030	191.39	338	12.5	4
Karnali River	1361	1740	127.81	907	37.67	0
Mahakali River	87	143	10.06	16	0.38	0
Total	**3252**	**5324**	**481.32**	**2323**	**75.64**	**20**

Source: after Mool et al, 2001

Table 5: Famous Glacial Lakes in Nepal Himalayas

Description	Lower Barun	Imja	Tsho Rolpa	Thulagi	Dig Thso	Tam Pokhari
Latitude	27° 48′N	27° 59′N	27° 50′N	28 ° 30′N	27° 52′N	27° 44′N
Longitude	87 ° 07′E	86 ° 56′E	86 ° 28′E	84 ° 30′E	86 ° 35′E	86 ° 15′E
Altitude (m)	4570	5000	4580	4146	4365	4432
Depth (m)						
Average	50	47	55.1	41.8	20	45
Maximum	118	99	131	81		
Length (km)	1.25	1.3	3.2	2	1.21	1.15
Width (km)	0.6	0.5	0.5	0.45	0.44	0.5
Area (sq. km)	0.78	0.6	1.39	0.76	0.5	0.47
Average water (106 x m3)	28	28	76.6	31.8	10	21.25
Approximate age (year)	35	45	45	45	50	45

Source: ICIMOD, 2007

Ground Water Potential in Nepal

The groundwater of Nepal is being used for domestic, industrial and irrigation purposes. The hydro-geological mapping indicates that the Terai region has a good potential of groundwater resources. The Terai, with a thick layer of saturated sediments of alluvial origin, is one of the most productive aquifers in the South Asian sub-continent (UNEP, 2001). The erosion of the Siwalik hills and the outwash fans of rivers form the northernmost Bhabar region. The aquifers consisting of coarse sediments materials are unconfined and have a very high permeability in the range of 100-150 metre per day (m/d). The Chure/Bhabar region is considered as the main source of recharge for the Terai groundwater. Groundwater recharge at some specific areas is estimated to be as high as 600 mm per annum; however, on an average 450 mm can be considered as a recoverable recharge figure for all of the Terai area. Inner Terai areas such as Chitwan, Dang and Surkhet are also considered as regions with good groundwater potential. The groundwater of the Kathmandu Valley is under immense pressure as it is being heavily used for drinking as well as for other activities, resulting in a decline of its water level (WECS, 2005).

It is estimated that the Terai region has a groundwater recharge potential of about 6.5 billion cubic m in the Terai and about 3.1 billion cubic m in Chure /Bhavar making a total of 9.6 billion

cubic m (JVS/GWP Nepal, 2014). About 0.8 billion cubic m of groundwater is annually being used for irrigation / industrial purpose and about 0.3 billion cubic m of groundwater is being used for drinking purpose. With this, the current average groundwater withdrawal is about 1.1 billion cubic m per year. The aquifers in the Terai and Bhavar region, which consist of sediments of alluvial origin, are very much appropriate for water accumulation beneath the surface area (UNEP, 2001).

Water Utilization in Nepal

The requirements for water in Nepal do not vary much from those in other countries. However, the amount and type of water-use may vary according to the level of economic development, living standards of the people, industrial activities, climate, religious/traditional practices etc. Generally, water is being used for drinking and personal hygiene, agriculture, religious activities, industrial production, hydropower generation, and recreational activities such as navigating, rafting, swimming, and fishing. Over the time, the requirements for water in Nepal in these activities have increased due to population growth, industrial/economic developments, urbanisation and improved living standards. There is an intense pressure on the water resources being used in Nepal due to the limited availability of water in time and space with respect to demand. Urbanisation caused by natural growth and migration is another factor that has put additional pressure not only on water supply but also on management of municipal solid waste and industrial effluents (UNEP, 2001). With increase in additional pressure on water supply, the total annual withdrawal of water is also increasing in order to meet the additional requirements. The ADB/ICIMOD (2006) has reported that the total annual withdrawal has increased from 14.0 cubic km in 1995 to 18.5 cubic km in 2001, whereas the total available renewable annual water resource in Nepal is 224 cubic km.

Irrigation

Irrigation is a fundamental infrastructure for agricultural development of Nepal. So far, the agricultural sector is largely dependent on the monsoon rains due to lack of adequate modern irrigation facilities. Agriculture is the largest consumer of water use in Nepal, which uses about 96% of the total annual water use (ADB/ICIMOD, 2006). Nepal has about 2.6 million ha (18% of total area of Nepal) of cultivable area and about 1.8 million ha (12% of total area of Nepal and 67% of cultivable area) of the land has potential for irrigation (NPC, 2014). As of June 2014, about 1.3 million ha (76% of the potential) of Nepal's agricultural land has been irrigated but only about 36% of which (i.e. 0.8 million ha) has the year round irrigation services, out of which 0.5 million ha through surface irrigation schemes and 0.3 million ha through groundwater schemes (JVS/GWP Nepal, 2014).

Irrigation is the largest water use sub-sector affecting the life of many people involved in agriculture. Irrigation has been given due importance in annual plans/programmes and five year national development plans. Given the importance of irrigation and large investments already made and planned for the future, the effectiveness of water delivery and its ultimate sustainability are of major concern. In the future, it is necessary to increase the irrigated area by constructing new schemes and at the same time to increase the efficiency, coverage area, cropping intensity as well as recovery of operation and maintenance costs of the existing irrigation schemes. Two types of activities would be needed to continue side by side for irrigation development, firstly modernization of the already constructed irrigation schemes and secondly construction of new schemes to provide irrigation to more agricultural sectors. Most of the schemes in Nepal are supply oriented with main objective of distributing irrigation water to the maximum number of farmers. The design capacity of the canals is not enough for intensive irrigation. There has been a tendency to overestimate the available water in the source and to include more command area due to the social pressure. The problem is further augmented by seepage losses and reduced canal capacity due to sedimentation.

Drinking Water

The urban population in Nepal is growing faster

than the overall population. Both the percentage of population being served by drinking water connections and the total connections are increasing. With an increase in population, the total water demand per year has also increased. Nevertheless, the per capita consumption of piped water of municipal drinking water system has decreased because of scarcity of water in supply system. This has put a pressure on groundwater extraction, especially in Kathmandu Valley. Another striking feature of the drinking water supply system in the urban areas of Nepal is the large percentage of unaccounted water as 'leakage', which accounts for about 40% of the total supply (UNEP, 2001). Water supply system seems to be one of the most critical sectors having very serious issues in Nepal. As of June 2013, about 86% of the population had access to basic services of drinking water supply and about 11% of country's population had access to safe drinking water supply services. Likewise, about 62% of the population had access to basic sanitary services as of June 2013 (NPC, 2014).

Hydropower

The estimated theoretical hydropower potential of Nepal is 83,000 MW, out of which 114 projects with a combined capacity of 45,610 MW have been identified as economically feasible ones. The Integrated Nepal Power System (INPS) is primarily managed by the Nepal ElectricityAuthority (NEA). At present, the NEA has a total installed electricity generation capacityof about 746 MW (MoF, 2014). Besides, there are hundreds of mini and micro hydropower plants as well as improved water mills in the hills and mountains of Nepal, which are providing electricity and mechanical power of about 26 MW for lighting, small enterprises and agro processing to the households in isolated mountains, valleys and hills yet-to-be connected to the national electricity grid system (NPC, 2013).

Industrial Use, Tourism, Fisheries and Navigational Uses

In the present context, growing use of water in hotel, carpet, brick, agro-based and other large water-consuming industries as well as the increased wastewater produced by these industries is a big concern. Water supply needs should be guaranteed for sustained industrial growth. Big industries depend largely on groundwater extraction through deep tube wells and such water-use needs to be regulated through licensing and effectively monitored. The industrial wastes and waste-water need to be properly treated before discharging them into waterbodies. Establishment of bottling plants for spring water from pristine mountain springs for export as well as domestic uses needs to be expanded and encouraged by providing a legal base and proper incentives. Himalayan spring water has exotic value and Nepal should take advantage of it.

Water has significant religious and cultural value. Important religious and cultural sites are located next to water bodies like rivers or lakes. Hence, these water bodies should be protected and maintained in good condition, which will not only respect the sentiments of local residents but also encourage tourism in the form of pilgrimage and at the same time protect the religious and cultural values of the country. Water tourism in the form of white water rafting and kayaking is attracting domestic as well as foreign enthusiasts. The Himalayan rivers are becoming popular for such adventure tourism and provide employment for many private companies and individuals through white water rafting. There are several rivers that are popular for white-water rafting and kayaking such as Bhote Koshi, Trishuli, Marsyangdi, Kaligandaki and Karnali. The total number of white water rafting and kayaking tourists at present is estimated at 40,000 annually and is expected to grow (WECS, 2005). While developing water projects, due consideration should be given to avoid adverse effects on water tourism.

Commercial fishery has a great potential in Nepal, as the potential area of fishing covers an area of around 800,000 ha at present in the form of rivers, lakes, reservoirs, marginal swamps, irrigated paddy fields and ponds. Though small-time fishing by traditional fishermen is an age-old tradition, fish culture was popularized by the government with foreign assistance only after planned interventions in the early1980s (WECS, 2005). The per capita production of fish was below 100 grams (gm) before the Government's intervention, and reached over1,400 gm in 2000/01. The con-

tribution of fisheries to agriculture GDP (AGDP) reached 2.02% of current price and the share of fishery in national GDP at current price reached 0.81%. In terms of quantity, it was estimated that Nepal produced around 32,000 metric tons of fish in 1999/2000 (WECS, 2005). At the same time, the fish-eating habit of Nepalese people has been increasing since the mid-1980s, and, therefore, the fish export, which peaked at 1,000 metric tons annually in the early period of the Aquaculture Development Project, has diminished considerably and the import of fish has picked up. Fisheries in Nepal consist of aquaculture and open water fishery (capture fishery). Aquaculture is considered the fastest-growing fish production system and Nepal has achieved considerable production of fish and has great potential to increase the production to meet the challenges of food security as well as to generate employment through aquaculture.

Nepal so far has very limited water transport except small boats being used for crossing rivers and entertainment in some of the lakes. Identified storage dams on rivers such as the Koshi, Gandaki and Karnali could open up navigational waterways in the hills of Nepal. The total length of navigational waterways in the Koshi basin could be around 400 km; in the Gandaki basin around 400 km and in the Karnali basin around 250 km (WECS, 2005). However, commercial inland waterways in dams and reservoirs are prone to several risks, including volume of traffic. It could also be quite complicated in designing water locks and associated management problems during large draw-down effects due to dam-water releases for other purposes.

Issues and Challenges related to Water Sector

Issues related to water include both quantity and quality of the resource and relate to human health standards. Normally, a person requires 2.5 litres of water per day for their basic physiological processes (UNEP, 2001). Besides, water is also required for domestic hygiene such as washing, bathing, cleaning, and so on. Any changes in water quality are reflected in its physical, biological, and chemical conditions; and these in turn are influenced by physical and anthropogenic activities. In Nepal, there is still a need for comprehensive water resources policy. Nepal lacks an integrated river basin planning and management system and a scientific water pricing and cost recovery mechanism. There is good potential of water transportation –navigation. The issues related to water sector might have micro- and macro-economic implications for the country.

There are information and database related issues in the water sector, e.g. inadequate hydro-meteorological network; inadequate funding for management of existing network; inadequate flood forecasting and warning systems; lack of regulatory mechanism in hydrogeology and geo-seismology sectors; inadequate geo-seismic data and information. There are also some international issues in this sector like, compliance with the provisions stipulated in Koshi and Gandak agreements; formulation of general legal framework for development of trans-boundary rivers; absence of mechanism for institutionalized cooperation between riparian countries. Environmental issues also become very critical in the development of water resources sector, e.g. lack of environmental database and mapping; weak integration of environmental considerations into planning of water resources developments; poor implementation and enforcement of environmental impact assessment (EIA) and strategic environmental assessment (SEA) norms and recommendations; bio-diversity conservation; surface and groundwater pollution; lowering of groundwater tables; lack of environmental awareness; landslides, erosion, sedimentation, glacial lake outburst flood (GLOF), flooding; watershed conservation, etc.

Institutional issues have also been not less critical in the water sector, e.g. absence of an effective central planning organization; unclear (sometimes overlapping) responsibilities between policy, implementation, operational and regulatory institutions; absence of an institutional framework for coordinated and integrated water resources development; jurisdictional overlaps and the challenge of maintaining coordination between public and local bodies.

Water Supply and Sanitation Issues

In drinking water supply and sanitation sector, there are several issues like, lack of adequate planning, design and construction of water supply and sanitation projects; lack of appropriate approach towards rural water supply system; improper management of water supply systems of Kathmandu Valley and other urban centres; and lack of water quality standards for drinking water (WECS, 2005). Similarly, lack of coordination among the different agencies; inadequate repair and maintenance as well timely improvement of the operational schemes due to unavailability of enough budget and finance; drying up of the sources of water (e.g. springs, spouts, streams, rivers) due to deforestation, landslides, human activities or climate changes are some of other issues encountered in drinking water supply sector.

Irrigation Issues

The present focus for the development of irrigation in Nepal has been to promote quick yielding small irrigation systems. Despite considerable investments in infrastructure development and a well-trained cadre of technicians for the design, development, operation and management; the public sector irrigation schemes have been performing below expectations. The irrigation efficiency is around 30%; the crop productivity is stagnant or declining; and the problem of system management still remains an issue. The issues can be summarized as (WECS, 2005; NPC, 2014):

- Poor performance of irrigation systems
- Farmers' dependency syndromes and sustainability
- Problems of river management
- Weak institutional capability
- Weak relationship between agriculture and irrigation
- Not adequately strong Water Users Associations (WUAs)

Without adequately conserving the watershed, the use of dynamite during the construction of contour canals along the hill slopes has caused slope instability, rock falls, landmass movements and canal damage, which ultimately has disturbed the natural state of the habitat. With the increased network of canal systems in the hills and mountains, water leakage and drainage problems have caused damages to the physiography of the terrain causing soil erosion in the hills and siltation problems in the Terai (ADB/ICIMOD, 2006). Increased use of agro-chemicals together with irrigation water has further degraded the quality of soil, the groundwater and surface water.

A large number of the households in the Terai are being affected by arsenic contamination in groundwater. In the Terai, groundwater pumped for drinking purposes is also used for irrigation. Use of arsenic contaminated water not only affects crops but also results in the accumulation of arsenic in top soil, which may again be harmful. Arsenic contaminated soils are a major source of contamination in the food chain through plant uptake, animal consumption and water supplies. The issues, such as lack of enough resources for operation, repair and maintenance; inadequate irrigation tariff; inadequate institutional strengthening and capacity building; and poor coordination has hindered the pace of irrigation development in Nepal. Likewise, land acquisition, sustainability of handed over irrigation projects, multiple use of water of the irrigation project are some of the challenges faced by the irrigation sector in Nepal (NPC, 2014).

Hydropower Development Issues

The capital investment cost of developing hydropower projects in Nepal has been a quite high so far. Therefore, it is still a challenge to produce sufficient hydropower at cheaper cost and make it available at an affordable price to meet the growing demand for different economic sectors such as agriculture, industry, transport, domestic and others. As the hydropower development is a high investment proposition, there is a need of mobilizing the private and public sector financing in order to meet the future demand for hydropower. National capabilities are yet to be strengthened to produce cheaper hydro energy (WECS, 2005). Similarly, there are some legal issues for the development of hydropower such as, non-specificity of water rights and ownership; lack of sub-ordinate enabling legislation; lack of harmony among related legislation; lack of adequate legal provisions to encourage private sector participation in multipurpose projects etc.

Water Quality

Water quality refers to the suitability of the water to sustain living organisms and other uses such as drinking, bathing, washing, irrigation, and industry. The rising demand for water by the population has put pressure on the quality of water. The quality of water sources at both surface and groundwater is being degraded. The quality of water is deteriorated by inflow of pollutants including industrial waste, solid waste, domestic waste water, man-made natural disasters, increased use of agro-chemicals, change in land-use etc (UNEP, 2001).

Not all the houses, even in the cities of Nepal are connected to a waste water system. Many people, even in urban areas, defecate on open ground, often along the banks of rivers and streams. There is no sewerage network system in the country's rural region or in many of the municipalities in Nepal. Increasingly, pit latrines are being introduced, particularly in rural areas and some people have constructed septic tanks. Even so, much domestic waste water percolates directly into the groundwater or flows as runoff into local streams. Likewise, most of the domestic sewers discharge directly into rivers without treatment. Such practices resulted in the contamination of the water.

Water Resources under Climate Change: Current Scenarios and Future Projection

Currently, about 10% of total precipitation in Nepal falls as snow (UNEP, 2001). About 23% of Nepal's total areas lie above the permanent snowline of 5000 m (MOPE, 2004). Presently, about 3.6% of Nepal's total areas are covered by glaciers (Mool et al.2001). There are about 3,808 glaciers with a total area of 4,212 sq km in Nepal Himalayas (ICIMOD, 2011), which provide perennial flows for major river systems in Nepal. The contribution of snow and glacier melt water to the flows of these rivers, particularly during dry season is substantial. The average temperature in Nepal is increasing and increasing faster in higher altitudes than in the lower ones, resulting in accelerated melting of glaciers, formation of glacial lakes in the mountain valleys and expansion of existing glacial lakes in Nepal Himalayas. This has resulted in increased risks of glacial lake outburst floods creating threats to people, property, infrastructures, livestock and ecosystem not only in the mountains but also far downstream in the hills and plains. Studies have suggested that glacial lake outburst floods in the Himalayas have occurred more frequently during the last fifty years (Mool et al, 2010). Accelerated melting of snow and glaciers in the Himalayas has adversely affected the water storage capacity of the mountains. Decreased melt water contribution to the river flows particularly during non-monsoon season has negative impact on run-of-river hydropower, irrigation and even municipal water supply (Chaulagain, 2015).

The time series studies on glacier and snow show that majority of glaciers in Nepal Himalayas have retreated in the range of 30 to 60 m in the past and while some smaller glaciers have begun to disappear. The most studied glaciers of Nepal (Glacier AX010 in Shorong Himal, Yala Glacier in Langtang Valley, Rikha Samba Glacier in Hidden Valley and Khumbu Glacier in Khumbu region) are retreating and thinning. Such retreats are helping to expand the existing glacial lakes such as the most studied glacial lakes of Nepal such as Imja, Tsho Rolpa and Thulagi Glacial Lakes. The ongoing climatic changes and projected future changes are likely to have severe impact on water resources. It also increases the risk of the sudden flooding following glacial lake outbursts. The water induced disasters in Nepal are increasing in terms of magnitudes as well frequency (MoEST, 2012). MoEST (2012) has revealed that the likely changes in the river flows in the future vary widely from river to river; the rain-fed rivers might have shown a decreasing trend during lean seasons and an increasing trend during rainy season; and magnitude of the change would be relatively higher than the snow-glacier fed rivers. Trend of the annual discharge of three major River basins Koshi, Gandaki and Karnali indicated a decreasing trend. Early shift of the hydrographs might be possible which might impact on the normal water withdrawal pattern of the river.

Reduced Water Availability

Increased temperature will not only affect the annual glacier mass balance, but also will change precipitation pattern, i.e. more rainfall and less snowfall. Rainfall, unlike snowfall, will not be stored in the mountains, but will immediately be drained out from the basin resulting in less ground water recharge upstream and more floods downstream during the monsoon.

Majority of the glaciers in Nepal Himalayas are retreating at the rate is higher than the glaciers elsewhere in the world, though the rate of retreat varies from glacier to glacier. A sensitivity analysis of all the glaciers in Nepal Himalayas was done by using glacier mass balance model originally developed by Y. Ageta (Kadota and Ageta, 1992; Naito et al, 2001) for the glacier AX010 in the eastern Himalayas and by applying the same empirical equation for the 24 glaciers in the Langtang Himalayas of the central Nepal. The analysis has shown that many of the glaciers in Nepal Himalayas will disappear by the end of this century, if melting of the glaciers continue at the present rate. Likewise, the analysis has revealed that the current ice reserve of 481 cubic km in Nepal Himalayas will come down to 0.6 cubic km by 2100, if the temperature will increase by 0.03 degree C per year (Chaulagain, 2015). Such an accelerated decrease of ice reserve in Nepal Himalayas may result in the decrease of melt water contribution to the annual river flows.

Water-supplies stored in glaciers and snow cover are projected to decline in the course of the century, thus reducing water availability during warm and dry periods (Bates et al, 2008). The glacier-melt water contribution will initially rise with the rise in temperature and ultimately will go down after the contributing glaciers disappear (IPCC, 2007). Decreasing glacier-melt water and disappearance of glaciers will ultimately change the hydrograph of the river system. The snow- and glacier-fed rivers will be converted into rain-fed ones. The monsoon stream-flows including flood water will further increase and the dry season stream flows will further decrease. Currently, the snow and glacier-melt contributes to about 13% of Nepal's total annual surface water. However, the snow and glacier-melt contribution is significant (up to 34%) during April-May (Chaulagain, 2015).

Reduced Hydropower Generation

Flood waters and river flows during monsoon seasons have a relatively less meaning for hydropower generation in the Nepalese context where majority of the hydropower plants are of the run-of-river type. As the glacier-melt water initially increases with increase in temperature and hydropower potential generally increases accordingly as it largely depends on the lean season flows. Nepal's hydropower generation generally follows the pattern of dry season flows (Chaulagain, 2007). Over 90% of Nepal's existing hydropower plants are the run-off river type which are generally designed based on the dry season flows. These power plants have been already facing the problem of water shortages during dry seasons and generating only about 30% of the total installed capacity in dry months. The problem will be further exacerbated during dry season by the reduced snow and glacier-melt contribution in the future (Chaulagain, 2015).

The anticipated future adverse impact on the electricity generation of the hydropower plants largely depends on the rate of temperature increase. Initially, the electricity generation potential may increase with the rise in temperature and then gradually goes down. The higher the rate of temperature increase in the future, the earlier the peak of the electricity generation potential of the hydropower plant will arrive. However, the electricity generation may also depend on the rain-fed contribution, which is adversely affected due to changed precipitation pattern (i.e. too much of rainfall during monsoon and too little during non-monsoon seasons). Out of the total available energy in 2012, only less than 1% was from thermal sources and about 80% was from domestic hydropower plants (NEA, 2013). Because of the insufficient river flows during dry season, the existing hydropower plants could generate just around 30% of the total installed capacity of the hydropower plants. Any decrease in the river flows

during dry season due to the decreased glacier ice reserve and decreased flows of the rain-fed rivers as projected, will further deteriorate the electricity generation situation.

Adverse Impacts on Irrigation and Agriculture

Increased temperature will result in increased evapo-transpiration leading to increased irrigation water demand, and decreased river flows. Studies have suggested that glacier-fed perennial rivers will be converted into rain-fed seasonal rivers after the glaciers disappear. The ratio of maximum to minimum flows of rain-fed rivers is substantially higher than that of snow-fed rivers indicating a possible future re-distribution of water among months after glacier-fed rivers will become the rain-fed ones. Furthermore, increased temperatures will widen the gaps between the water supply and demand for irrigation. A water balance analysis of Bagmati river basin at Kathmandu Valley has shown that a one-degree rise in annual temperature may increase the water demand by 3.7% and reduce the annual river flow by 1.5% simultaneously (Chaulagain, 2007).

Due to monsoon dominated flow pattern, the Kathmandu valley in Bagmati river basin has already been facing water shortage during non-monsoon seasons though there is surplus water during monsoon. The increase in temperature will further worsen the situation of too much water during rainy season and too little during dry seasons. Increase in frequency of climate extremes may lower crop yields (Tubiello et al, 2007). Increased evapo-transpiration and increased soil moisture deficit due to increased temperature can have significant adverse impacts on agriculture production and food security. Water availability is a key component of food security as the availability of water supplies is the single most important factor in food production (McGuigan, 2002). Changes in glacier melt, along with other changes in high-altitude hydrology, will affect agricultural production (Malone, 2010). Nepal's agriculture contributes to 35% of GDP (MoF, 2013). The small landholdings, subsistence farmers and the poorest of the poor will face the biggest adverse impact of reduced agriculture production due to reduced water availability, which ultimately may lead to the famine (Chaulagain, 2015).

Increased Risks of Water-induced Extreme Events

The shrinkage and disappearance of mountain glaciers may result in changes in the flow characteristics of glacier- fed rivers and changes in flood severity and frequency (Kaltenborn et al, 2010). Glaciers in Nepal Himalayas have been thinning and retreating at rates of 10 m to 60 m per year and many small glaciers with surface area of less than 0.2 sq km have already disappeared (Bajracharya et al., 2007). Upward shifts in the elevation of a terminus as great as 100 m have been recorded during the past 50 years and retreat rates of 30 m per year are common in Nepal Himalayas (Malone, 2010). Increased melt of snow and glaciers in Nepal Himalayas has resulted in formation of glacial lakes and expansion of existing ones in the mountain valleys (Ives et al, 2010).

Higher temperature increases the likelihood of precipitation falling as rain rather than snow (IPCC, 2007), which can result in increased likelihoods of floods during rainy season and decreased river flows during dry season. Chaulagain (2009) has revealed that decrease in snow cover areas exponentially increases the ratio of maximum-to-minimum stream-flows (i.e. increased maximum flows and decreased minimum flows simultaneously) in Nepalese rivers. Moreover, increased melting of snow and ice including permafrost can induce an erodible state in the mountain soil which was previously non-erodible. This has increased likelihoods of landslides in the mountains. Because of warming, snowmelt begins earlier and winter becomes shorter, which ultimately affects river regimes, natural hazards, water supplies, infrastructures and people's livelihoods (Jianchu et al, 2007).

Adverse Socio-Economic Consequences

Increase in evaporation, reduction in snow cover, and fluctuations in precipitation are key factors contributing to the degradation of mountain ecosystems. While too little water leads to vulnerability of production, too much water can also have adverse effects on crop productivity. Heavy precipitation events, excessive soil moisture and flooding disrupt food production and rural livelihoods (Bates et al, 2008). Changes in glacier regimes and runoff from snow and ice, combined with changes in precipitation timing and intensity, increase human vulnerability and affect agriculture, forestry, health conditions and tourism (Kaltenborn et al, 2010). Decreased snow cover due to warming can result in direct adverse impacts on tourism. Rayamajhi (2012) has revealed that absence of snow on mountain caps degrade the aesthetic view of the mountains and divert the tourists to other destinations. Increased risks of avalanches and glacier lake outburst floods in the mountains due to accelerated melting of snow and glaciers can adversely affect the tourist arrival in the mountains.

Water infrastructure, usage patterns and institutions have been developed in the context of current and past climatic conditions. Any substantial change in the frequency of floods and droughts, or in the quantity and quality of water or seasonal timing of water availability, will require adjustments that can be costly, not only in monetary terms but also in terms of societal and ecological impacts, including the need to manage potential conflicts between different interest groups. Increased risk of food and water shortage, water shortages for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration due to floods and landslides are some of likely major adverse impacts associated with the water resources. Enhanced melting and increased length of the melt season of glaciers leads at first to increased river runoff and discharge peaks, while in the longer time-frame, glacier runoff is expected to decrease. The future socio-economic pathways will most likely increase the future water demand resulting in widening gap between water supply and demand, which will further exacerbate the existing water stress particularly during dry season (Chaulagain, 2015).

Currently, Nepal's annual renewable water availability is 7656 cubic m per person, which is well above the global average water availability of 6000 cubic m per capita per year and the water stress level of 1700 cubic m per capita per year (FAO, 2007). The analysis of different scenarios of future temperature increase and the United Nations population projection have revealed that the annual renewable water availability in Nepal even in 2100 AD will be above the critical line of water stress (Chaulagain, 2015). However, the water stress is already a common phenomenon during non-monsoon seasons and in many regions within Nepal.

The impact of water scarcity is unevenly distributed among the sectors and income levels. Water scarcity is an issue of poverty. Unclean water and lack of sanitation are the major water issue for poor people. Water scarcity for poor people is not only about droughts or rivers running dry but it is also about guaranteeing the fair and safe access, they need to sustain their lives and livelihoods (FAO, 2007). Decreased runoff will make it harder to improve access to safe drinking water, which leads to additional costs for the water supply sector and higher socio-economic impacts and follow-up costs. In the areas, where water-induced extreme events become more intense and more frequent, the socio-economic costs of those events will increase significantly. Poor communities can be particularly vulnerable in such areas.

Recommendations

The mountains and hills of Nepal have been not adequately studied because of the rugged topography, remoteness, severe weather conditions and little economic development, leading to the information and knowledge gaps regarding the water resources of Nepal. More hydrological, glaciological and meteorological stations to record the data and information should be established and strengthened. An integrated institutional, regulatory and policy framework should be established to ensure the holistic and sustainable development of water resources sector of Nepal.

Conclusions

Nepal is rich in water resources. There are more than 6000 rivers flowing from the Himalayan Mountains to the hills and plains. Most of these rivers are glacier-fed and provide sustained flows during dry seasons to fulfill the water requirements of hydropower plants, irrigation canals and water supply schemes downstream. The melting of snow and glaciers and subsequent changes in water system due to climate change have multifaceted impacts on society and economy because of direct linkage of water with people, ecosystem, economy and society. The impact of changed runoff regime and widening gaps between water supply and demand disproportionately falls more on the poor, marginalized, subsistence farmers and the economic units which are directly dependent on natural system. Changing precipitation pattern would increase the likelihoods of floods, landslides and droughts. Likewise, accelerated glacier melt and a decreased snow-to-rain ratio would increase the likelihood of formation and expansion of the glacier lakes in the Nepal Himalayas and subsequent collapse of them creating devastating floods, which can cause substantial damages to the property, people and the environment of a large section along the river valley downstream.

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CHAPTER 7

Biological Resources

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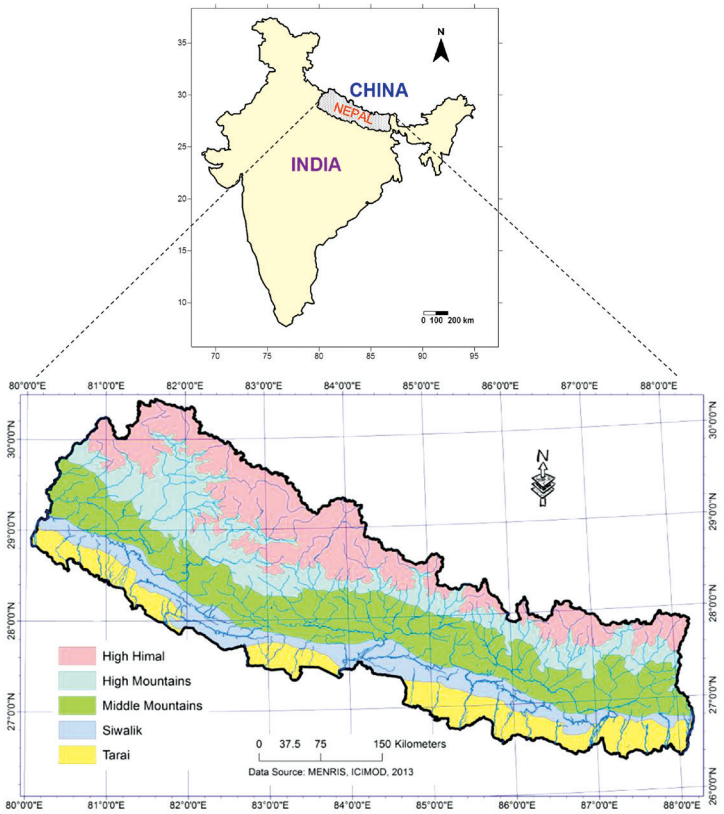
Nepal lies in the cross-road between Palaearctic and Palaeotrophic biogeographic realms with unique topographic and climatic variations. Thus, it is rich in biological resources relative to the proportion of its land area. The country comprises only 0.1% of global land area; it possesses 3.3% and 1.1% of global flora and fauna respectively with a high rate of endemism. This diversity is distributed from the dense tropical forests to the sub-alpine and alpine pastures and snow-covered peaks of the Himalayan mountain range. Nepali communities are largely dependent on natural ecosystems for their livelihood. Although, the country has favored diverse flora and fauna with significant eco-economic significances, they have been threatened by multiple factors including climate change, over exploitation, increased anthropogenic pressure and habitat destruction. Amidst such challenges, the Government of Nepal is committed to preserving and maintaining the natural biological integrity of the country, and it has formulated and implemented both in-situ and ex-situ approaches along with policy and legal measures. Under such circumstances, the status of biological resources may change and several new findings and information might have been added. Therefore, the status of biological resources needs to be reviewed and updated regularly. In the present paper, effort has been focused on assessing the current status of biological resources, their threat, and conservation measures adopted and achievement made so far. For the purpose, historical data pertinent to the subject, recently published and unpublished documents produced by scholars or concerned institutions have been thoroughly reviewed. The information updated would be useful for researchers, planners, policy makers, professionals and development workers involved in the field of natural resource management, biodiversity conservation and climate change.

Introduction

Nepal lies in the central part of the Himalaya between 26°22' and 30°27' N latitudes, and 80°04' and 88°12' E longitudes. The country covers an area of 147,181 sq. km with east-west elongated length of 800 km and average north-south width of about 200 km. The altitude varies from around 70 meters above sea level in eastern Terai region to 8,848 meters at the Mount Everest. Within this altitudinal span, the country has been divided into five major physiographic zones, viz. Terai, Siwaliks (Churia Range), Middle Mountains (the Mahabharat or Middle Hills), High Mountains (Lesser Himalayas), and High Himalayas (LRMP, 1986) (Fig. 1). By area, Terai occupies about 17% of the total area and consists of dense forests and fertile lands; Hill region occupies about 68% of the land consisting of hills, valleys, rivers, lakes, waterfalls, streams, springs, etc.; and Mountain region occupies about 15% of the land with fully snow-capped mountains. These physiographic zones coincide with the bioclimatic zones described by Dobremez (1976) (Table 1). The country receives an average annual rainfall of approximately 1600 mm with mean annual minimum and maximum precipitation range

Figure 1: Physiographic Zones of Nepal (modified MoFSC, 2014a)



from 165 mm in the rain-shadow areas (north of the Himalaya near Tibetan plateau) to 5500 mm in the Pokhara Valley of western Nepal (along the southern slopes of the Annapurna Himalaya range). About 80% of rain falls between June and September in the form of summer monsoon. The eastern region is wetter than the western region. The country is drained by four major Himalayan river systems (Koshi, Gandaki, Karnali and Mahakali), a few medium-sized perennial rivers arising from the High Mountains region, and a number of seasonal streams mostly originating from the Siwalik Hills (MoFSC, 2014a). The temperature varies with topographic and orographic variation with the record of maximum summer temperature fluctuation from 25°C to 46°C and minimum winter temperature fluctuation from -26°C to nearly zero or freezing point (MoFSC, 2009, & 2014). Due to its unique topographic features, the country exhibits wide range of climate variation from tropical humid condition in Terai to alpine cold semi-desert condition in the trans-Himalayan region.

People in Nepal, especially in rural areas, largely rely on natural ecosystems for their livelihood. For example, substantial numbers of wild plants are used as food crops. Moreover, they are heavily dependent on traditional biomass fuels such as fuel-wood, animal dung, agricultural residues, etc. Substantial use of medicinal plants in healing common ailments and non-timber forest products (NTFPs) for making livelihood have been reported by previous researchers. In the present context of changing climate, growing population and increased consumption patterns show that tremendous increase in climate stress and anthropogenic pressure on the natural resources, especially in the developing world. Consequently, there is massive degradation of natural ecosystems with alteration in wildlife habitats that are causing multiple threats to natural resources and biodiversity. The present paper discusses the existing status of biological resources, their threat, and conservation approaches adopted so far in Nepal.

Table 1: Physiographic and Climatic Conditions of Nepal

Physiographic Zone	Surface Area (%)	Elevation (m)	Bioclimatic Zones
Terai	14	Below 500	Tropical
Siwalik Hills	15	500-1000	Tropical
Mid Hills	29	1000-2000	Sub-tropical
		2000-3000	Temperate monsoon
High Mountains	19	3000-4000	Sub-alpine
		4000-5000	Alpine
High Himalayas	23	Above 5000	Nival

Source: Dobremez (1976); LRMP (1986); MoFSC (2014a)

Biological Resources

According to Udvardy (1975), Nepal lies at the crossroads between two bio-geographic realms: Palaeoartic in the north and Palaeotrophic in the south (Bhuju et al., 2007). Zoo-geographically, the country falls within two biogeographical realms: Indo-Malayan and Palaeartic. Phyto-geographically, it lies at a transition zone of six floristic regions: Central Asiatic in the north, Si-

no-Japanese in the east, Southeast Asia-Malaysia in the south-east, Indian in the south, Sudano-Zambian in the south-west, and Irano-Turanian in the west (Bhuju et al., 2007). This transitional location with altitudinal and climatic variation has made Nepal a thriving place of species originating from these biographic regions and contributed to high level of biodiversity at ecosystem, genetic and species levels. Although, the country occupies only about 0.1% of global land area, it harbors 3.3% of world's known flora and 1.1% of fauna (MoFSC, 2014b; Table 2& 3).

Ecosystem Diversity

Stainton (1972) delineated phytogeographic boundaries based on climate, vegetation and floristic composition and classified 35 types of forest in Nepal. According to Dobremez (1972, 1976) and Dobremez et al. (1970-1985), there are four domains (western, northwestern, central, and eastern), six levels, and 11 sub-levels of bioclimatic zones and 136 ecosystems in Nepal (Bhuju et al., 2007). However, during the preparation of ecological map, closely allied ecosystems were grouped together and the number was reduced to 118 (BPP, 1995). Among the 118 ecosystems, 112 are forest (shrublands, rangelands and alpine meadows) ecosystems, four are cultivated ecosystems, one is water body ecosystem, and one is glacier/snow/rock ecosystem. The Middle Mountains have the highest (53) number of ecosystems, followed by the High Himalaya and Mountain together (38), the Terai (14) and Siwalik (12). The remaining one, water ecosystems occur in all zones, except the Siwalik (BPP, 1995). The Tree Improvement and Silviculture Component (TISC), further reduced this number to 36 in order to present a simplified picture of vegetation of Nepal (TISC, 2000). These ecosystems are of international importance in view of the number of globally threatened wildlife and floral elements as well as their diversity represented within these areas (Bhuju et al., 2007).

With respect to aquatic ecosystem, Nepal encompasses diverse forms of natural lakes from the tropical low land of the Gangetic plain to the alpine Higher Himalaya within a north-south horizontal distance of about 150 km. In total, 5358 lakes have been recorded (Bhuju et al., 2010). These lakes are considered to be a favorable area for comparative studies on the influence of altitude and climate on the biogeochemical properties of water (Hickel, 1973). In addition, there are 6000 rivers and rivulets in Nepal (WECS, 2011). These wetlands harbor many threatened and endemic species of flora and fauna and serve as resting places for many migratory and globally threatened birds, thus they bear great ecological significances. Furthermore, the wetlands also play a vital role in conserving floral diversity, as 25% of Nepal's vascular plants, including 26 endemic species of flowering plants are believed to be wholly or significantly wetland dependant (MoFSC, 2014b). In connection to glacier ecosystem, 3,808 glaciers with an area of 3,902 sq. km, and 1,466 glacial lakes covering 64.78 sq. km have been identified (ICIMOD, 2011).

Floral and Faunal Diversity

The history of botanical and zoological explorations in Nepal started from 1802 and 1820 AD respectively (Bhuju et al., 2007; Shrestha, 1997) and are mostly focused on higher level taxa and thus they appear to be well represented compared to the lower level taxa. The floral and faunal diversity is considered to be relatively high in Nepal. These explorations have identified over 7004 species of flowering plants (including gymnosperms), 5481 species of non-flowering plants (Table 2), 1556 vertebrates and 10341 invertebrates (Table 3). Among the plants, the global proportion of gymnosperms, bryophytes, pteridophytes and lichens, and among the animals, proportion of mammals, birds, and butterflies are relatively high.

Agricultural Diversity

In order to maintain the food security, the agricultural biodiversity is important for a mountainous country like Nepal. Previous studies have shown 599 species of crop plants including both wild and cultivated (Table 4). The data show that out of 599 food crop species reported in Nepal, 225 species are cultivated and 331 species are wild, indicating dependency of rural community to the natural ecosystem for their sustenance.

Table 2: Diversity of Floral Species in Nepal

S.N.	Group	No. of known species in the World	No. of known species in Nepal	Share in Nepal (%)	Reference
1	Angiosperms	231638[1]	6973	3.0	UNEP-WCMC (2004)
2	Gymnosperms	529[2]	31	5.9	Rajbhandari and Adhikari (2009)
3	Pteridophytes	10369[1]	534	5.1	DPR (2002) andMoFSC (2002)
4	Lichens	> 17000[3]	771	4.5	Sharma (1995); Sharma et al. (2009)
5	Bryophytes	>14000[3]	1150	8.2	Pradhan and Joshi (2010)
6	Fungi	> 70000[3]	2025	2.9	Adhikari (2009)
7	Algae	> 40000[3]	1001	2.5	Prasad (2013)
	Total	**>383140**	**12480**	**3.3**	

[1]UNEP-WCMC (2006); Wilson (1988; 1992); [3]WCMC (1992) (Source: CBS. 2014)

Table 3: Diversity of Faunal Species in Nepal

S.N.	Group	No. of known species in the World*	No. of known species in Nepal	Share in Nepal (%)	Reference
1	Mammals	4675	212	4.4	Baral and Shah (2008); Jnyawanli et al. (2011); Subba et al. (2014); Chetri et al. (2014); NTNC (2014); Shrestha et al. (2014)
2	Birds	9799	874	8.9	Bhuju et al (2007); BCN and DNPWC (2011)
3	Reptiles	7870	123	1.6	Schleich and Kastle (2002)
4	Amphibians	4780	117	2.4	Bhuju et al. (2007)
5	Fishes	10000	230	2.3	Rajbansi (2013)
6	Mollusks	NA	217	NA	Budha (2012); Budha et al. (2015)
7	Moths	160000	3958	2.5	Haruta (2006)
8	Butterflies	17500	651	3.7	Bhuju et al. (2007)
9	Spiders	39490	175	0.4	Bhuju et al. (2007)
10	Rotifer	NA	61	NA	Surana et al. (2005)
11	Crustaceans	NA	59	NA	Tiwari and Chhetry (2009)
12	Other insects	NA	5052	NA	Thapa (1997)
13	Platyhelminthes	NA	168	NA	Gupta (1997)

*CBS (2014)

Table 4. Sources of Cultivated and Wild Food Crops

Group	Total No. of species	Cultivated species	Wild species	Imported Food Species
Dicotyledons	395	175 (44)	190 (48)	30 (7.6)
Monocotyledon	83	50 (60)	20 (24)	13 (15.7)
Pteridophytes	11	NA	11 (100)	NA
Thallophytes	108	NA	108 (100)	NA
Gymnosperms	2	NA	2 (100)	NA
Total	**599**	**225 (37.6)**	**331 (55.3)**	**43 (7.2)**

Source: MoFSC (2002)
Figures in parenthesis refer to percent of the total crop species

Endemism in Nepal

Among four hotspots viz. Himalaya, Indo-Burma, Mountains of South-West China, and Mountains of Central Asia occurring in the region, Nepal is a part of the Himalaya biodiversity hotspot. Out of 7004 flowering plants, 284 species, and among non-flowering plants 255 species have been reported to be endemic to Nepal (DPR, 2012). Among the physiographic regions, the High Mountains region has high (63%) plant endemism indicating more active speciation rate compared to the Mid-Hills (38%) and the Terai/Siwaliks (6%) endemism (Bhuju et al., 2007). Similarly, 160 animal species, including one mammal (Apodemus gurkha); one bird (Turdoides nepalensis) (MoFSC, 2005), 23 species of herpeto-fauna (Shah, 2013), and 16 species of fish (Rajbanshi, 2013; Shrestha, 2013) are reportedly endemic to Nepal. Recently, additional 22 species of terrestrial gastropods have been reported to be endemic to the country (Budha et al., 2015).

Bio-resources in Socio-economy

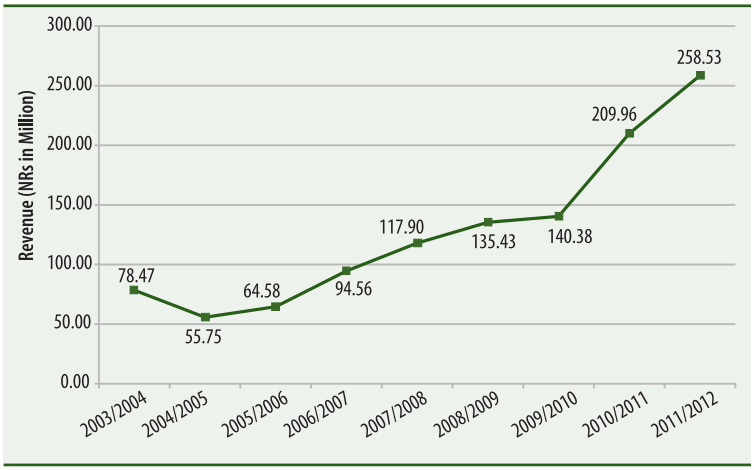
The Nepalese economy is largely dependent on the natural resources including agricultural land, forests, wetlands, and rangelands. Biodiversity is closely linked to the livelihoods and economic well being of most people (MoFSC, 2014b). Agriculture plays a vital role in Nepalese economy. Its contribution in fiscal year 2013/2014 remained 33.1% of the Gross Domestic Production (GDP) (Economic Survey, 2013/2014). In Nepal, 225 species of crop plants are cultivated and 331 species of food crops are wild (Table 4). The substantial number of wild food crops suggests dependency of livelihood in the natural ecosystem. Tourism is the second most important source of foreign exchange and protected areas are major tourist destination in Nepal. About 40% of the total visitors to Nepal have visited protected areas (DNPWC, 2009). The increase in revenue from the protected areas during the period from fiscal year 2003/2004 to 2011/2012 (Figure 2) signifies substantial increase in number of tourist in those areas

(DNPWC, 2012). Out of the total revenue generated from the protected areas, 30% to 50% are shared with the buffer zone committee for buffer zone management and community development (DNPWC, 2012). In addition, the wetlands also have high cultural and economic significances, as livelihoods of many ethnic groups are dependent on wetlands. Furthermore, the local communities as well as the nation are getting incredible ecosystem services from the protected areas.

In international trade, Nepal's bio-resources are considered mostly wild in origin. It has been reported that 188 biomaterials commonly found in international trade consists of various plant parts such as root and tubers (39 plants), barks (seven plants), leaves (26 plants), flowers (14 plants), fruits and seeds (61 plants), whole plants (12 plants), gums and resins (eight plants), and miscellaneous parts of 11 plants (Bhuju et al., 2007). Annual export value of biomaterials has been reported to range from USD 7 - 30 million with USD 16 million in 1997/1998. The five major species with the highest export value (> 52% of the total) are the Soap nut tree (Sapindus mukorossi), Nepal pepper (Zanthoxylum armatum), lichens (Parmelia sp), Cotton paper (Persia bombycina) and an indigenous medicinal plant 'Chiraita' (Swertia chirata) (Olsen, 2005). There are about 1800 medicinal and aromatic plant species reported in Nepal (Shrestha et al., 2001; Baral & Kurmi, 2006). The National Register of Medicinal and Aromatic Plants has documented and described 185 species of medicinal plants with medicinal importance in Nepal (IUCN, 2004). Likewise, DPR (2007) has reported 701 species of medicinal plants in Nepal. Therefore, positive growth of Nepalese economy can be achieved by increasing the value of medicinal and aromatic plants.

Nepal relies heavily on biomass energy in the absence of fossil fuel deposits.. For instance, in the year 2008/2009, out of 9.3 million tons (equivalent to 401 million G Joule) energy consumed, 87% was derived from traditional (biomass) resources, 12% from commercial and less than one percent from the alternative resources (WECS, 2010). Yet, the fuel-wood has remained the main source of energy along with agricultural residue, animal dung and other biomass such as municipal solid waste, agro-based waste and forest industry waste (Acharya, 2014).

Figure 2: Annual Revenue Generated from the Protected Areas



Source: DNPWC, 2012

Threat to the Biodiversity

Nepal's biodiversity is threatened by multiple factors. Among them, the loss and degradation of habitats (forests, grasslands and wetlands) due to expansion of settlements, agriculture and infrastructure, over exploitation, invasion by alien species, and pollution of water bodies are the predominant threats to natural ecosystems (MoFSC, 2014b). Moreover, climate change can have profound impacts, particularly in the mountains with the risk of biodiversity loss and species extinction in the future (MA, 2005; IPCC, 2007). Most threats are likely to increase in the days to come. The interaction of multiple threats is speculated to have increased pressure leading to further decline, degradation and loss of habitats. As a result of such threat, a number of species, including 9 plants, 55 mammals, 149 birds, 15 herpeto-fauna, and 21 fish are included in the The International Union for Conservation of Nature and Natural Resources (IUCN) Red List (Table 5). Similarly, 474 plant and 192 animal species have been included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendices (Table 6) (DNPWC, 2014/2015).

Table 5: Number of Selected Group of Species in the IUCN Red List

Category	Plants	Mammals	Birds	Herpeto-fauna	Fish
Critically Endangered	NA	8	61	1	3
Endangered	2	26	38	3	1
Vulnerable	5	14	50	7	4
Near Threatened	2	7	0	4	13
Total	**9**	**55**	**149**	**15**	**21**

Source: Bhuju et al. (2007); Jnyawali et al. (2011); BCN and DNPWC (2011); Shah (2013)

Table 6: Floral and Faunal Species of Nepal in the CITES Appendices

Appendix	Plants	Animals				
		Mammals	Birds/Aves	Reptile	Amphibia	Butterfly
Appendix-I	2	28	12	8	0	0
Appendix-II	468	17	95	21	2	3
Appendix-III	4	5	1	0	0	0
Total	**474**	**50**	**108**	**29**	**2**	**3**

Source: DNPWC (2014/15)

Most of the threatened species of flora and fauna have been reported to be wetland dependent (MoFSC, 2014b). Despite their ecological and socio-economic functions, the wetland biodiversity is also threatened by several factors like drainage and encroachment, diversion of water for irrigation, unsustainable over exploitation, over mining of gravel from streams and rivers beds, water pollution, invasion by alien species, illegal hunting and trapping of birds and other wildlife, and siltation.

Conservation Strategy

In order to preserve the biological resources, the Government of Nepal has adopted both *in-situ* and *ex-situ* conservation approaches. Amongst the approaches, *in-situ* conservation, i.e. the protected area management approach seems to be the dominant one. The protected area management in Nepal began by enacting the National Parks and Wildlife Conservation Act, 1973 that allowed establishment of the Department of National Parks and Wildlife Conservation (DNPWC) as a separate entity under the Ministry of Forest and Soil Conservation in 1980 for conservation, management and regulation of the protected areas and biodiversity (DNPWC, 2012; Thapa, 2014). At present, DNPWC is the administrative authority of Ramsar Convention, management authority of the fauna under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (short form is already mentioned above); and focal institution of the World Heritage Convention (UNESCO), Global Tiger Forum (GTF) and Convention on Biodiversity (CBD) (DNPWC, 2012).

In-situ Conservation

The *in-situ* conservation such as the protected areas which allows preservation of not only wildlife species, but also ecological and evolutionary processes, habitats, ecosystems, biodiversity and wilderness itself (Thapa, 2014) seems to be the dominant approach of biodiversity conservation in Nepal. The Chitwan and Lagntang National Park, along with the World Heritage Sites (DoI, 2002; Annex I), are the first and second protected areas of Nepal, established in 1973 and 1976 respectively. Since then, there has been a steady rise in the number of protected areas. In between 1973 and 2010, the coverage of protected area has increased by more than 30 times (MoFSC, 2014a). At present, protected areas cover 34,185.62 sq. km, i.e. 23.23% of the country's total area (DNPWC, 2012; DNPWC, 2015) which is one of the highest in Asia. These protected areas include 10 National parks, three Wildlife reserves, one Hunting reserve, six Conservation areas, and 12 Buffer zones (Table 7). The main focus of the National parks and Wildlife reserves is conservation of flagship wild fauna, such as tiger (*Panthera tigris tigris*), rhinoceros (*Rhinocerus unicornis*), Asian elephant (*Elephas maximus*), snow leopard (*Panthera uncia*) and red panda (*Ailurus fulgens*). Furthermore, keeping in view of global/local significance of the wetlands, the Government of Nepal has declared nine Ramsar sites in different parts of the country for the better management and conservation of wetlands per se and their biodiversity (Table 8). In order to protect wildlife and their habitat in non-protected areas, the Government of Nepal has adopted six types of management arrangement:

i) community, ii) collaborative, iii) leasehold, iv) religious, v) protection, and vi) government managed (MoFSC, 2014b).

Establishment of Protected Forests

In addition to the protected areas, the Government of Nepal has also formulated the provision of protected forest with the aim of enhancing biodiversity through rehabilitation of habitats of rare and important species, biological corridors, and wetlands, and also enhancing local livelihoods through implementation of income generating activities (DoF, 2013). Under this provision, eight forests covering a total area of 133,754.8 hectares have been declared as protected forests (Table 9). Among them, seven forests with a total area of 133,579 hectares have been declared as protected forests just after 2010. These forests are important wildlife corridors and are rich in biodiversity (Table 9).

Ex-situ Conservation

In addition to *in-situ* conservation, efforts have also been given to *ex-situ* conservation such as establishment of botanical gardens, conservation centers (forest genetic resources, vulture), zoo, and breeding centre (elephant, & gharial).

Botanical Gardens and Herbarium

In the various ecological zones, 12 botanical gardens have been established by the Government of Nepal (Table 10). These botanical gardens are managed by the Department of Plant Resources under Ministry of Forest and Soil Conservation. The botanical gardens conduct landscape development, ex-situ and in-situ conservation, as well as conservation with educational programs and pilot productions. Among the gardens, the National Botanical Garden of Lalitpur spread over an area of 82 hectares with varied topography and interesting landscapes, manages varieties of plants of medicinal and other importance (DPR, 2015). Government of Nepal has declared lunching campaign of constructing urban gardens for public land conservation and environment improvement in urban areas (MoF, 2014/15). Likewise, the Department of Plant Resources has prepared working plan for 10 urban gardens in Morang, Ilam, Kaski

Table 7: Distribution of Protected Areas in Nepal

S.N.	Protected Area	Declaration Year	Area (sq. km)	Physiographic Zone	Buffer zone area (sq. km)
National Parks					
1	Chitwan National Park	1973	932	Terai/Siwalik	750
2	Langtang National Park	1976	1710	High Mountain	420
3	Rara National Park	1976	106	High Mountain	198
4	Sagarmatha National Park	1976	1148	High Mountain	275
5	She-Phoksundo National Park	1984	3555	High Mountain	1349
6	Khaptad National Park	1984	225	Middle Mountain	216
7	Bardia National Park	1976 , 1984	968	Terai	507
8	Makalu Barun National Park	1991	1500	High Mountain	830
9	Shivapuri Nagarjun National Park	2002	159	Mid hills	NA
10	Banke National Park	2010	550	Terai	343
Sub Total			**10853**		
Wildlife Reserves					
1	Shuklaphanta Wildfife Reserve	1976	305	Terai	243.5
2	Koshi Tappu Wildlife Reserve	1976	175	Terai	173
3	Parsa Wildlife Reserve	1984	499	Terai /Siwalik	298.17
Sub Total			**979**		**5602.67**
Hunting Reserve					
1	Dhorpatan Hunting Reserve	1987	1325	Middle Mountain	NA
Sub Total			**1325**		
Conservation Area					
1	Annapurna Conservation Area	1992	7629	Middle Mountain	NA
2	Kanchenjunga Conservation Area	1997	2035	Middle Mountain	NA
3	Manasalu Conservation Area	1998	1663	High Mountain	NA
4	Krishnasar Conservation Area	2009	16.95	Terai	NA
5	Gaurisankar Conservation Area	2010	2179	High Mountain	NA
6	Api Nampa Conservation Area	2010	1903	High Mountain	NA
Sub Total			**15425.95**		
Grand Total			**28582.95**		**34,185.62**

NA = Not applicable
Source: DNPWC (2015)

Table 8: Distribution of Ramsar Sites in Nepal

S.N.	Name of Ramsar Site	Location	Inclusion Date	Area (ha.)	Elevation (m)
1	Koshi Tappu	Koshi	17 December 1987	17500	75-81
2	Beeshazari and Associated Lake	Chitwan	13 August 2003	3200	286
3	Ghodaghodi Lake Area	Kailali	13 August 2003	2563	205
4	Jagadishpur Reservoir	Kapilvastu	13 August 2003	225	197
5	Gokyo and Associated Lakes	Solukhumbo	23 September 2007	7770	4700-5000
6	Gosaikund and Associated Lakes	Rasuwa	23 September 2007	1030	4000-4700
7	Phoksundo Llake	Dolpa	23 September 2007	494	3611.5
8	Rara Lake	Mugu	23 September 2007	1583	2990
9	Mai Pokhari	Ilam	28 October 2008	90	2100

Source: Ramsar (2015)

Table 9: Protected Forests and their Conservation Significance

Forest	Year Established	Area (ha)	Location (District)	Conservation Significance
Kankre Bihar	2002	175.5	Surkhet	Historical; archeological and biodiversity
Madhane	2010	13,761	Gulmi	Biodiversity; ecotourism
Barandabhar	2011	10,466	Chitwan	Biological corridor; wetland; habitat for several endangered species
Panchase	2011	5,775.7	Kaski, Parbat, Syanja	Biodiversity; eco-tourism, religious
Laljhadi-Mohana	2011	29,641.7	Kailali, Kanchanpur	Biological corridor; wetland
Basanta	2011	69,001.2	Kailali	Wildlife habitat and corridor
Khata	2012	4503.7	Bardia	Wildlife habitat and corridor
Dhanushadham	2012	430	Dhanusha	Historical; religious; biodiversity

Source: MoFSC (2014a)

Table 10: Distribution of Botanical Gardens in Nepal

S.N.	Name	Location (District)	Altitude (m)	Established Year
1	National Botanical Garden	Godavari, Lalitpur	1515	1962
2	Vrindaban Botanical Garden	Hetauda, Makawanpur	500	1962
3	Daman Botanical Garden	Daman, Makawanpur	2320	1962
4	Tistung Botanical Garden	Tistung, Makawanpur	1900	1962
5	Dhakeri Botanical Garden	Dhakeri, Banke	130	1962
6	Mulpani Botanical Garden	Kapurkot, Salyan	2000	1990
7	Dhitachor Botanical Garden	Dhitachaur, Jumla	2500	1990
8	Maipokhari Botanical Garden	Maipokhari, Ilam	2200	1992
9	Dhanusha Botanical Garden	Dhanushadham, Dhanusha	100	1998
10	Godavari Botanical Garden	Godavari, Kailali	130	1998
11	Deoria Botanical Garden	Dhangadhi, Kailali	100	1998
12	World Peace Biodiversity Botanical Garden	Pokhara, Kaski	1500	2013

Source: DPR (2014)

(Pokhara), Lalitpur, Kathmandu, Bhaktapur, Nuwakot, Chitwan, Dang and Baglung (DPR, 2014/2015).

In order to preserve the plant specimen, the National Herbarium (KATH) has been established in 1960 under the Department of Plant Resources at Godavari, Lalitpur. The Herbarium houses over 150,000 specimens of plants, including 4443 species of flowering plants belonging to 1403 genera and 203 families, and further 30,000 specimens are reported to be still identified and housed (Rajbhandari, 2015). Besides KATH, Central Department of Botany, Tribhuvan University, established in 1965, manages a herbarium (TUCH) that houses over 22,000 plant specimens (S.K. Ghimire, personal communication, June 7, 2015). In addition, Nepali herbarium specimens are also housed in 38 herbaria throughout the world (Shakya, 2002).

Conservation Centers

In order to conserve the genetic resources, the Silviculture Division under the Department of Forest has established seed stand for 38 socially and economically important tree species in various eco-regions. Likewise, the division has established 27 breeding seedling orchards, and has a plan for in-situ gene pool conservation of *Pterocarpus marsupium (Bijayasal)* as its population in natural habitats, i.e. western Terai and Siwalik mixed hardwood forest, is continuously declining. Farmers are also conserving considerable number of plants, including threatened species such as Acacia catechu, *Butea monosperma, Choerospondias axillaris, Elaeocapurs sphaericus* and *Michelia champaca*, on their farms as part of their subsistence farming (MoFSC, 2013).

For the conservation of threatened animal species, in 2008, the DNPWC has established a Vulture Conservation and Breeding Center at Kasara inside the Chitwan National Park for ensuring long term survival of two vulture species viz. *Gyps tenuirortris* (slender billed vulture) and *Gyps bengalensis* (oriental white-rumped vulture) (MoFSC, 2014a). Moreover, there are seven community-managed 'vulture restaurants' in Nawalparasi, Rupandehi, Dang, Kailali, and Kaski Districts, established by the Bird Conservation Nepal (BCN) and Himalayan Nature at different locations, where vultures are provided safe and diclofenac-free carrion (BCN, 2015; MoFSC, 2014a).

Central Zoo

The Central Zoo of Nepal is located at Jawalakhel of Lalitpur District. The zoo was established in 1932 AD as a private zoo by the late Prime Minister Juddha Shamsher Jung Bahadur Rana. After 1951's political change, the Government of Nepal took over the ownership; and after 1956, it was opened for public. Over the period, the zoo man-

agement has remained under various government departments. However, after 1995, its management has been handed over to the National Trust for Nature Conservation (NTNC) for 30 years. The zoo covers an area of about 6.5 hectares By 2015, it has a collection of 957 animals belonging to 115 species, including 33 species of mammals, 61 species of birds, eight species of reptiles and 17 species of fishes (NTNC-Central Zoo-information brochure). The successful results of captive breeding of animal species including tigers and leopard have distinguished the zoo as a source of gene pool for some animals. In addition to the Central Zoo, Hetauda municipality has established a mini zoo in 1991 and maintained thereafter. It covers an area of 0.3 hectare , and is integrated with the Public Park and picnic spot (Bhuju et al., 2007).

Captive Breeding

The Gharial Breeding Centre, established in 1978, has successfully carried out captive breeding of crocodiles in the Gharial Farm located at Kasara, Chitwan. Although, the population of gharial crocodiles was close to extinction, the breeding effort has revived its population. By 2010, 761 captive bred gharials have been released into the various rivers of Nepal (Acharya & Dhakal, 2012). Crocodile breeding has also been initiated in Bardia National Park (Bhuju et al., 2007). Likewise, the Elephant Breeding Centre at Khorsor, Chitwan, established in 1989, since then it has been playing an important role in elephant conservation. The elephant stables in Shuklaphanta, Bardia, Chitwan, Parsa, and Koshitappu are noteworthy for elephant breeding.

In addition to these efforts, the Government of Nepal has approved the Working Policy on Wild Animal Farming, Breeding, and Research in 2003. Under this provision, the protected wild animal species, such as Gharial Crocodile (*Gavialis gangeticus*), Black Buck (Antelope cervicapra), Impeyan Pheasant (*Lophophorus impejanus*), Crimpson-horned Pheasant (*Tropan satyra*) and Cheer Pheasant (*Catreus walllichii*); and other wild animal species; Barking Deer (*Muntiacus valginalis*), Spotted Deer (*Axis axis*), Samber Deer (*Rusa unicolor*), Monkey (*Macaca mulata*), Hog Deer (*Axis porcinus*), Wild Boar (*Sus scrofa*), Snakes and all kinds of birds have been permitted for commercial farming. However, the parties involved in farming, export and import of wildlife should be abided by CITES and other similar international laws (MoFSC, 2003).

Natural History Museum

The Natural History Museum (NHM), established in 1975 under Institute of Science and Technology, Tribhuvan University, is situated on a hillock of the World Heritage Site of ancient Swoyambhu stupa, Kathmandu. The museum nurtures Nepal's natural history and serves as a research and educational facility in Nepal for scientists, teachers, students, and other scholars. The NHM serves as the scientific authority of fauna for CITES implementation in Nepal. It houses about 35,332 specimens of Nepalese flora and fauna and manages their public exhibition. Further, the museum manages the Swoyambhu Environment Garden (representing medicinal plants of Nepal), which also consists of the public park, an experimental park, and a nursery. The focus of the NHM is to trace, collect and preserve the holistic natural artifacts on the subjects of Anthropology, Botany, Geography, Geology, Earth history, and many more like evolution, environmental issues and biodiversity (TU, 2015). In addition to these collections, Central Department of Zoology, Tribhuvan University manages Central Department Zoology Museum of Tribhuvan University (CDZMTU), particularly for animal specimens (Budha et al., 2015).

Table11: The Flora and Fauna Species Protected in Nepal

Species Group	Number of Species	Reference
Fauna		
Mammals	27 (14.9)	GoN, 1973
Birds	9 (1.0)	GoN, 1973
Reptiles	3 (2.4)	GoN, 1973
Flora		
Angiosperms	14 (0.2)	GoN (2001)
Gymnosperms	4 (15.4)	GoN (2001)
Lichens	1 (0.1)	GoN (2001)

Figures in parenthesis refer per cent of total known species in Nepal

Table 12: The Major Conventions and Agreements Signed and Implemented by the Government of Nepal

Name of Convention	Entry into force
United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, 1994	26 December 1996
Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and their Disposal, 1989	5 May 1997
Vienna Convention for the Protection of the Ozone Layer, 1985	22 September 1988
Montreal Protocol Substance that Deplete the Ozone Layer, 1987	1 January 1989
United Nations Framework Convention on Climate Change, 1992	21 March 1994
Convention on Biological Diversity, 1992	29 December 1993
Cartagena Protocol on Bio-safety to the CBD, 2000	11 September 2003
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefit Arising from their Utilization to CBD, 2010	12 October 2014
Agreement on the Network of Aquaculture Centers in Asia and the Pacific Region, 1988	--
Convention on Wetland of International Importance Especially as Waterfowl Habitat, 1971	21 December 1975
Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973	1 July 1975
Plant Protection Agreement for Southeast Asia and the Pacific Region, 1956	--
Convention on the High Seas, 1958	30 September 1962
International Tropical Timber Agreement (ITTA), 1983	1 April 1985
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972	30 August 1975
Stockholm Convention on Persistent Organic Pollutants, 2001	17 May 2004
Kyoto Protocol to the UNFCCC, 1997	16 February 2005
The Convention on the Migratory Species of Wild Animals, 1979	1 November 1983
United Nations Convention on the Law of the Sea, 1982	1994
International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	29 June 2004
Convention on the Prohibition of the Development, Production and Stock-pilling of Bacteriological and Toxic Weapons and on their Destruction, 1972*	26 March 1975
Convention on Fishing and Conservation of the Living Resource of the High Sea, 1958*	20 March 1966
Convention on the Continental Shelf, 1958*	10 June 1964

*Only signed

Wildlife Museums in the Protected Areas

The protected areas maintain local museums for research as well as for educational purposes. They mainly house wildlife parts collected within specific protected areas. They also put on display materials confiscated from poachers and smugglers. Among these, the collections at the museums of Khaptad, Bardia, Chitwan, Sagarmatha, Makalu-Barun, Koshitappu National Parks, and Annapurna Conservation Area are considered to be mention worthy. The similar items have been reported to be housed in the Forest Guard Training Centers at Tikauli, Chitwan under the Department of Forest (Bhuju et al., 2007).

Protected Species

Under National Park and Wildlife Conservation (NPWC) Act 1973 (as amended), the Government of Nepal has protected 19 species of plants and 39 species of animal (GoN, 1973; 2001) (Table 10, Annex II, Annex III). Likewise, under the Forest Act 1993, the Government of Nepal has banned the collection, use, sale, distribution, transportation, and export of three species: *Dactylorhiza hatagirea* (Panch aunle in Nepali), *Juglans regia* (*Okhar)* bark, and *Picrorhiza scrophulariflora (Kutki)* from February 2001. The government has also banned the export of eight species of plants and rock exudes (shilajit) except for their processed products. and upon the permission of the Department of Forest, and transportation, export, and felling of seven three species for commercial purposes (Annex II).

BOX 1: THE MAJOR CROSS-SECTORAL POLICIES AND LEGAL FRAMES LINKED TO BIOLOGICAL RESOURCES

- Biotechnology Policy, 2006
- Climate Change Policy, 2011
- Eleventh Three Year Interim Plan, 2007-2010
- Environment Friendly Local Governance Framework, 2013
- National Bio-safety Framework, 2006
- Sustainable Development Agenda for Nepal, 2003
- Tenth Five Year Plan, 2002-2007
- Interim Constitution of Nepal, 2007
- National Foundation for Development of Indigenous Nationalities Act, 2002
- National Land Use Policy, 2012
- Rural Energy Policy, 2006
- Science and Technology Policy, 2005
- Twelfth Three Year Plan, 2010-2013

BOX 2. THE MAJOR SECTORAL POLICIES AND LEGAL FRAME RELATED TO BIOLOGICAL RESOURCES

Plan/Policies

Agro-biodiversity Policy, 2007
Domesticate Elephant Management Policy, 2003
Forest Encroachment Control Strategy, 2012
Forest Fire Management Strategy, 2010
Forestry Sector Policy, 2000
Herbs and Non-Timber Forest Products Development Policy, 2004
Industrial Policy, 2011
Irrigation Policy, 2013
Leasehold Forest Policy, 2002
Master Plan for the Forestry Sector, 1989
National Agricultural Policy, 2004
National Conservation Strategy for Nepal, 1988
National Wetland Policy, 2003
Nepal Biodiversity Strategy Implementation Plan, 2006
Nepal Biodiversity Strategy, 2002
Nepal Environmental Policy and Action Plan I, 1993
Nepal Environmental Policy and Action Plan II, 1998
Plan for Conservation of Ecosystems and Genetic Resource, 1988
Protected Area Management Plan,
Rangeland Policy, 2012
Revised Forest Policy, 2000
Sustainable Development Agenda for Nepal, 2003
TAL Implementation Plan, 2006 (2004-2014)
Terai Arc Landscape Strategy, 2004 (2004-2014)
Three Years Interim Plan, 2007/2008-2009/2010)
Tourism Policy, 2009
Water Resource Strategy, 2002
Working Policy on Construction and Operation of Development Projects in Protected Areas, 2008
Working policy on Wild Animal Farming, Breeding and Research, 2003

Act

Aquatic Animal Protection Act, 1960
Environment Protection Act, 1997
Forest Act, 1993
Local Self-Governance Act, 1999
National Parks and Wildlife Conservation Act, 1973
National Trust for Nature Conservation Act, 1982
Pasture Land Nationalization Act, 1974
Plant Protection Act (2007)
Private Forest Nationalization Act, 1957
Seed Act, 1988
Soil and Watershed Conservation Act, 1982
Tourism Act, 1978
Water Resource Act, 1992

Rules/Regulations

Bardia National Park Regulation, 1997
Buffer Zone Management Regulation, 1996
Chitwan National Park Rules, 1974
Conservation Area Government Management Regulation, 2000
Conservation Area Management Rules, 1997
Environment Protection Rules, 1997
Forest Regulation, 1995
Kanchenjungha Conservation Area Management Regulation, 2007
Khaptad National Park Regulation, 1988
Mountain National Parks Regulation, 1980
Mountaineering Expedition Regulations, 2002
National Parks and Wildlife Conservation Regulation, 1974
Plant Protection Rules, 2010
Water Resource Rules, 1993
Wildlife Reserve Regulation, 1978

Guidelines/Directives

Buffer Zone Management Guideline, 1999
Conservation Management Guideline, 1999
Wildlife Damage Relief Guideline, 2009

International Commitments and Agreements

Nepal strives to attain sustainable economic growth through wise use of natural resources. The country is committed to manage its rich biological resources as per the national need and according to the spirit of Multilateral Environmental Agreements (MEAs) to which it is a Party (Table 12). The MEAs provide important opportunities as well as bring obligation to the country. These conventions and agreements help improve and harmonize conservation legislation and environmental governance within and among countries to adopt standards and stringent legal measures. They can also help enhance national capacity for setting conservation agenda and its effective implementation. Nepal has made considerable efforts and achieved successes in the implementation of several international commitments, including CBD (1992), CITES (1973), Ramsar (1971), World Heritage Convention (1972), and Millennium Summit (2000). In addition, Nepal is committed to other global affiliations pertinent to biodiversity conservation and sustainable development, including the World Trade Organization(WTO), IUCN, the Global Tiger Forum, the World Conservation Strategy 1980, and the World Charter

for Nature 1982. Though, Nepal has signed several international agreements, some of them are yet to be ratified including Nagoya Protocol on Access to Genetic Resources and Benefit Sharing (2010). Therefore, there are some gaps in the implementation of agreements.

Policies, Strategies and Regulatory Framework

Nepal is rich in biodiversity and livelihood is largely dependent on biological resources. There lies tremendous potential of achieving sustainable conservation-friendly economic development by wise use of natural biological resources as per the spirit of Multilateral Environmental Agreements. Over the past few decades, there has been considerable change and transformation of policies on biodiversity conservation sectors. The concept of conservation-friendly economic growth seems to be translated since the Five Year Plan (1997-2002) that was further refined and internalized in the sebsequent Five Year Plan (2002-2007). In the present ongoing Three Years Plan (2013-2016) approach paper, biodiversity has been featured prominently. Over the years, the Government of Nepal has formulated and enacted various enabling plans, policies, strategies and legislations (Box, 1,2) to facilitate sustainable economic growth with further enhanced local participation in biodiversity conservation and natural resources management. Several cross-sectoral (Box 1) as well as sectoral (Box, 2) policies have been formulated. Among others, policies and legislations pertaining to community-based forest management and protected area management have been observed to be effective in bringing success. However, some policy gaps still remain. For instance, one of the major gaps in the existing laws relates to sustainable utilization of biological resources and equitable sharing of the benefits accrued from the conservation of genetic resources. Likewise, strategy to activate and capacitate local bodies (DDCs, VDCs, municipalities) for biodiversity management is still in lacking (MoFSC, 2014a). The lack of required legislation has also affected effective implementation of a number of multilateral environmental agreements concerning biodiversity conservation in which Nepal is a Party.

Conclusion

Nepal is rich in biodiversity and shares a high proportion of global biodiversity. Nepalese economy and livelihood are largely based on the biological resources. The rural people are still using substantial number of wild plants as their food crops and for healing common ailments. In addition, the forest has remained the dominant source of energy for rural inhabitants. Despite these ecosystems services and socioeconomic benefit that people are getting from natural biological resources, these resources are under pressure of unsustainabilities of exploitation due to increased anthropogenic activities with the growing population. Several species of flora and fauna have been listed under the categories of threatened species in IUCN red list and CITES Annexes. These pressures are likely to further hasten climate change and variability. Keeping in view the multiple stresses leading to environmental degradation and habitat destruction, the Government of Nepal has adopted both in-situ and ex-situ conservation approaches along with legal policy and regulation measures for the conservation of biodiversity, unique landscapes and wilderness. Amongst the conservation approaches, the in-situ approach such as establishment of protected areas can be the dominant approach. However, the distribution of protected areas are not proportionate to the ecological zones. In order to have improved and harmonized policy and legal measures and conservation governance within and between the countries, Nepal is committed to the international conventions and agreements and accordingly has formulated policies, laws and rules and duly monitored the achievements made so far. Yet, there still exist some gaps in implementation of International conventions. With respect to policy measures, the policy/regulation pertinent to community forest management with the participation of local community has been found to be effective in managing forest successfully in recent decades. Though there is a fairly comprehensive set of biodiversity related policies and strategies in

Nepal, their implementation aspect generally is not encouraging.

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Annex I

The World Heritage Sites in Nepal

S.N.	World Heritage Site	Place of Establishment	Existed Year (AD)
1	Haunumandhoka Durbar Square	Kathmandu	613
2	Patan Durbar Square	Lalitpur	1565
3	Bhaktapur Durbar Square	Bhaktapur	1427
4	Pashupatinath Temple	Kathmandu	5th Century
5	Swayambhunath Stupa	Kathmandu	5th Century
6	Bouddhanath Stupa	Kathmandu	5th Century
7	Changunarayan Temple	Bhaktapur	306
8	Chitwan National Park	Chitwan	1974
9	Sagarmatha National Park	Solukhumbu	1975
10	Lumbini	Rupandehi	1997

Annex II

Protected Floral Species in Nepal

S.N.	Scientific Name	English Name	Local Name	Potential Use
I. Banned for collection, use, sale, distribution, transportation and export				
	Angiosperms			
1	*Dactylorhiza hatagirea*	Orchid	Panchaunle	Tonic
2	*Picrorhiza scrophulariifolia*	Gentian	Kutki	Medicine
3	*Juglans regia*	Walnut*	Okharko bokra	Medicine
II. Banned for export except for processed with permission of Department of Forest				
	Angiosperms			
4	*Cinnamomum glaucescens*		Sugandakokila	
5	*Cordyceps sinensis*		Yarsagumba	
6	*Rauvolfia serpentina*	Serpentine	Sarpagandha	Medicine
7	*Valeriana jatamansi*	Spike nard	Jatamansi	Medicine
8	*Valeriana wallichii*	Vallerian	Sugandhwal	Medicine
	Gymnosperms			
9	*Abies spectabilis*	Himalayan Fir	Talispatra	Medicine
10	*Taxus baccata*	Himalayan yew	Lauth salla	Medicine
11	*Taxus wallichiana*	East Himalayan yew		??
12	*Taxus contorta*	West Himalayan yew		??
	Lichen			
13	*Parmelia spp.*	Lichen	Jhyaau	Medicine
III. Banned for harvest, transportation and export for commercial purpose				
	Angiosperms			
14	*Acacia catechu*	Cutch tree	Khayar	Medicine
15	*Bombax malbaricum*	Silk Cotton tree	Simal	Medicine
16	*Dalbergia latifolia*	Rose Wood	Satisaal	Timber
17	*Michelia champaca*	Magnolia	Champ	medicine , timber
18	*Pterocarpus marsupium*	Indian Kino tree	Bijayasal	Timber
19	*Shorea robusta*	Common sal	Sal	Timber

Source: GoN (2001)

*Protection of walnut is from National Forest only.

Annex III

Protected Faunal Species in Nepal

S.N.	Scientific name	Common English name	Local name
	Mammals		
1	Macaca assamensis	Assam Macaque	Asami Rato Bandar
2	Manis pentadactyla	Chinese Pangolin	Kalo Salak
3	Manis crassicaudata	Indian Pangolin	Tame Salak
4	Caprolagus hispidus	Hispid Hare	Laghukarna Kharayo
5	Canis lupus	Grey Wolf	Bwanso
6	Ursus arctos	Brown Bear	Himali Rato Bhalu
7	Ailurus fulgens	Red Panda	Habre
8	Prionodon pardicolor	Spotted Linsang	Silu Biralo
9	Felis bengalensis (Prionailurus bengalensis)	Leopard Cat	Chari Bagh
10	Felis lynx (Lynx lynx)	Lynx	Pahan Biralo
11	Neofelis nebulosa	Clouded Leopard	Dhwanse Chituwa
12	Panthera tigris	Royal Bengal Tiger	Pate Bagh
13	Panthera uncial (Uncia uncial)	Snow Leopard	Hiun Chituwa
14	Elephas maximus	Asian Elephant	Hatti
15	Rhinoceros unicornis	Greater One-horned Rhino	Gainda
16	Sus salvanius	Pygmy Hog	Pudke Bandel
17	Moschus chrysogaster	Alpine Musk Deer	Kasturi Mriga
18	Cervus duvauceli	Swamp Deer	Bahrasingha
19	Bos gaurus	Gaur	Gauri Gai
20	Bos grunniens	Wild Yak	Chauri Gai
21	Bubalus arnee	Wild Water Buffalo	Arna
22	Ovis ammon	Great Tibetan Sheep	Nayan
23	Pantholops hodgsoni	Tibetan Antelope	Chiru
24	Antelope cervicapra	Blackbuck	Krishnasar
25	Tetraceros quadricornis	Four-horned antelope	Chauka
26	Hyaena hyaena	Stripped Hyaena	Hundar
27	Platanista gangetica	River Dolphin	Shons
	Birds		
1	Buceros bicornis	Giant Hornbill	Gaj Dhanesh
2	Catreus wallichii	Cheer Pheasant	Cheer
3	Houbaropsis bengalensis (Eupodotis bengalensis)	Bengal Florican	Khar Mayur
4	Lophophorus impejanus	Impeyon Pheasan	Danphe
5	Ciconia nigra	Black Stork	Kalo Bhundiphor
6	Ciconia ciconia	White Stork	Seto Bhundiphor
7	Tropan satyra	Crimpson-horned Pheasant	Munal
8	Sypheotides indica (Eupodotis indica)	Lesser Florican	Sano Khar Mayur
9	Grus antigona	Saras Crane	Saras
	Reptiles		
1	Gavialis gangeticus	Gharial Crocodile	Gharial Gohi
2	Python molurus	Asiatic Rock Python	Ajingar
3	Varanus flavescens	Golden Monitor Lizard	Sun Gohoro

Source: GoN (1973)

CHAPTER 8

Solid Waste Management: Status and Challenges in Nepal

Kedar Rijal, Ph.D. * • Saroj Adhikari**

The current concern regarding the solid waste is the changing amount and types of waste produced, and methods of its management. Solid Waste Management (SWM) was initially the lowest priority in the country but with increase in the level of public awareness about its need, it has now come to the top of the priorities and is being considered as an important issue of environmental protection. The study conducted by Solid Waste Management Resources Mobilization Center (SWMRMC) in 2008 in 58 municipalities of the nation showed that 61.6% of the municipal waste constitutes organic waste and still the composition of its part is more or less in increasing trend reflecting the increasing trend of generation of solid waste in recent years, except the slight decrease for the year 2012/2013. The generation of solid waste in other newly declared 133 municipalities may reflect similar conditions due to inadequate technical, infrastructural and financial resources to tackle the problems of waste management. The household waste composition analysis of 58 municipalities made by Asian Development Bank in 2013 indicates that the highest waste fraction is organic matter (66%), followed by plastics (12%), paper and paper products (9%), others (5%), and glass (3%). Metal, textiles, and rubber and leather each accounted for 2%, 2% and 1% respectively. In recent years, e-waste management has also been a very important concern in Nepal and there has been increasing trend of consuming electrical and electronic goods. Health care waste management is yet another pertinent issue in waste management as the health care institutions have not provided adequate attention. The common practice of management in the municipalities are street sweeping and waste collection (door to door collection and collection from storage points), transport (transporting waste by tippers, trucks, tractors and trailers and small pickups) and final disposal. Solid waste management has become a challenge mainly due to the increasing rate of generation of wastes, limited (municipal) budget as a result of the high costs associated to its management and lack of understanding over a diversity of factors that affect the processes of waste management. Strengthening the capacity of municipalities and Village Development Committees (VDCs) with sufficient infrastructures, technical, financial and human resource coupled with strict enforcement of policies will help for effective management of solid waste. Similarly, development of regulations dealing with the specific waste stream should get a clear priority. The comprehensive policies and strategies are required in specific sectors (e-waste and radioactive waste) of solid waste management.

Background

Urban population growth and changing consumption pattern have resulted in the increased generation of wastes. Increase in resource consumption and use of readymade packaged food items are examples of elevated amount of generation of solid waste problems in Nepal. Similarly, haphazard management of healthcare wastes with the increasing number of health care institutions is also causing problems in some of the urban areas of Nepal.

Waste means the solid, liquid, gas, slurry, smoke, dust, radiated element or substance or similar other materials disposed in a manner to degrade the environment (GoN, 1996). Waste comprises of discarded substances from households, industries, chemical industries and health care services. If any other substance exists, found or disposed in an environment that could cause adverse effect on environment are also dealt as waste (GoN, 2011).

Solid waste is any material discarded by its users perceiving that it has no more economic value. Although human or animal excreta often end up in the solid waste stream, generally the term solid waste does not include such materials. Synonyms to solid waste are terms such as "garbage", "trash", "refuse" and "rubbish".

Solid waste is not a new issue as humans have always produced and managed trash in some ways, but the current concern is the change in amount and types of waste produced, and methods of its management. Urban population growth together with the economic development leads to increasing generation of municipal solid waste (MSW). Improper disposal of biomedical waste also contributes to pollution and public health hazards in the localities (ADB, 2013). Solid Waste Management (SWM) is the discipline associated with controlling the generation, storage, collection, transfer and transport, processing and finally disposal of solid waste in a manner that is in accordance with the best principles of health, economics, engineering, conservation, aesthetics, and other environmental considerations (Organization, 2007).

Because of higher demand for rest of the public services in most of the municipalities in Nepal, solid waste management accords a low priority in the country. Due to the lack of SWM baseline information, local bodies have not been able to produce the waste management plans and data related to the functional elements of SWM. For the sound management of solid waste, it is important to know the waste characteristics (Dangi et al., 2010) which are controlled by culture, climate, socio-economic variable and institutional setting (Vergera&Tchobanoglous, 2012).

In the recent years, human beings have been exploring and using more and more resources that have continuously added more and more wastes into the environment. With increase in level of public awareness about the need of solid waste management, it has now come to the top of the priorities. So, waste management has been an important issue of environmental protection. In this context, integrated and participatory approach to tackle with the solid waste is needed (Manfredi et al., 2010). Additionally, if economic incentives are clearly recognized then it will add a milestone to manage waste by sorting for particulars that have a value for selling. It has been already proven that waste remains no more waste if it is properly managed and valued. Besides this, effective local governance system, level of awareness and sharing of responsibility are also equally important for effective and efficient solid waste management (Vergera & Tchobanoglous, 2012). Measures such as at-source segregation, recycling and reusing of waste are also equally important, but these require major efforts to raise the awareness of the community and develop participation (Practical Action Nepal, 2008).

As a first attempt to collect SWM baseline information at national level, SWM and Resource Mobilization Centre carried out baseline survey of the municipalities in Nepal in 2003.The Solid Waste Management and Resource Mobilization Center (SWMRMC)and others made efforts to update these data, but due to lack of consistent scientific methods and the different assumptions made to quantify the waste generated from different sources, the findings of these waste quantity and quality studies were inconsistent (ADB, 2013).

Waste Generation in Urban (Municipalities) Areas

Management of solid waste is a major challenge in urban areas throughout the world including Asian cities. Waste generated from various human activities, both industrial and domestic, can result negative consequences on the environment and ultimately to human health. The average per capita waste generation of major Asian cities (Table 1) shows that generation of solid waste in Kathmandu is less compared to other Asian cities but the problem in reality is severe due to inadequate management interventions.

In Nepal, solid waste management is one of the major environmental issues, especially in the urban areas (Rijal and Sapkota, 2014). Waste segregation, though has been started in most of the hospitals, other aspects of healthcare waste management such as transportation and disposal

are not taken into consideration adequately; in many cases are being disposed along with municipal solid waste. Similarly, increase in production of electrical and electronic wastes and hazardous waste are also the emerging concerns in urban areas. Solid waste being dumped in riverbanks, roadsides, or other low-lying lands, or in open pits or temporary open piles of the municipalities, without significant technical and socio-economic studies is also one of the problems in solid waste management in the municipalities of Nepal.

The survey conducted by Solid Waste Management Technical Support Center (formerly Solid Waste Management and Resource Mobilization Center) has determined different waste fractions in terms of percentage composition by wet weight obtained from the analysis of waste samples of each municipality. Average physical composition of household waste of 58 municipalities in four major waste components, i.e. organic waste, recyclable, inert and others (with average values by wet weight %), that play a vital role in treatment and recycling/resource recovery aspects of waste management has been represented graphically in Figure 1.The study showed that 61.6% of the municipal waste constitutes organic waste (SWMRMC, 2008). Though initiatives have been taken for management of organic fraction of solid wastes in urban centers like Kathmandu, the composition of its part is more or less in increasing trend (Figure 2; Table 3).

Characteristics of the Solid Waste

Figure 3 shows waste production from 2006/07 to 2012/13 by 58 municipalities, reflecting the increasing trend of generation of solid waste in recent years, except the slight decrease for the year 2012/2013. The generation of solid waste in other newly declared 133 municipalities may reflect similar conditions due to related circumstances faced by all the municipalities with inadequate technical, infrastructural and financial resources to tackle the problems of waste management.

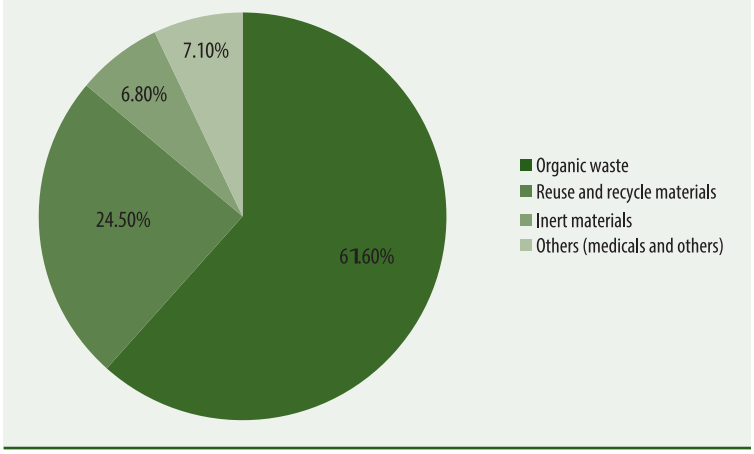
A study by ADB on solid waste of different municipalities in different ecological regions shows the variation in composition of average

Table 1: Average Per Capita Waste Generation of Major Asian Cities

Country	City	Generation (kg/capita/day)
Bangladesh	Gazipur	0.25
Bhutan	Thimphu	0.54
China	Beijing	0.80
India	Doddaballapur	0.28
Indonesia	JogJakarta	0.90
*Nepal	Kathmandu	0.23
Pakistan	Lahore	0.84
Philippines	Quezon City	0.67
Sri Lanka	Balangoda	0.83
Thailand	Bangkok	1.10

Source: Guerrero et al., 2013; *ADB, 2013

Figure 1: Average Value (by wet weight) of Waste in Municipalities



Source: SWMRMC, 2008

Figure 2: Organic Fraction in Solid Waste in Kathmandu Valley

Source: SWMRMC, 2008

Figure 3: Average Waste Generation by Municipalities of Nepal

Source: CBS, 2013; Rijal and Sapkota, 2014

Table 2: Average Household Wastes Generation and Composition (%) in Different Ecological Regions

Composition	Ecological regions		
	Mountain municipality	Hill municipality	Terai municipality
Average daily waste generation (kg/households)	0.49	0.72	0.88
Organic waste	51	65	69
Plastics	11	13	10
Paper and paper products	11	9	9
Glass	3	4	2
Metals	3	2	2
Textiles	4	3	2
Rubber and leather	1	1	1
Others	16	3	6

(Source: ADB, 2013)

daily household waste (Table 2). Terai municipalities generate the largest amount of per capita daily waste (ADB, 2013). The household waste composition analysis of 58 municipalities made by the study indicates that the highest waste fraction is organic matter (66%), followed by plastics (12%), paper and paper products (9%), others (5%), and glass (3%). Metal, textiles, and rubber and leather each accounted for 2%, 2% and 1% respectively (ADB, 2013). The high organic content indicates a need for frequent collection and removal, as well as good prospects for organic waste resource recovery. The content of major reusable and recyclable materials (i.e., plastic, paper and paper products, metal, glass, rubber and leather, and textiles) comprised 29% on average.

Healthcare, E-waste and Chemical Wastes

Waste generated during the process of examining and treating patients, immunization and conducting research in health care facilities (hospitals, clinics, medical research centres, and laboratories) is known as healthcare waste. About 80 percent of such waste is normally ordinary or non-hazardous in nature, while about 20 percent is hazardous (infectious waste, pathological waste, chemical waste and sharps) and it is important to think that although only about 20 percent of the health care waste is hazardous, if all the waste is mixed together, all of the waste becomes hazardous (http://swmtsc.gov.np).

Healthcare waste management is ranked as the highest priority need for capacity-building in Nepal (http://www.unep.org). Most of the hospitals practice disposing of healthcare waste alongside municipal solid waste. Waste segregation though have been initiated, must be improved by the majority of healthcare institutions, as well as special consideration should be given on scientific basis of transportation and disposal of such category of wastes.

ENPHO (2001) has reported an average health care waste generation of 1.7 kg/person/day and 0.48 kg/person/day of Health Care Risk Waste (HCRW) at an average bed occupancy rate of around 65%. Out of 24 Health Care Institutes (HCIs) studied by Joshi 2013, information on amount of waste generation was available only from 3 Health Care Institutions (Patan Hospital, National Kidney Center and Koshi Zonal Hospital; Table 4)

From above statistics, more than 50% of the waste in the hospitals were observed to be of general category type so waste segregation and collection are the most important process during the process of health care waste management that minimize the volume of waste as well as separate nature of medical waste generated from health

Table 3: Characteristics of Solid Waste in Kathmandu Valley

Components	Waste composition (% wt)									
	a1976	a1981	a1985	a1988	a1995	a1999	b1997	c2000	d2003	e2013
Organic materials	67.8	60	67.5	58.1	65.0	67.5	65.5	69.84	70	73.22
Paper	6.5	19.3	6	6.2	4	8.8	7.3	8.5	8.5	6.89
Plastics	0.3	3.6	2.6	2.0	5	11.4	5.4	9.17	9.5	11.43
Glass	1.3	3.4	4	1.6	1	1.6	3.1	2.5	2.5	2.10
Metals	4.9	3.4	2.2	0.4	1	0.9	2.2	-	-	1.06
Textiles	6.5	5.3	2.7	2	3.0	3.6	1.7	3.02	3	1.61
Rubber and leather	0	0	0	0.4	1	0.3	1.6	0.6	-	0.62
Wood	2.7	1.6	0	0.5	3	0.6	1.4	0.73	-	-
Dust/construction debris	10	3.4	15	28.9	17	5.3	9.1	-	4.5	-
Others	-	-	-	-	-	-	1.7	0.23	2	3.07

a - UNEP, 2001
b - Jindal et al., 1997 (cited in Pokhrel and Viraraghavan, 2005)
c - http://www.fern.org.np/topics/swaste.htm#swaste, 2000 (cited in Pokhrel and Viraraghavan, 2005)
d - Joshi, 2003 (cited in Pokhrel and Viraraghavan, 2005)
e – ADB, 2013

care institutions. Health care institutions can simply segregate waste on the basis of nature of waste as prescribed on health care waste management guidelines but only few hospitals have adopted the process.

Most of health care institutions (governmental or non-governmental) are yet to carry with systematic segregation of waste at the place of generation. National Health Care Waste Management Guidelines guides for practicing the system of color coding and labeling of waste containers but most of the hospitals were not found with such practice.

The major problem of management of health care waste in Nepal is the mixing of infectious hospital waste with municipal waste. Practice has been made for segregating wastes in different colored bins but the wastes have been transported by the sweepers (cleaners) to the central storage facility, either in plastic bags or in the waste collection bucket and in most of health care institutions, locations of the temporary storage are not satisfactory and are close to water bodies or premises of hospital (Joshi, 2013). The temporary storage location, storage containers and storage management have a direct impact on the resulting environmental and health risks at the hospital, which must be well sanitized and secured for access only to authorized personnel. Though, very few hospitals of Nepal have used containers as guided by guidelines of Nepal government, the training protocol and education mechanism in most of the hospitals have not been functioning though they have committed to apply legislation (Joshi, 2013).

Table 4: Classification of Health Care Wastes

Hospitals/Wastes	Patan Hospital	National Kidney Center	Koshi Zonal Hospital
Waste production per day (average, kg)	594.0	28	441.14
General waste	377 (63.5%)	14 (50%)	302 (68.4%)
Hazardous waste	165 (27.8%)	5 (17%)	125 (28.4%)
Sharps	52 (8.8%)	9 (33%)	14 (3.1%)

(Source: Joshi, 2013)

In recent years, e-waste management has also been a very important concern in Nepal (Photographs 1 and 2). There has been increasing trend of consuming electrical and electronic goods, yet research focusing on the waste characterization and effects have to be undertaken in detail in Nepal (http://ipen.org/sites; Table 5). The responses therefore conclude that Nepal needs to identify the e-waste concerns it faces. Specific policies on e-waste are again absent, and the enactment of legislation is another priority (http://www.unep.org).

The findings of the study conducted by Upadhyaya, 2015 in Kathmandu Metropolitan City (KMC) regarding the quantification of e-waste has been presented as follows as a case:

Table 5: Import of Major Eelectronic Products (in numbers) in Nepal

Major electronic products	Fiscal year		
	2003/04	2004/05	2005/06
Televisions	109,194	145,577	245,908
Computers	46,566	25,238	216,713
Electric bulb, board and accessories	8,074,565	13,655,080	-
Pager, mobiles, wireless phones	-	26,208	28,661
Printers	12,854	52,003	-
Photocopy machines	2,402	2,597	28,858

Source: PACE Nepal, 2007

Photograph 1: E-wastes Dumped after Recovery (Maharjgunj)

Photograph 2: E-wastes at the Scrap Dealers (Kalanki)

Similarly, excessive use of pesticides and fertilizers contamination has impacted rivers and lakes. Heavy metals such as mercury and lead and chemicals discharged from industries like cement and textile have also contaminated natural environment. Other wastes which are hazardous in nature are wastes produced from industries like dry cell, foam, iron galvanizing, paint, paper and pulp, pesticides, pharmaceuticals, soap, tannery, dying, vegetable oil.

Kathmandu Metropolitan City, which contributes 70% of the total MSW generation in the nation, produces 2,968 tons of e-waste annually. Taking into consideration the total population of 1,744,240, the annual per capita e-waste generation of KMC is 1.70 kg. The cost associated with this fraction of waste generation which is evaluated on the basis of material recovery of those wastes is about 190 million Nepali rupees.

Waste Management Systems

Prior to 1950, solid wastes in Nepal were managed locally. Almost all the wastes were used as organic manure. In due course of time, significant change in both volume and character of the wastes generated led to haphazard disposal and dumping in nearby open spaces. With good initiation at some municipalities to keep themselves in harmony with environment, still there are haphazard disposal of wastes in other municipalities. Until 1980s, municipal solid waste management problems were negligible other than in Kathmandu Valley. At present, solid waste management in both industrial and domestic sectors has been a great concern in urban areas.

After the establishment of Solid Waste Management Technical Support Center (the then Solid Waste Management and Resource Mobilization Center: SWMRMC) in 1980s, with assistance from GTZ, collection segregation at transfer stations, transportation and final disposal in the sanitary landfill at Gokarna was initiated. Even now, municipal solid waste of the valley are collected, transported and disposed off through in-

stitutional efforts of Solid Waste Management Technical Support Center (SWMTSC) and the municipalities. The common practices of management in the municipalities are street sweeping and waste collection (door to door collection and collection from storage points), transport (transporting waste by tipper, trucks, tractors and trailers and small pickups) and final disposal (dumping of wastes) (Photographs 3 and 4).

The methods of final disposal carried out in previously existing 58 municipalities of Nepal vary among municipalities (Table 6). Some of the wastes generated are recycled and recycling of material separated by waste pickers has been an important part of solid waste management. In few of the cases, wastes are composted at the household level (composting and vermi-composting). In addition solid wastes should be managed in the integrated approach for sustainable management and solutions (Figure 4). Nowadays, attempts have also been made for resource recovery from solid wastes.

Existing Legal Provisions for Solid Waste Management

Existing organizational and legislative provisions for guiding solid waste management in Nepal have been outlined. It appears that legislative framework for management of specific category of solid waste needs to be framed.

SWM related Policies and Legislations

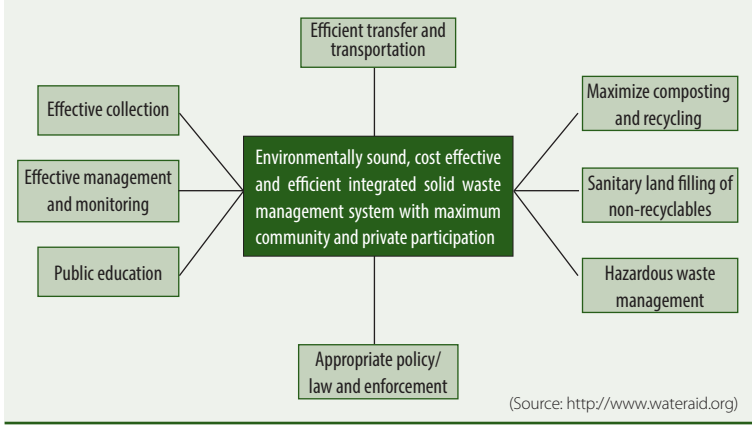
Enactment of Solid Waste Management Act in 2011 is a major step towards improving SWM practices in Nepal. Similarly, Solid Waste Management Rules, 2070 (2013) has been framed which has emphasized about the responsibility of generator in managing the chemical and harmful solid waste.

Solid Waste Management Act, 2011was enacted by Nepal Government with the major objective of maintaining a clean and healthy environment by minimizing the adverse effects of solid waste on public health and the environment. The local bodies, such as municipalities,

Photograph 3: Waste Collected at Teku Transfer Station

Photograph 4: Waste being Loaded for Transfer to Landfill from Teku

Figure 4: Strategy for Integrated Solid Waste Management



(Source: http://www.wateraid.org)

Table 6: Waste Disposal Methods in Municipalities of Nepal

SN	Types of disposal methods	Number of municipalities (N=58)
1	Sanitary landfill	6
2	Controlled dumping	5
3	Open dumping	25
4	Riverside dumping	13
5	Open dumping and riverside dumping	6
6	Roadside dumping	1
7	No municipal system	2

(Source: ADB, 2013)

have been made responsible for the construction, operation, and management of infrastructure for collection, treatment, and final disposal of MSW. The Act mandates local bodies to take the necessary steps to promote reduce, reuse, and recycle (3R), including segregation of MSW at source. It also provides for the involvement of the private sector, community-based organizations (CBOs), and nongovernment organizations (NGOs) in SWM through competitive bidding. Procedures for bidding, selection of the successful bidder, and authority of the bidder in collecting tipping fees (tariffs) against SWM services are provided. In addition, the act authorizes the imposition and collection of service fees against SWM services, and prescribes the basis for fixing such fees and procedures for their collection and usage. It also authorizes the local bodies to formulate rules, bylaws, and guidelines, with the approval of the municipal board. As provisioned in the act, the SWM Technical Support Center under the Ministry of Urban Development shall provide technical support to all local bodies for effective and sustainable SWM and advance research and development in this sector.

Other policies, acts, rules and guidelines to govern municipal waste management and settle the disputes that can arise during management and disposal of wastes which provide basic provisions on the related aspects are:

i) Acts and Regulations

1. Interim Constitution of Nepal, 2007
2. Solid Waste Management Act, 2011
3. Solid Waste Management Regulation, 2013
4. Local Self Governance Act,1998
5. Local Self Governance Regulation, 1999
6. Environment Protection Act, 1996
7. Environment Protection Rules,1997 (with amendments)
8. Industrial Enterprises Act, 1992
9. Labor Act, 1991
10. Soil and Watershed Conservation Act, 1982

ii) Policies

1. Solid Waste Management National Policy, 1996
2. Nepal Environmental Policy and Action Plan, 1993
3. National Urban Policy, 2007
4. Industrial Policy, 2010
5. National Health Policy, 1991

iii) Guidelines

1. Health Care Waste Management Guidelines, 2008/09
2. Environment Friendly Local Governance Framework, 2013

iv) International Legislations

1. Basel Convention on the Control of Transboundary Movements of Hazardous Waste, 1989
2. Stockholm Convention on Persistent Organic Pollutants, 2001
3. Strategic Approach to International Chemicals Management (SAICM)

Organizational Framework

Existing organizational mechanism for waste management in Nepal scopes from planning level governmental body to local bodies. The ministries directly responsible for solid waste management are Ministry of Science, Technology and Environment, Ministry of Federal Affairs and Local Development and Ministry of Health and Population. The ministries are responsible for guiding and supporting local bodies including municipalities and VDCs. Similarly, the role of CBOs, NGOs and private sectors working in grassroots level are also noteworthy. However, plans and programs in this sector needs to be strengthened for integrated sustainable waste management.

Conclusion

Solid waste management has become a challenge mainly due to the increasing rate of generation of wastes, limited (municipal) budget as a result of the high costs associated to its management and lack of understanding over a diversity of factors that affect the processes of waste management. Urbanization, population increase and higher consumer demand are some of the many factors for increasing the generation of solid waste in municipalities in Nepal. This review found that the major percentage of the waste in the municipalities in Nepal included organic waste that could be composted. Regarding solid waste in Nepal, various methods of reduction of the waste such as reuse and recycling can be further promoted in the municipality. The major concern is the generation of large amounts of MSW and the challenges faced by local authorities in its management. Strengthening the capacity of municipalities and VDCs with sufficient infrastructures, technical, financial and human resource coupled with strict enforcement of policies will help for effective management of solid waste.

Similarly, development of regulations dealing with specific waste stream should get a clear priority. The comprehensive policies and strategies are required in specific sectors (e-waste and radioactive waste) of solid waste management. Furthermore, technical education and public awareness at grassroots level is also needed. Financial resources will also have to be made available so as to facilitate public campaigns and waste treatment technologies. Similarly, scientific approach of landfilling is required for disposing the wastes. Especially, optimum care should be given to industrial, healthcare and hazardous wastes. Integrated solid waste management can be the future option for waste management in Nepal.

Future Directions for Solid Waste Management

The following are the future working dimensions for making the solid waste management sustainable and integrated.

- Cooperation and coordination among private/public sector organizations, CBOs, NGOs and INGOs should be further promoted.
- Almost all of the municipalities do not have adequate financial, technical, human and managerial resources. Therefore, empowerment of the municipalities in these regards is essential.
- MSW in Nepal has a larger fraction of organic waste and hence 3R should be promoted to reduce the amount of waste to be finally disposed off.
- Integrated approach of waste management is needed for segregation, collection and final disposal.
- Information and communication campaigns should be prioritized to ensure the community participation for enhancing cleaner production and green productivity.
- Enforcement of legal/economic instruments is required along with policies formulation for specific wastes like e-waste and radioactive wastes.
- Solid waste management options should be strengthened by enhancing research and development.

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CHAPTER 9

Human Settlement Situation in Nepal

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Despite long history of human settlement within the territory of Nepal, research works on settlement history, its development and salient features are very scanty. Even in the contemporary times ever since the country began to collect, compile and publish population and other data at various scales, i.e., since 1950s, settlements have been overlooked as unit of data compilation and publication. The lowest unit of data reporting in the census publications is the Village Development Committee (VDC). At the most, the total figures of population and households are available at ward level i.e., subdivisions of the VDC but not beyond. In this context this document discusses the human settlement situation in Nepal. For lack of settlement level information, the analysis has been largely limited to spatial analysis of population at various levels of scale. These various levels of scale are assumed to represent one or other levels of settlement units. Older settlements in Nepal developed along river basins and along the spurs of the hills. Permanent settlements in the lowlands of Terai are rather recent ones. As the population has grown rapidly in the country so has the expansion of settlements from highland to the lowlands. Growth is reflected in the size of population, its growth and density and in these entire components regional dimension is evident with lowlands and Terai demonstrating more prominence. At present about 62 percent population live in rural settlements and a little over 38 percent in urban settlements of various categories. Demographically, urban settlements demonstrate high growth rates, density and level of increase (change). Urban settlements are relatively better with respect to literacy, human development, and basic facilities such as electricity, drinking water, sanitation and road lengths. Likewise, urban areas are more developed with respect to housing related indicators such as types of houses, number of floors, construction materials for outer wall and roofs. However, in terms of the age of the houses, differences by rural urban categories were marginal. In the case of Jumla district for which data at the settlement hamlet level was available, suggests predominance of smaller settlements, their locations guided by river valleys and safer sites plus larger settlements along river basins. On the whole, measured on the basis of available information, human settlement situation in the country is not satisfactory in respect to locational characteristics and basic service provisions and with respect to knowledge about the settlements per se. The need for more information at the settlement hamlet level and consideration of such settlement units as basis for local level planning as well as for research and development is immediately warranted for the local and regional development of the country.

Introduction

This chapter discusses human settlement situation in Nepal based on the available information from census reports and other accessible sources. The latest census report i.e., Population and Housing Census 2011 has been taken as the main source but information from earlier censuses have also been used as and when considered appropriate. The unit of analysis has been nation, urban rural categories, the regions - both ecological and development regions, and in a limited case, the districts. Not all information is available at all four levels of scale. Therefore, the discussion is based on the scale of availability of information. Wherever, information is not available at lower scale, the discussion is limited to national and/or regional scale only.

This chapter is divided into 11 sections. The first section introduces the Chapter by providing the main purpose, source of data and organization of the

study. The second section places the concept of settlement in the Nepalese context and provides a flavor of how Nepalese have conceptualized the concept of settlement. The third section focuses on population size and growth in the country. The fourth section concentrates on the spatial aspect of population and discusses spatial pattern of population growth, household size, sex ratio, size-class distribution of population, growth rate and population density and changes therein. The fifth section primarily focuses on urban settlements. As far as possible, information is based on 191 municipalities but in some cases lack of updated information has limited some discussions to 58 municipalities only.

The sixth section provides a brief note on refugee population in Nepal. The seventh section presents details of housing conditions in the settlements by concentrating on foundations, materials used, roof, floors and the year of construction. The eighth section presents a brief account of sources of lighting and use of fuel-wood in the houses. The Ninth section is about road network situation in the district and in urban areas. It also presents a brief of vehicle registration trend in the country. The tenth section is a case of settlement situation in Jumla district where demographics and size class distributions of settlements in all village development committees (VDC) have been discussed and this is the first time such information is provided by the census returns. The last section presents conclusion of the chapter with a plea to pay attention to settlement studies and their situations and clarity on the concept of "urban" so as to make it internationally comparable.

Placing the Concept of Settlement in the Nepalese Context

Settlements are central to human beings and it is through settlements that human beings adapt to the environment to suit his/her needs. Settlements are also the most visible signs of human interventions on natural earth. Location, distributions, forms, patterns and sizes of settlements are very important aspects for understanding the natural and social setting of any portion of the globe. Therefore, settlements can be studied or analyzed at various geographic scales ranging from the world, through national and regional and the local level.

Research works on the history of development of settlements in Nepal are absolutely scanty. Whatever literature exists is based on the books of history and mostly about Kathmandu valley (see Sharma, 1989; Haffner, 1981/82). Notable oldest settlements in Nepal such as Kathmandu, and Pokhara are located along the river valleys but elsewhere in the hills, the ridges and the elevated plateau like areas appear to be the preferred locations for settlements in the earlier days. The elevated plateaus like areas are called "Tar" in vernacular Nepali and thus settlements on these lands are referred accordingly. Settlements such as Tumlingtar (Sankhuwasabha), Jarayotar (Bhojpur), Rumjatar (Okhaldhunga), Beltar (Udayapur), Palungtar (Gorkha), Kharanitar (Nuwakot), Kalikatar (Makwanpur), Majhimtar (Dhading) are a few examples of settlements from Eastern and Western hills developed on such lands. On the other hand, many settlements have developed on the plain-like lands in the hills that are likely to be level land created as the flood plain in the geological time. Such settlements are variably refereed as Patan such as Patan (Baitadi), Lekhpatan(Jajarkot), Dhorpatan (Baglung), Malepatan and Chhorepatan (Kaski). Elevated plain-like lands in the hills are also called Madi (Palpa and Chitawan), Sindhulimadi (Sindhuli) and Madi in Sankhuwasabha. Normally, settlements on such plain lands are referred as Patan in the west and as Madi in the east.

Along the hills of Nepal, human settlements have been developed on all sections: along the ridges or hilltops, in the middle part and at the foothills. Those located on the hill tops or ridges have nomenclature of "pur" or "gadhi/kot." These are settlements with sizeable number of houses to be referred as townships. Settlements with such geographic locations are spread all along the hills. For example, Silgadhi (Doti), Amargadhi (Dadeldhura), Chainpur (Bajhang), Galkot (Gulmi), Rukumkot (Rukum), Rampur (Palpa), Kaskikot (Kaski), Bhirkot (Tanahu), Charikot (Dolakha), Bhojpur (Bhojpur), Chainpur (Sankhuwasabha), and Jitpur (Ilam). Gadhi

are fort settlements whereas the purs are regular settlements. In Kathmandu valley and adjacent hills, settlements developed on elevated open land have khel as their suffix; Jawalakhel, Jhamsikhel, Bhuinkhel, Jhaukhel, Dhulikhel etc.

Along the hills, villages such as Dandagaun and Gairigaun reflect the development of settlements on the ridges/hill tops and on the middle/lower sections of the undulating hill terrain. Similarly, villages such as Jhulaghat (Baitadi), Arughat, Benighat (Gorkha), Ramdighat (Palpa), Dolalghat (Sindhupalchok), Tamaghat (Kavre), Moolghat (Dhankuta) clearly demonstrate that settlements developed in the river-crossings and/or along the river banks. More importantly, newly developed flood plains and/or river basins have become common sites for human settlements in the recent decades. Settlements such as Dhunibesi, Mahadevbesi (Dhading), Manthalibesi (Ramechhap), Mai/Majuwabesi (Ilam), signify that they have developed on the basins of small rivers.

A conjecture on succession of settlement development can be made. Until 1950s and even till 1960s, human settlements in Nepal were primarily confined to the ridges and middle sections of the hill slopes. It is after the opening of the Terai in the late 1950s and the campaign of malaria eradication in the country that encouraged hill villagers to settle in the basins. Until then, the hill people normally preferred to live in the upland (hills) rather than in the lowlands (basins). Basins were largely used for farming and not for permanent settlement due to unfavorable local environment. Temporary sheds were constructed to be used during planting and harvesting seasons. Regarding migration pattern, hill to Terai migration became notable at the national level in the 1960s and 1970s, and the highland (uphill) to lowland (basin) migration became like a normal practice at the local level (see Subedi 2015). The terms such as Gaun-besi garne, lek-besi, besi jarne commonly used in local conversation in the hills exemplifies this. The alignment of highways along the rivers and the foothills together with construction of local roads (including durable bridges) by the government provided impetus for highland residents to permanently settle in the lowlands during the late 1970s and 1980s. Population growth, family separation (inheritance related), a sense of security (from wildlife and malaria) and relatively improved access collectively encouraged their shift of residence from upland to the lowlands. This trend continues to date and it would not be an overstatement to mention that there are more settlements in valley floors of the hill region than there are settlements in the uplands at present. Nonetheless, this needs to be further investigated.

In the mountain regions, settlements are relatively small and compact. They are largely found along safe grounds and/or close to the river basins where there is availability of drinking water and where there is possibility for farming through terracing. Settlements of Manang (along Marsyangdi river), Mustang (along Kaligandaki river), Humla (along Karnali river), Jumla (along Karnali river), and Dolpa (along Suligad river) are excellent examples. The isolated dwellings and seasonal settlements in the pastures are there in the mountains but their population size and their role in the societal affairs are relatively less prominent

In the Terai region, settlements have been developed in the elevated flood plains that are relatively older. Nagars, and purs are the common terminologies to denote notable settlements there. A few examples of nagar include Biratnagar, Hanumannagar, Mechinagar, Gitanagar, Harinagar, Jayanagar (Rautahat), Srinagar (Sarlahi), and Krishnanagar. Most common settlements in the Terai have their suffixes such as pur or pura. Such names also signify the terrain characteristics of the settlements. Settlements with their identity as pur or pura are distributed throughout Terai from east to west. Bhadrapur, Chandranigahpur, Lalpur, Kanchanpur (Saptari), Janakpur, Bharatpur, Basantapur (Kapilvastu), Motipur, Kohalpur, Bhagwanpur, Kirantpur, Tikapur are some of the notable settlements demonstrating that settlements have developed in the uplands of the Terai plains. Likewise, Gunj, Gadi and Baas are also common terminologies denoting notable settlements on the safer (having low risk of natural disaster and wildlife) locations. Birgunj, Gaurigunj, Amalekhgunj, Bahadurgunj, Nepalgunj are a few examples of gunj as settlements in safer locations.

Likewise, Gadhi/Gadhs (or fort settlements) have also developed in the plain-lands of Terai. Kichhakgadh, Simroungadh, Langgadhi, Dhangadhi etc are examples of gadhi settlements. Bardibaas, Khasibaas (Siraha), Dumkibas (Nawalparasi) and Koilabas (Dang) are also good examples of older settlements in the Terai.

Overall, Nepalese landscape demonstrates regional dimension of settlement evolution and choice of locations for living. Much of the terrain characteristics of settlements can be drawn from their names and suffixes used therein. While the settlements in the hills, show more of historicity, those in Terai show more of recent development. Important point to note in the case of Terai settlements is that there are so many nagars and they definitely signify better locations and better sites but not all of them are urban settlements as per contemporary use of the term nagarpalika for municipalities.

The Population Size and Growth

The first official head count was made in 1911 which recorded a total of 5.6 million people in the country. Since then data on total population of the country has been available on a decennial basis. In between 1911 to 1930, the population of the country decreased due to World War casualty and disease epidemics. It is only by 1941 that total population showed an increase. The 1952/54 count is taken as the first scientific census since it followed the UN standard in the content and enumeration process. Onwards, Nepal has experienced a rapid population growth till 2001. In a period of 100 years, Nepal's population has increased by almost five fold i.e., from 5.6 million to 26.5 million (Table 1).

The inter-censal rate of population growth has been over 2 percent per-annum since 1952/54 till 2001 (1961 is an exception). The doubling time of population between these years has been a little over 33 years on an average. The latest census shows a low growth rate compared with the past 6 decades. But this small figure of growth rates needs to be understood cautiously since the total population figure of 2011 i.e., 26,494,504 does not include total absentee population of 1,921,494 in its arithmetic. Nevertheless, this low growth rate demonstrated by 2011 census suggests a positive scenario when rapid growth in the past had been blamed for sluggish development and environmental degradations in the country. Socio-demographically, it also suggests that investment on population should now be directed towards quality development of population from an emphasis on quantity control to date.

Table 1: Population Trends, Inter-censal Growth Rates and Doubling Time

Census year	Total population	Change in population size		Inter-censal annual growth rate	Doubling time
		Number	Percent		
1911	5,638,749	-	-	-	-
1920	5,573,788	-64,961	-1.2	-0.13	-
1930	5,532,574	41,214	0.7	-0.07	-
1941	6,283,649	751,075	13.6	1.16	60
1952-54	8,256,625	1,972,976	31.4	2.27	31
1961	9,412,996	1,156,371	14.0	1.64	42
1971	11,555,983	2,142,987	22.8	2.05	34
1981	15,022,839	3,466,856	30.0	2.62	26
1991	18,491,097	3,468,258	23.1	2.08	33
2001	23,151,423	4,660,326	25.2	2.25	31
2011	26,494,504	3,343,081	14.4	1.35	51.3

Source: Respective population Censuses.

Spatial Aspects of Population

Area Coverage, Population and Density

With respect to territorial units three ecological regions namely mountain, hill and Terai have been recognized in Nepal. Similarly, five development regions namely Eastern, Central, Western, Mid-western, and Far-western are also recognized for political-administrative reasons. The country is divided into 75 districts for administrative purposes. Table 2 presents the area, population and density of population by ecological and development regions of the country. Kathmandu, the capital city lies in the hill region. Since the valley has unique demographic and social characteristics, it has been treated as separate category.

With respect to area coverage, Terai is the smallest region but with respect to population it is the largest region. On the contrary, with respect to area coverage, hill is the largest region and with respect to population the mountain region is the smallest. Population size by ecological regions increases from north to south and so is the density of population. The average density of population is 180 persons per sq km in the country. Terai region shows the highest density with respect to three fold classifications of mountain, hill and Terai but when Kathmandu valley is treated separately it has the highest density demonstrating 2,800 persons per sq km.

Households, Sex Ratios and Population Growth

Table 3 shows the household size, sex composition and population growth rates by ecological and development regions. Population and Housing Census (PHC) 2011 reported a total of 5,427,302 households and household size of 4.9 persons. Differences by regions are evident and Hill shows the largest number of households. But Terai demonstrates largest household sizes i.e., 5.3 persons per household. The hill region shows the smallest household size.

Results of PHC 2011 showed more females than males among usual resident people in the country. However, the census also reported 1,921,494 absent population from the country: of which males constituted 87.6 percent. The average sex ratio was 94.2 (males per 100 females). The hill demonstrated lowest sex ratio (91.4) although Kathmandu valley showed otherwise. Terai has the highest sex ratio among ecological regions. These regional difference in sex ratios in general and that of ratios less than 100 are reflections of large exodus of males from the country.

Table 4 presents population, sex ratio, households and household sizes by eco-development (sub-regions) regions. Of all the sub-regions, Western Mountain has the lowest share of population and Central Terai shares the largest proportion. Likewise Central Hill, Eastern Terai and Western Hill are among sub-regions that share large proportion of population. More importantly, sub-regions that share larger proportion of national population are associated with one or more larger urban settlements. For example Central Terai has urban settlements such as Birgunj and Bharatpur. Kathmandu lies in the Central hill while Western Hill's larger share is associated with the presence of Pokhara sub-metropolitan. In Terai, migration was the main impetus of population growth in the past (see Gurung, 1989).

Household sizes differ by sub-regions. Generally sub-regions of Terai demonstrate larg-

Table 2: Area, Population and Density by Regions

Regions	No. of districts	Area coverage		Population		Density (p/km²)
		Total area (km²)	Percent share	Total size	Percent share	
Ecological						
Mountain	16	51817	35.2	1,781,792	6.7	34.4
Hill excluding Kathmandu valley	36	60446	41.1	8,876,984	33.5	146.9
Kathmandu valley	3	899	0.6	2,517,023	9.5	2799.8
Terai	**20**	**34,019**	**23.1**	**13,318,705**	**50.3**	**391.5**
Development						
Eastern	16	28,456	19.3	5,811,555	21.9	204.2
Central	19	27,410	18.6	9,656,985	36.4	352.3
Western	16	29,398	20.0	4,926,765	18.6	167.6
Mid-western	15	42,378	28.8	3,546,682	13.4	83.7
Far-western	9	19,539	13.3	2,552,517	9.6	130.6
Nepal	**75**	**147,181**	**100**	**26,494,504**	**100**	**180.0**

Source: Central Bureau of Statistics, 2012.

Table 3: Household Size, Sex Ratio and Population Growth Rate

Regions	Households		Sex composition of population			Population growth rate
	Total	HH size	Male	Female	Sex ratio	
Ecological						
Mountain	364,120	4.9	862,592	919,200	93.8	0.54
Hill excluding Kathmandu valley	1,919,653	4.6	4,134,100	4,742,884	87.2	0.31 (1.06)
Kathmandu valley	614,777	4.1	1,305,967	1,211,056	107.8	4.25
Terai	2,528,752	5.3	6,546,382	6,772,323	96.7	1.72
Development						
Eastern	1,231,505	4.7	2,790,483	3,021,072	92.4	0.84
Central	1,964,045	4.9	4,841,624	4,815,361	100.5	1.84
Western	1,066,362	4.6	2,292,597	2,634,168	87.0	0.75
Mid-western	695,419	5.1	1,706,450	1,840,232	92.7	1.63
Far-western	469,971	5.4	1,217,887	1,334,630	91.3	1.53
NEPAL	**5,427,302**	**4.9**	**12,849,041**	**13,645,463**	**94.2**	**1.35**

Source: Central Bureau of Statistics 2012.

Table 4: Nepal: Population, Sex Ratio and Household Size by Eco-development Region, 2011

Regions	Population			Number of households	Household size
	Total	Percent	Sex ratio		
Mountain					
Eastern	392,089	1.5	91.2	84,918	4.6
Central	517,655	2.0	91.1	122,154	4.2
Western	19,990	0.1	116.4	4,834	4.1
Mid-western	388,713	1.5	101.5	68,902	5.6
Far-western	463,345	1.7	92.1	83,312	5.6
Hill					
Eastern	1,601,347	6.0	89.5	346,571	4.6
Central	4,431,813	16.7	100.5	1,016,181	4.4
Western	2,811,135	10.6	81.3	677,498	4.1
Mid-western	1,687,497	6.4	90.2	332,153	5.1
Far-western	862,215	3.3	87.0	162,027	5.3
Terai					
Eastern	3,818,119	14.4	93.7	800,018	4.8
Central	4,707,517	17.8	101.7	825,710	5.7
Western	2,095,640	7.9	95.1	384,030	5.5
Mid-western	1,470,472	5.6	93.5	294,364	5.0
Far-western	1,226,957	4.6	94.0	224,632	5.5

Source: Central Bureau of Statistics, 2012.

er household sizes than the national average but Eastern Terai is an exception. Mid-western and Far-western mountains show larger household sizes. In the case of hills, the sub-regions clearly show regional difference from east to west. Household sizes in the Eastern, Central and Western sub-regions are smaller than those in the Mid-west and Far-west.

Inter-censal Growth Rates of Population

Inter-censal annual growth rates of population over the last six censuses shows that until 2001 there was rapid growth of population at the national level. Between 1961 and 2001, the average annual growth rate has been consistently over 2 percent per annum. This roughly means with respect to total population size there is likelihood of another Nepal in every 35 years. However, the latest census has suggested otherwise and if the rate of growth of population continues as per census 2001, we may have another Nepal only in 52 years which probably is a positive note amidst rapid growth in the past. Table 5 presents the annual growth rates of population for the last five inter-censal periods.

Regional differences are but quite natural in the growth rate of population in the country. The mountain region has always demonstrated low population growth rates and census results of the last five decades have clearly shown this. The hill as it occupies middle position in its location shows the similar intermediate position in annual population growth rates. Both these regions have shown growth rates lower than the national average in all these inter-censal periods. Terai has remained very dynamic in its demography and in all inter-censal periods noted above, it has demonstrated far higher growth rates than the national average. This consistent high growth rate in Terai can largely be explained by large scale in-migration from the hills and the mountain until recently.

Table 5: Population Growth Rates by Ecological regions

Inter-censal Periods	Average Annual Growth Rate of Population 1961-2011			
	Mountain	Hill	Terai	National total
1961-1971	-	-	2.39	2.05
1971-1981	1.35	1.65	4.11	2.62
1981-1991	1.02	1.61	2.75	2.08
1991-2001	1.57	1.97	2.62	2.25
2001-2011	0.54	1.06	1.72	1.35

Source: Respective Censuses.

Size Class Distribution of Population and Change by Districts

Districts differ in their population sizes as they differ in area coverage. In 1971, the average population per district (75) was 154,080. Manang (the smallest district in population) had a total population of 7,436 and none of the districts had population over 400,000. Forty one districts belong to the size class between 100,000 and 200,000 population. Only 7 districts had population more than 300,000. In 1981 the average population per district increased to 200,304. Manang remained at the bottom falling in the size class of less than 10,000 people. Largest number of districts had population in the size classes between 100,000 and 200,000. One district (Kathmandu) had population above 500,000 and three others had

Table 6: Change in Size Class Distribution of Population by Districts

Size class	Number of District					Population Size				
	1971	1981	1991	2001	2011	1971	1981	1991	2001	2011
Less than 10,000	1	1	1	1	1	7,436	7,021	5,363	9,587	6,538
10,000-19,999	3	1	1	1	1	45,644	12,930	14,292	14,981	13,452
20,000-29,999	3	2	1	1	-	82,186	42,346	25,013	29,545	-
30,000-39,000	-	1	3	-	1	-	30,241	107,491	-	36,700
40,000-49,999	-	1	-	3	1	-	43,705	-	129,263	43,300
50,000-59,999	1	-	-	-	2	57,946	-	-	-	106,144
60,000-69,999	3	1	-	-	-	199,073	68,797	-	-	-
70,000-79,999	-	1	1	-	-	-	74,649	75,964	-	-
80,000-89,999	2	3	1	1	-	171,279	262,736	88,805	89,427	-
90,000-99,999	2	4	2	-	-	190,986	378,888	189,210	-	-
100,000-199,999	41	28	25	16	20	5,802,698	4,433,030	3,842,156	2,240,152	3,014,094
200,000-299,999	12	18	20	23	19	2,752,028	4,293,871	5,034,279	5,570,510	4,816,345
300,000-399,999	7	10	6	11	6	2,245,707	3,505,384	2,092,131	3,920,048	2,014,279
400,000-499999	-	3	9	4	6	-	1,334,549	4,006,670	1,913,623	2,749,844
500,000 or more	-	1	5	14	18	-	534,692	3,009,723	9,234,287	13,693,808
Total (Nepal)	75	75	75	75	75	11,554,983	15,022,839	18,491,097	23,151,423	26,494,504

Source: Respective Population Censuses.

between 400,000 and 500,000 people (Table 6).

In 1991, the average population of the district was 246,548. A large number of districts belonged to the size class over 200,000. Fourteen out of 75 districts had their population above 400,000. More importantly, five districts reached the ladder of size class more than 500,000. Increase in population in 2001 census resulted into shift of many districts from lower size classes to higher size classes. Largest number of districts belonged to the size class between 200,000 and 300,000 population. The average population of the district increased to 308.686.

The census results of 2011 showed an increase of 44,574 people in the average district population compared with 2001 census. The average population per district increased to 353,260. Twenty four districts demonstrated their population sizes over 400,000 and there were 18 districts with population sizes over 500,000 people. By now largest chunk of population lived in districts with their population sizes over 500,000 populations.

Population Density

Since density reflects a relationship between area and population a brief discussion of relative status of regions and sub-regions by their area is a precursor. Table 7 presents the area coverage and relative status of 15 sub-regions (eco-development regions). Relative status of major regions, ecological and development, have already been discussed above. Of all the sub-regions, Mid-western region is the largest and Far-western Terai is the smallest. The average areal size of sub-regions is 9812 sq km. In the hill region, Far-western sub-region is

Table 7: Area Coverage by Regions and Sub-regions

Ecological Regions		Development Regions (area in km²)					Total	
		Eastern	Central	Western	Mid-Western	Far-western	Area	Percent
Mountain		10,438	6,277	5,819	21,351	7932	51,817	35.2
Hill		10,749	11,805	18,319	13,710	6762	61,345	41.7
Terai		7,269	9,328	5,260	7,317	4845	34,019	23.1
Total	**Area**	**28,456**	**27,410**	**29,398**	**42,378**	**19539**	**147,181**	**100**
	Percent	**19.3**	**18.6**	**20.0**	**28.8**	**13.3**		**100**

Source: Department of Survey, Ministry of Land Reform and Management.

Table 8: Changing Population Density by Regions and Sub-regions

Ecological regions	Year	Development Regions (density in persons/sq km)					Total
		Eastern	Central	Western	Mid Western	Far Western	
Mountain	1981	32	66	3	11	36	25
	1991	34	75	3	12	42	28
	2001	38	88	4	14	50	33
	2011	38	82	3	18	58	34
Hill	1981	117	179	117	76	89	117
	1991	133	227	132	89	99	137
	2001	153	300	152	107	118	167
	2011	149	375	153	123	128	186
Tarai	1981	291	256	182	92	88	193
	1991	366	325	253	127	140	254
	2001	454	422	333	168	205	330
	2011	525	505	398	201	253	392
Nepal	1981	130	179	106	46	68	102
	1991	156	226	128	57	86	126
	2001	188	293	155	71	112	157
	2011	204	352	168	84	131	180

Source: Respective population Censuses.

the smallest and Western sub-region the largest. On the whole, regional disparity in the areal extent of sub-regions is quite evident.

As the country is characterized by high population growth till lately, the density of population in the sub-regions have also changed or increased accordingly. All sub-regions have experienced change in population density. Table 8 demonstrates changing population density by 15 sub-regions. The country as a whole had a population density of 102 persons per sq km in 1981 which increased to 126 in 1991, 157 in 2001 and 180 in 2011. By major ecological regions, Terai has always demonstrated higher density. Given the terrain condition, the density of population gradually increases from north to south and this is true of all the census results. Likewise, Central development region shows high density consistently in all censuses.

In all four censuses i.e., 1981, 1991, 2001 and 2011, the population density in the Eastern

Table 9: Population, Households and Population Density by District, 2011

District	Population 2011			Annual Growth Rate (%)	Sex Ratio	Number of Household	Average Household Size	Area in Sq.km.	Population Density (persons / km^2)
	Total	Male	Female						
Taplejung	127,461	60,552	66,909	-0.55	90	26,509	4.81	3,646	35
Panchthar	191,817	90,186	101,631	-0.52	89	41,196	4.66	1,241	155
Ilam	290,254	141,126	149,128	0.26	95	64,502	4.50	1,703	170
Jhapa	812,650	385,096	427,554	1.66	90	184,552	4.40	1,606	506
Morang	965,370	466,712	498,658	1.35	94	213,997	4.51	1,855	520
Sunsari	763,487	371,229	392,258	1.99	95	162,407	4.70	1257	607
Dhankuta	163,412	76,515	86,897	-0.19	88	37,637	4.34	891	183
Terhathum	101,577	47,151	54,426	-1.08	87	22,094	4.60	679	150
Sankhuwasabha	158,742	75,225	83,517	-0.03	90	34,624	4.58	3,480	46
Bhojpur	182,459	86,053	96,406	-1.07	89	39,419	4.63	1,507	121
Solukhumbu	105,886	51,200	54,686	-0.17	94	23,785	4.45	3,312	32
Okhaldhunga	147,984	68,687	79,297	-0.57	87	32,502	4.55	1,074	138
Khotang	206,312	97,092	109,220	-1.15	89	42,664	4.84	1,591	130
Udayapur	317,532	149,712	167,820	0.99	89	66,557	4.77	2,063	154
Saptari	639,284	313,846	325,438	1.14	96	121,098	5.28	1,363	469
Siraha	637,328	310,101	327,227	1.07	95	117,962	5.40	1,188	536
Dhanusa	754,777	378,538	376,239	1.17	101	138,249	5.46	1,180	640
Mahottari	627,580	311,016	316,564	1.26	98	111,316	5.64	1,002	626
Sarlahi	769,729	389,756	379,973	1.91	103	132,844	5.79	1,259	611
Sindhuli	296,192	142,123	154,069	0.57	92	57,581	5.14	2,491	119

District	Population 2011			Annual Growth Rate (%)	Sex Ratio	Number of Household	Average Household Size	Area in Sq.km.	Population Density (persons / km^2)
	Total	Male	Female						
Ramechhap	202,646	93,386	109,260	-0.47	85	43,910	4.62	1,546	131
Dolakha	186,557	87,003	99,554	-0.91	87	45,688	4.08	2,191	85
Sindhupalchok	287,798	138,351	149,447	-0.61	93	66,688	4.32	2542	113
Kavrepalanchowk	381,937	182,936	199,001	-0.10	92	80,720	4.73	1396	274
Lalitpur	468,132	238,082	230,050	3.26	103	109,797	4.26	385	1216
Bhaktapur	304,651	154,884	149,767	3.01	103	68,636	4.44	119	2560
Kathmandu	1,744,240	913,001	831,239	4.78	110	436,344	4.00	395	4416
Nuwakot	277,471	132,787	144,684	-0.39	92	59,215	4.69	1,121	248
Rasuwa	43,300	21,475	21,825	-0.33	98	9,778	4.43	1,544	28
Dhading	336,067	157,834	178,233	-0.08	89	73,851	4.55	1,926	174
Makwanpur	420,477	206,684	213,793	0.69	97	86,127	4.88	2,426	173
Rautahat	686,722	351,079	335,643	2.31	105	106,668	6.44	1,126	610
Bara	687,708	351,244	336,464	2.07	104	108,635	6.33	1,190	578
Parsa	601,017	312,358	288,659	1.90	108	95,536	6.29	1,353	444
Chitawan	579,984	279,087	300,897	2.06	93	132,462	4.38	2,218	261
Gorkha	271,061	121,041	150,020	-0.61	81	66,506	4.08	3,610	75
Lamjung	167,724	75,913	91,811	-0.55	83	42,079	3.99	1,692	99
Tanahu	323,288	143,410	179,878	0.25	80	78,309	4.13	1,546	209
Syangja	289,148	125,833	163,315	-0.93	77	68,881	4.20	1,164	248
Kaski	492,098	236,385	255,713	2.57	92	125,673	3.92	2,017	244
Manang	6,538	3,661	2,877	-3.83	127	1,480	4.42	2,246	3
Mustang	13,452	7,093	6,359	-1.08	112	3,354	4.01	3,573	4
Myagdi	113,641	51,395	62,246	-0.07	83	27,762	4.09	2,297	49
Parbat	146,590	65,301	81,289	-0.74	80	35,719	4.10	494	297
Baglung	268,613	117,997	150,616	-0.01	78	61,522	4.37	1,784	151
Gulmi	280,160	120,995	159,165	-0.57	76	64,921	4.32	1,149	244
Palpa	261,180	115,840	145,340	-0.28	80	59,291	4.41	1,373	190
Nawalparasi	643,508	303,675	339,833	1.34	89	128,793	5.00	2,162	298
Rupandehi	880,196	432,193	448,003	2.17	96	163,916	5.37	1,360	647
Kapilbastu	571,936	285,599	286,337	1.71	100	91,321	6.26	1,738	329
Arghakhanchi	197,632	86,266	111,366	-0.53	77	46,835	4.22	1,193	166
Pyuthan	228,102	100,053	128,049	0.71	78	47,730	4.78	1,309	174
Rolpa	224,506	103,100	121,406	0.67	85	43,757	5.13	1,879	119
Rukum	208,567	99,159	109,408	1.01	91	41,856	4.98	2,877	72
Salyan	242,444	115,969	126,475	1.27	92	46,556	5.21	1,462	166
Dang	552,583	261,059	291,524	1.78	90	116,415	4.75	2,955	187
Banke	491,313	244,255	247,058	2.42	99	94,773	5.18	2,337	210
Bardiya	426,576	205,080	221,496	1.09	93	83,176	5.13	2,025	211
Surkhet	350,804	169,421	181,383	1.95	93	72,863	4.81	2,451	143
Dailekh	261,770	126,990	134,780	1.50	94	48,919	5.35	1,502	174
Jajarkot	171,304	85,537	85,767	2.39	100	30,472	5.62	2,230	77
Dolpa	36,700	18,238	18,462	2.17	99	7,488	4.90	7,889	5

District	Population 2011			Annual Growth Rate (%)	Sex Ratio	Number of Household	Average Household Size	Area in Sq.km.	Population Density (persons / km²)
	Total	Male	Female						
Jumla	108,921	54,898	54,023	1.97	102	19,303	5.64	2,531	43
Kalikot	136,948	68,833	68,115	2.60	101	23,013	5.95	1,741	79
Mugu	55,286	28,025	27,261	2.30	103	9,619	5.75	3,535	16
Humla	50,858	25,833	25,025	2.25	103	9,479	5.37	5,655	9
Bajura	134,912	65,806	69,106	2.15	95	24,908	5.42	2,188	62
Bajhang	195,159	92,794	102,365	1.56	91	33,786	5.78	3,422	57
Achham	257,477	120,008	137,469	1.07	87	48,351	5.33	1,680	153
Doti	211,746	97,252	114,494	0.22	85	41,440	5.11	2,025	105
Kailali	775,709	378,417	397,292	2.29	95	142,480	5.44	3,235	240
Kanchanpur	451,248	216,042	235,206	1.77	92	82,152	5.49	1,610	280
Dadeldhura	142,094	66,556	75,538	1.19	88	27,045	5.25	1,538	92
Baitadi	250,898	117,407	133,491	0.68	88	45,191	5.55	1,519	165
Darchaula	133,274	63,605	69,669	0.88	91	24,618	5.41	2,322	57

Source: Population and Housing Census (PHC), 2011.

Terai has remained the highest. On the contrary, Western mountain has the lowest density. Among sub-regions of the mountain, the highest change has been noted in Mid-western region between 1981 and 2011 and the Far-western region comes next. Western mountain shows almost no change in the density of population over the last 20 years. In the hill region, largest change (increase in density has been observed in the central region and this is primarily the impact of migration of people to the capital city. A gradual change in density is observed in the Eastern and Western hill.

District Scenario of Population, Growth Rates and Densities

Table 9 provides the district level scenario of total population by sex composition, annual population growth rates, number of households and density of population in 2011. Districts have been arranged in the previous zonal order starting from the districts of Mechi zone and ending with districts of Mahakali zone. Population composition needs no further mention. The annual growth rate figures are interesting. Of the 75 districts, 27 districts demonstrate negative growth rates and most of such districts are from the hills and mountains. Fifteen districts show their average annual growth rates over 2.0 percent per annum. Kathmandu by far, shows the highest annual population growth rate. All three districts of Kathmandu valley demonstrate their population growth rates exceeding 3 percent per annum. If these growth rates for Kathmandu valley districts continue, the valley population is likely to double in less than 24 years.

Population in Urban Settlements

In Nepal, as elsewhere, there is a tendency of dividing and discussing population into spatial categories of urban and rural. Urban population refers to people living within the municipalities designated by the government of Nepal. Rest of the population i.e., people living within the village development committees are categorized as rural population. In 2011 at the time of census enumeration, there were 58 municipalities. Thus, in 2011, there were a total of 4,523,820 individuals living in the municipalities and this constituted 17.2 percent of the total population of the country. On May 8, 2014, The Government of Nepal had declared 72 municipalities and by this declaration, the proportion of population living in urban settlements by the middle of 2014 had reached 27.2 percent (for detail see Subedi, 2014)

In 2014, The Government of Nepal declared 133 new municipalities incorporating sev-

eral VDCs. By the end of 2014, there were 191 municipalities and the total urban population reached 10,125,986. Thus, by 2014, of the total population enumerated by 2011 census, 37.2 percent live in designated urban settlements. Likewise a total of 16,368,518 people live in rural settlements of various sizes and the proportion living in rural settlements constitutes 61.8 percent.

Regional Pattern of Urban Population

Table 10 presents the distribution of urban population by ecological and development regions. There is a relative concentration of urban population in Terai and almost 53 percent of the total urban population lives in Terai. The share of Hill region is less than 45 percent. More importantly, the mountain region that shares 6.7 percent of total population of the country, shares only 2.5 percent urban population. Compared with the share of total national population, Terai region is over represented and both, the hill and the mountain region, under-represented with respect to urban population.

Among five development regions, the Central region shares the highest proportion of urban population. 45 percent of total urban population lives in Central development region. This is primarily because this region has large urban areas such as Kathmandu -the capital city, Lalitpur, Birgunj, Bharatpur and Hetauda. Eastern development region shares about one-fifth of total urban population. This region also has a relatively large urban areas such as Biratnagar, Dharan and Itahari among others. Western development region shares about 18 percent of the urban population. Pokhara – the second largest city in the nation belongs to Western development region. The share of urban population in Mid-western and Far-western development regions is fairly small compared with other regions.

Urban Area and Its Regional Dimension

Total municipal area covered by 191 municipalities in the country is 17,448 sq km. This constituted 11.9 percent of the total area in the country. Similar to the proportional share in population, the share of total urban area is also the highest in the Terai. 52 percent of municipal area lies in the Terai and the hill shares 38 percent. The Mountain region shares 9.3 percent of total urban area and this proportional share of mountain is higher than its share in total urban population (Table 11).

Development regions differ in their share of urban area but the interregional difference is far lower compared with regional difference in the share of population. Central development region shares the highest and is followed by Eastern development region. The Mid-western region shares the least proportion. The proportional share of urban area is related to the total number of municipalities in the respective regions. The Mid-western region has the lowest number of municipalities (19) and the Central region the highest (68). The Eastern, Western and Far-western regions have 47, 36 and 21 municipalities respectively. Their standings in the proportional share of urban areas are also in accordance with their respective numbers.

Level of Urbanization

With declaration of 133 new municipalities (72 on May 8, 2014 and 61 on December 2, 2014) Nepal's urbanization level has reached to 38.2 percent. With this level of urbanization, Nepal ranks second

Table 10: Urban Population Distribution by Regions 2011

Ecological Regions		Development Regions					Total	
		Eastern	Central	Western	Mid-western	Far-western	No.	%
Mountain		95,838	80,746	0	19,047	59,284	254,915	2.5
Hill		341,536	2,849,075	884,467	281,970	157,735	4,514,783	44.6
Tarai		1,547,360	1,636,834	897,677	618,365	656,052	5,356,288	52.9
Total	**No.**	**1,984,734**	**4,566,655**	**1,782,144**	**919,382**	**873,071**	**10,125,986**	**100**
	%	**19.6**	**45.1**	**17.6**	**9.1**	**8.6**		**100**

Source: Central Bureau of Statistics, unpublished records 2014

Table 11. Urban Area by Ecological and Development Regions 2014

Region		EDR	CDR	WDR	MWDR	FWDR	Total	
							No.	%
Mountain		669.4	296.0	0.0	102.0	550.4	1,617.8	9.3
Hill		1,429.0	1,858.5	1,460.2	956.5	1,003.5	6,707.7	38.4
Tarai		1,992.7	2,833.8	1,736.8	1,190.1	1,369.5	9,122.8	52.3
Total		**4,091.1**	**4,988.3**	**3,197.0**	**2,248.6**	**2,923.3**	**17,448.3**	**100**
	%	**23.4**	**28.6**	**18.3**	**12.9**	**16.8**		**100**

Source: Calculation based on Survey Department, Ministry of Land Reform and Management, GoN.

Table 12: Urbanization Level by Regions and Sub-regions (eco-development regions) 2014

Region	Eastern	Central	Western	Mid-western	Far-western	Total
Mountain	24.4	15.6	0.0	4.9	12.8	14.3
Hill	21.3	64.3	31.5	16.7	18.3	39.6
Tarai	40.5	34.8	42.8	42.1	53.5	40.2
Nepal	34.2	47.3	36.2	25.9	34.2	38.2

Source: PHC 2011.

in South Asia. The only country to exceed Nepal's urbanization level is Maldives. India, Bangladesh, Sri Lanka and Pakistan are far behind Nepal in this matter. This comparison is simply based on percent of population living in defined nagarpalika (municipalities). The issue of quality of urban life, availability of urban facilities and urbanism among residents of urban settlements are different matters and this is beyond the scope of this paper.

Urbanization by broad regions has been discussed earlier. To reiterate, Terai is the most urbanized region, where more than 40 percent of its population live in urban settlements and mountain is the least urbanized region. With respect to level of urbanization, the hill and Terai are fairly similar and Hill is behind only by 0.6 percentage point. Similarly, Central development region is the most urbanized region and it far exceeds others by a large margin. Western and Eastern regions that rank second and third are not much distant apart in their level of urbanization. Table 12 presents the level of urbanization by 15 sub-regions in the country. Western Mountain does not have any municipality and urban settlements are non-existent there to date.

Of all the sub-regions, Central hill is the most urbanized sub-region and Mid-western Mountain the least urbanized one. With an exception of central hill, all sub-regions of Terai demonstrate higher level of urbanization. A trend of decrease in level of urbanization is evident as we move from south to north along ecological regions. Eastern region appears as an exception where the hill (sub-region) is the less urbanized than the mountain. For example, the level of urbanization is more than 24 percent in eastern mountain and its corresponding hill's urbanization level is only slightly over 21 percent. In a similar manner, among sub-regions of Terai, Far-western Terai shows highest level of urbanization where more than half of its population lives in designated urban settlements. Much of these differences noted have to do with number game i.e., number of defined municipalities rather than actual urbanism demonstrated by these regions and sub-regions. However, given lack of other succinct measures of urbanization, the declared numbers of municipalities in a particular sub-region and population living within this defined urban area have remained the main indicators of measuring and comparing inter-regional urbanization in Nepal at this time.

Table 13: Urban Population Density and Change between 2001 and 2011

Regions	2011			2001			Change in density (%)
	Urban area (km^2)	Population	Density (person/ km^2)	Urban area km^2)	Population	Density (person/ km^2)	
Mountain	1617.8	254,915	157.6	156	43,705	280.0	-43.7
Hill (all)	6,707.7	4,514,783	673.1	1,598	1,716,277	479.9	40.3
Kathmandu valley (KV)	636.98	2,381,302	3,738.4	97	995,966	10,262.4	-63.6
Hill (excl. KV)	6,070.72	2,133,481	351.4	1,501	720,311	479.9	-26.8
Terai	9,122.8	5,356,288	587.1	1,522	1,467,897	961.3	-38.9
Nepal	17,448.3	10,125,986	580.3	3,276	3,227,879	985.3	-41.1

Source: PHC 2011 and Department of Survey, Ministry of Land Reform and Management.

Density of Population in Urban Settlements and Their Change

In 2011, the urban population density was 580 persons per sq km. This refers to an overall man-land (all) ratio of 191 municipalities. Urban areas in the hills in general have higher densities than those in the mountain and the Terai areas. However, this average high density in the hill municipalities is largely because of the dense population in the municipalities of Kathmandu valley. When Kathmandu valley, which comprises 21 out of total 191 municipalities is considered separately, it shows the urban density of 3738 persons per sq km. It is almost 6.5 times greater than the national average density of urban area. On the other hand, the population density of urban areas in the hills excluding Kathmandu valley is only 351 persons per sq km. Table 13 presents the population density of urban areas by regions for 2001 and 2011 and their inter-censal change.

Of all the municipalities Terai region has 96. Urban density in Terai municipalities is slightly higher than the national average but lower than

that of the average for the hill region. The mountain region that has 13 municipalities has very low urban population density compared with the national average. This is because municipalities of the mountain region cover larger areas but they have small population size.

In 2001 the average urban population density was 985 persons per sq km. By then, only 2.2 percent area of the country was urban and there were only 58 municipalities. Terai had the highest urban density followed by the hill and the mountain. Of course, when 5 municipalities of Kathmandu valley are treated separately, average urban density was as high as 10,262 persons per sq km. Except hill, average urban density was high in Terai and the mountain in 2001 compared with 2011.

Inter-censal change in urban density is negative between 2001 and 2011. It is only the hill (all) that shows a positive change of 40 percent. Otherwise, all regions show negative change. This is an interesting scenario and is largely a reflection of government's decision of reclassifying rural areas into municipalities without due consideration of population density as one of the criteria for defining urban area.

Urban Population Growth and Urbanization

Available data suggests that Nepal is rapidly urbanizing and the proportion of people living in urban areas is increasing rapidly. Whether all 191 municipalities have basic urban facilities or not is a different issue but given that the government of Nepal has declared them as *nagarpalika* and that all those designated *nagarpalika* are considered as urban areas, one would get an impression that in recent years, Nepal has progressed very well in its development. This is because, level of urbanization is normally taken as one of the indicators of development and 38.2 percent population in this country lives in municipalities. In 1952/54, the country had only 10 prominent localities and the proportion of people living in these urban settlements was only 2.9 percent. The urban scenario has changed significantly over the years. Table 14 shows the trends of urbanization and percent of people living in rural and urban settlements. There has been an increase in number of municipalities, total urban population and percent of people living in urban and rural settlements. Over the last 62 years, the number of urban places has increased from 10 to 191. Likewise, the population living in urban settlements has increased from 238,275 in 1952/54 to 10,125,986 in 2014. This is an increase of 42.5 times.

Table 14: Urbanization Trends and Proportions of Population Living in Urban and Rural Settlements

Year	No. of urban places (municipalities)	Population size	Percent of population living in	
			Urban settlements	Rural settlements
1952/54	10	238,275	2.9	97.1
1961	16	336,222	3.6	96.4
1971	16	461,938	4.0	95.8
1981	23	956,721	6.4	93.6
1991	33	1,695,719	9.2	89.9
2001	58	3,227,879	13.9	83.8
2011	58	4,523,820	17.1	82.9
2014*	191	10,125,986	38.2	61.8

Note: *The government of Nepal declared 133 new municipalities in by re-organizing more than 665 existing village development committees. It also annexed 98 VDCs to the existing municipalities in the same year.

Source: Based on respective censuses.

By 2014, more than 38 percent people in the country live in urban places of different sizes. The proportion of total nation's population living in rural settlements is 62 percent. This suggests that though Nepal is still dominated by rural population, the level of urbanization is rapidly increasing. The rate of growth of urban population is consistently high compared with the rate of growth of nation's total population. Figure 1 shows the

Figure 1: Growth Rate of Urban and Total National Population (1961-2014)

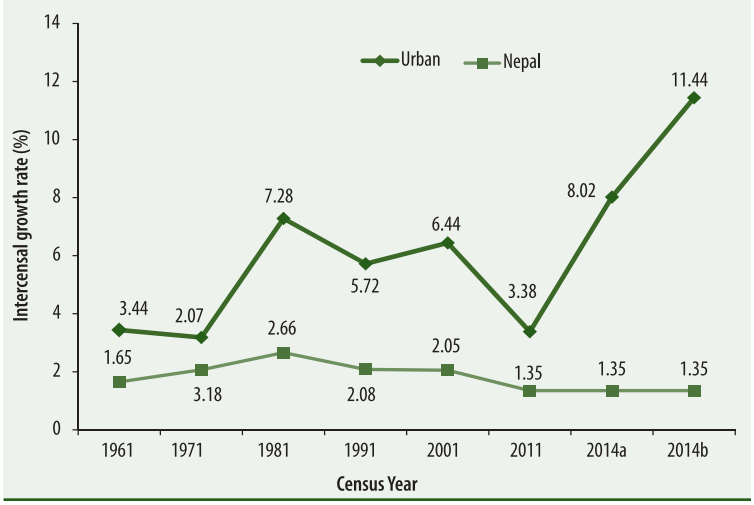

Table 15: Metropolitan and Sub-metropolitan Cities and Their Population in Nepal 2011

Name of the urban area	Category	Total population	Location	
			District	Sub-region
Mahanagarpalika (Metropolitan city)				
Kathmandu mahanagarpalika	Metropolitan City	975,453*	Kathmandu	Central hill
Upa-mahanagarpalika (Sub-metropolitan city)				
Pokhara	Sub-metropolitan	313,841	Kaski	Western hill
Lalitpur	Sub-metropolitan	254,308	Lalitpur	Central hill
Birgunj	Sub-metropolitan	202,240	Parsa	Central Terai
Biratnagar	Sub-metropolitan	201,125	Morang	Eastern Terai
Bharatpur	Sub-metropolitan	199,867	Chitawan	Central Terai
Janakpur	Sub-metropolitan	168,617	Dhanusha	Central Terai
Hetauda	Sub-metropolitan	152,875	Makwanpur	Central hill
Nepalgunj	Sub-metropolitan	141,700	Banke	Mid-western Terai
Itahari	Sub-metropolitan	140,517	Sunsari	Eastern Terai
Butwal	Sub-metropolitan	138,742	Rupandehi	Western Terai
Dharan	Sub-metropolitan	137,705	Sunsari	Eastern Terai

Note: *excluding institutional population.

Source: Based on PHC 2011.

growth rates of urban and total population for the last 62 years. It is to be noted that the 2014 in figure is given not because data pertain to this yeas but because 133 municipalities were added during this year using 2011 census data. Thus, the calculation is based on the population census 2011 and not 2014. Overall the growth rate of urban population is very high especially in recent years.

Urban Population, Growth Rates and Densities by Municipalities

Three categories of municipalities are recognized in the country. These are mahanagarpalika (metropolitan city), upa-mahanagarpalika (sub-metropolitan city) and nagarpalika (ordinary municipality). An area having populations of more than 20,000 people in Terai and more than 10,000 people in the hill and mountain and the annual revenue of NRs. 5 million or more in the Terai and NRs. 500,000 or more in the hill and mountain with minimum urban facilities is eligible for designation as nagarpalika. An ordinary nagarpalika is eligible for upa-mahanagarpalika when it has minimum of 100,000 population, annual revenue of at least NRs. 100 million and facilities such as electricity, drinking water, communication, paved roads, high standard education & health services, infrastructure for national & international sports, parks, city hall and other similar urban facilities. Likewise, an *upa-mahanagarpalika* becomes eligible for *mahanagarpalika* when this urban entity has: i) minimum of 300,000 population, ii) an average annual revenue at least NRs. 400 million and iii) facilities such as electricity, drinking water, communication, paved roads, University, specialized health services, infrastructure for international sports, adequate urban facilities and all other facilities specified for *upa-mahanagarpalika*. In 2014, the government of Nepal not only declared 133 new municipalities, it also designated a number of ordinary municipalities to the status of sub-metropolitan city. As a result, there are 179 ordinary *nagarpalika*, 11 *upa-mahanagarpalika* and one *mahanagarpalika* in the country at present. Table 15 presents name, district, sub-region of *mahanagarpalika* and *upa-mahanagarpalika* together with their total population in 2011. Kathmandu is the only metropolitan city and there are no comparable municipalities in the country until the date. Out of 11 *upa-manaarpalikas*, eight of them are in the Terai and only three in the hills. Among them, four namely Pokhara, Lalitpur, Birgunj and Biratnagar, where the later three have their population of more than 200,000 and Pokhara has population over 300,000.

Table 16 provides the municipal level scenario of total population by sex composition, annual population growth rates, number of households and density of population in 2011 for 58 municipalities. Municipalities have been arranged in the previous zonal order starting from the districts of Mechi zone and ending with districts of Mahakali zone. Total household sizes of the municipalities range from a minimum of 3,795 for Dasharathchand to 254,764 for Kathmandu. Females outnumber males in 30 out of 58 municipalities and 29 municipalities have sex ratios over 100 and two municipalities (Bhadrapur and Banepa) show almost an even number of males and females. All municipalities show positive growth

rates except Dasharathchand. Damak and Itahari are two municipalities that demonstrate highest inter-censal growth rates (more than 6 percent per annum). Other municipalities showing high growth rates include Madhyapur Thimi, Pokhara, Birendranagar, Bharatpur and Kirtipur.

Population densities are high in the municipalities of Kathmandu valley and those of Terai region. Municipalities located in the mountain regions have low population densities. Kathmandu demonstrates the highest urban density of 20,289 persons per sq km. Amargadhi, Kamalamai and Triyuga are among the urban settlements having the lowest population densities.

Refugee Population in Nepal

In the 1960s, a large number of Tibetan refugees entered Nepal due to unrest in Tibet (China). While many of them made their way to India in between years, some of them are still living in several camps in the cities of Kathmandu, Pokhara and other places. At present, the number of Tibetan refugees in Nepal is reported to be 12,540 according to the Ministry of Home Affairs, Nepal. During 1970s, Nepal also faced the problem of Bangladeshi refugees when there was internal instability in East Pakistan (then) during the process of independence of Bangladesh. But eventually all these Bangladeshi refugees are said to have returned back from Nepal.

The latest problem of refugees that Nepal faced is that of Bhutanese refugees since 1990s. These Bhutanese of Nepalese origin (BONO) were settled in seven camps of Jhapa and Morang with an assumption of repatriation to their home country. Their number was small in the beginning but by the year 2000, the number of refugees living in the seven camps had already reached around 100,000 (see, Subedi, 2001). Despite several rounds of bilateral talks between Bhutan

Table 16: Population, Households, Area, Density and Growth Rates of Municipalities as of 2011

Municipality	Household	Population			Growth Rate (2001-2011)	Area (km²)	Household Size	Sex ratio	Density (p/km²)
		Total	Male	Female					
Ilam	4,740	19,427	9,674	9,753	1.79	26.6	4.1	99.2	729.5
Bhadrapur	4,260	18,646	9,324	9,322	0.27	10.6	4.4	100.0	1,765.7
Damak	18,123	75,743	35,824	39,919	7.72	70.6	4.2	89.7	1,072.4
Mechinagar	13,196	57,909	27,856	30,053	1.66	55.7	4.4	92.7	1,039.3
Biratnagar SM	45,228	204,949	104,935	100,014	2.07	58.5	4.5	104.9	3,504.6
Dharan	27,796	119,915	57,562	62,353	2.29	103.4	4.3	92.3	1,159.9
Inaruwa	6,199	28,923	14,638	14,285	2.20	22.4	4.7	102.5	1,293.5
Itahari	18,306	76,869	37,606	39,263	6.23	42.4	4.2	95.8	1,814.2
Dhankuta	7,220	28,364	14,199	14,165	3.17	48.2	3.9	100.2	588.3
Khandbari	6,295	26,658	12,826	13,832	2.02	91.0	4.2	92.7	292.8
Triyuga	15,938	71,405	34,284	37,121	2.56	319.9	4.5	92.4	223.2
Rajbiraj	7,751	38,241	20,044	18,197	2.31	12.0	4.9	110.2	3,197.4
Lahan	6,483	33,927	17,536	16,391	2.04	20.2	5.2	107.0	1,677.1
Siraha	5,404	28,831	14,226	14,605	1.84	23.8	5.3	97.4	1,212.4
Janakpur	19,195	98,446	52,481	45,965	2.83	24.6	5.1	114.2	4,000.2
Jaleshwor	4,208	24,765	12,888	11,877	1.16	15.5	5.9	108.5	1,598.8
Malangawa	4,464	25,143	12,988	12,155	3.08	9.4	5.6	106.9	2,677.6
Kamalamai	9,320	41,117	20,360	20,757	2.25	208.0	4.4	98.1	197.7
Bhimeshwor	6,092	23,337	11,238	12,099	0.63	65.0	3.8	92.9	358.8
Banepa	5,546	24,894	12,446	12,448	4.53	5.6	4.5	100.0	4,477.3

Municipality	Household	Population			Growth Rate (2001-2011)	Area (km²)	Household Size	Sex ratio	Density (p/km²)
		Total	Male	Female					
Dhulikhel	3,291	16,263	8,392	7,871	3.45	12.1	4.9	106.6	1,346.3
Panauti	5,956	28,312	13,768	14,544	1.02	31.7	4.8	94.7	892.3
Lalitpur SM	54,748	226,728	117,932	108,796	3.30	15.2	4.1	108.4	14,965.5
Bhaktapur	17,655	83,658	42,678	40,980	1.43	6.6	4.7	104.1	12,752.7
Madhyapur Thimi	20,337	84,142	43,510	40,632	5.67	11.1	4.1	107.1	7,573.5
Kathmandu M	254,764	1,003,285	533,127	470,158	4.01	49.5	3.9	113.4	20,288.9
Kirtipur	19,464	67,171	37,485	29,686	4.98	14.8	3.5	126.3	4,550.9
Bidur	6,279	27,953	13,608	14,345	2.77	33.5	4.5	94.9	834.9
Hetauda	19,890	85,653	42,981	42,672	2.24	47.8	4.3	100.7	1,793.0
Gaur	5,639	35,370	18,697	16,673	3.32	21.5	6.3	112.1	1,642.8
Kalaiya	6,852	43,137	22,686	20,451	2.91	19.0	6.3	110.9	2,272.8
Birgunj SM	24,180	139,068	75,382	63,686	2.12	21.2	5.8	118.4	6,569.1
Bharatpur	36,987	147,777	74,205	73,572	5.03	162.2	4.0	100.9	911.3
Ratnanagar	10,861	46,607	22,373	24,234	2.10	35.6	4.3	92.3	1,308.5
Gorkha	8,810	33,865	15,895	17,970	2.73	60.3	3.8	88.5	561.8
Byas	11,326	43,615	20,005	23,610	4.34	60.0	3.9	84.7	726.7
Putalibazar	8,190	31,338	14,122	17,216	0.55	70.1	3.8	82.0	446.8
Waling	5,959	24,199	10,987	13,212	1.70	34.8	4.1	83.2	696.2
Lekhnath	14,958	59,498	27,394	32,104	3.63	77.5	4.0	85.3	768.2
Pokhara SM	68,398	264,991	133,318	131,673	5.28	55.2	3.9	101.2	4,798.8
Baglung	7,859	30,763	14,710	16,053	3.89	18.4	3.9	91.6	1,676.5
Tansen	8,433	31,161	15,332	15,829	4.22	21.7	3.7	96.9	1,434.7
Ramgram	4,982	28,973	15,505	13,468	2.47	34.7	5.8	115.1	834.5
Butwal	29,687	120,982	60,870	60,112	4.73	69.3	4.1	101.3	1,746.3
Siddharthanagar	12,513	64,566	32,671	31,895	2.06	36.0	5.2	102.4	1,792.0
Kapilvastu	5,136	30,890	15,654	15,236	1.28	37.2	6.0	102.7	830.4
Ghorahi	15,517	65,107	32,149	32,958	4.12	74.5	4.2	97.5	874.5
Tulsipur	12,223	52,224	25,293	26,931	4.33	92.2	4.3	93.9	566.3
Nepalgunj	15,200	73,779	38,113	35,666	2.49	12.5	4.9	106.9	5,897.6
Gulariya	11,230	57,232	29,399	27,833	2.18	95.1	5.1	105.6	601.6
Birendranagar	12,045	52,137	27,221	24,916	5.08	35.0	4.3	109.3	1,491.8
Narayan	4,681	21,995	10,733	11,262	1.23	67.0	4.7	95.3	328.2
Dipayal Silgadhi	5,509	26,508	13,686	12,822	1.84	74.0	4.8	106.7	358.3
Dhangadhi	21,059	104,047	53,237	50,810	4.34	103.7	4.9	104.8	1,003.1
Tikapur	11,639	56,983	27,640	29,343	3.86	67.1	4.9	94.2	849.1
Bhimdatta	20,695	106,666	53,098	53,568	2.77	171.2	5.2	99.1	622.9
Amargadhi	4,786	22,241	10,963	11,278	1.90	139.0	4.6	97.2	160.1
Dasharath chand	3,795	17,427	8,295	9,132	-0.51	55.0	4.6	90.8	316.8

Note: M stands for metropolitan city and SM stands for sub-metropolitan city. This Table lists municipalities that existed during the time of census enumeration in 2011. Therefore, the population figures and designations are as of 2011 i.e., before the government of Nepal annexed many VDCs to upgrade some of the municipalities to the status of sub-metropolitan and added new municipalities.

Source: PHC 2011.

and Nepal, their repatriation could not happen. As a result, they have now been resettled in the third countries such as USA, Australia and Scandinavian countries and other European countries. Table 17 shows the number of Bhutanese refugees living in Nepal from 2006 to 2013 by sex. Males outnumber female and the sex ratio is quite high compared with the sex ratio of the host country (94.2 males per 100 females). Since 2009, their number is decreasing because of their participation in the third country resettlement. By 2013, the number of these refuges has gone down to almost one-thirds in Nepal.

Given refugee's acceptance on third country resettlement, facilitation of this process by International Organization of Migration (IOM) and the willingness to receive them by host countries noted above, it is likely that the number of Bhutanese refugees in Nepal will further decrease in the years to come.

Table 17: Bhutanese Refugees in Nepal

Year	Male	Female	Total	Sex ratio
2006	54,486	52,261	106,747	104.3
2007	55,217	52,965	108,182	104.3
2009	48,014	46,429	94,443	103.4
2010	40,987	39,526	80,513	103.7
2011	34,168	32,819	66,987	104.1
2012	22,252	21,205	43,457	104.9
2013	18,175	16,993	35,168	107.0

Note: There are a total of 12,540 Tibetan refugees in Nepal in 2013 according to the Ministry of Home Affairs, Nepal.
Source: Ministry of Home Affairs, Government of Nepal.

Housing Condition of Settlements and Regions

Ownership of House/Housing Units Used

PHC 2011 reported a total of 5,423,297 housing units used in the country. Among them more than 85 percent was owned and 13 percent rented. Table 18 summarizes the ownership of housing units used by settlement categories and by ecological and development regional categories. There was a clear difference in the ownership and renting of housing units used by settlement categories. In rural settlements more than 92 percent houses were owned by the users but in urban settlements only 57 percent had owned the housing unit used by them currently. Likewise, more than 40 percent houses used by current residents in urban settlements are rented. Nearly 2 percent houses were under institutional use in urban settlements.

In the mountain and Terai region, more than 90 percent housing units currently under use are owned and less than 10 percent are either rented or under other kind of ownerships. In the hills, nearly 20 percent houses/housing units used are rented. This difference is attributed to the presence of capital cities and other large cities such as Pokhara and Lalitpur in the hill. It is in these large cities that a large number of migrants are present and majority of them live in rented houses. Central and Western development regions show sizeable proportion of houses/housing units under rental use. As noted above the existence of larger cities such as Kathmandu, Lalitpur, Bharatpur, Birgunj, Hetauda in the central region and Pokhara, Butwal, Siddharthanagar in the Western region has resulted into sizeable presence of rental use of housing there.

Table 18: Households by Type of Ownership of House/housing Units Used, 2011

Spatial Unit	Total Housing	Ownership of house/housing unit (in percent)			
		Owned	Rented	Institutional	Others
Nepal	**5,423,297**	**85.3**	**12.8**	**0.6**	**1.3**
Settlement category					
Urban	1,045,575	56.8	40.2	1.7	1.3
Rural	4,377,722	92.1	6.3	0.4	1.3
Ecological Region					
Mountain	363,698	92.3	5.6	0.6	1.5
Hill	2,532,041	78.8	19.3	0.6	1.2
Tarai	2,527,558	90.7	7.3	0.6	1.4
Development Region					
Eastern Dev. Region	1,230,743	89.1	8.2	0.8	1.9
Central Dev. Region	1,962,238	77.8	20.4	0.7	1.2
Western Dev. Region	1,065,599	85.4	12.7	0.6	1.3
Mid-western Dev. Region	695,014	93.0	5.8	0.4	0.8
Far-western Dev. Region	469,703	94.7	3.9	0.4	1.0

Source: PHC 2011.

Foundation of House/Housing Units Used

Of the total houses/housing units used, mud bonded bricks/stone was the foundation for 42 percent and about 18 percent had cement bonded bricks/stone as foundations. Difference by settlement categories was clearly notable. In rural settlements, about 50 percent houses/housing units had mud bonded bricks/stone as their foundations and the corresponding proportion in the urban settlements was only 22 percent. Rather largest proportion of houses had cement bonded bricks/stone as their foundations in the urban settlements. Table 19 presents the distribution of households by type of foundations of house/housing for various spatial units. In urban settlements RCC with pillar was the foundation for more than 28 percent houses and in rural settlements, the corresponding proportion was less than six percent. On the contrary, wooden pillar as the foundation was recorded for 29 percent houses/housing units in rural settlements. The urban areas also had houses with wooden pillar foundation but such proportion was less than 9 percent.

Regional difference in the type of foundations of houses/housing units used was obvious. In Terai, wooden pillar was the foundation of housing units for about 46 percent houses and only less than 17 percent houses had mud bonded brick/stone foundation. On the contrary, 93 percent houses in mountain and 65 percent in the hill had their foundation of mud bonded brick/stone. Moreover, of the three ecological regions, Terai had the largest proportion of house/housing units having cement bonded bricks/stone foundation (i.e., 24 percent).

Among development regions, Eastern region had largest proportion of houses with wooden pillar, whereas in the Mid-western and Far-western region, overwhelming majority houses had mud bonded bricks/stone as their foundations. Furthermore, type of foundation of house/housing unit was much more diversified in central region than any other development regions.

Table 19: Distribution of Households by Foundation of House/Housing Unit, 2011 (in percent)

Spatial Unit	Total	Type of foundation of house/housing unit					Not stated
		Mud bonded bricks/ stone	Cement bonded bricks/ stone	RCC with pillar	Wooden pillar	Others	
Nepal	**5,423,297**	**44.2**	**17.6**	**9.9**	**24.9**	**2.3**	**1.1**
Settlement Category							
Urban*	1,045,575	22.0	38.2	28.4	8.5	1.0	1.8
Rural	4,377,722	49.5	12.6	5.5	28.8	2.6	0.9
Ecological Region							
Mountain	363,698	92.8	2.2	0.8	3.2	0.3	0.7
Hill	2,532,041	64.8	13.6	12.8	7.4	0.3	1.1
Terai	2,527,558	16.6	23.8	8.4	45.5	4.7	1.1
Development Region							
Eastern	1,230,743	28.8	15.2	8.0	41.2	5.9	0.8
Central	1,962,238	32.6	23.3	15.3	26.5	0.8	1.6
Western	1,065,599	59.4	19.2	10.5	8.9	1.2	0.8
Mid-western	695,014	72.3	6.6	3.4	13.6	3.3	0.7
Far-western	469,703	56.8	12.5	1.2	28.4	0.3	0.8

Note: * Figures in this category refer to 58 municipalities only.
Source: PHC 2011.

Houses by Types of Outer Wall

PHC 2011 provides information on six categories of houses/housing units based on materials used in the outer wall of the house structure. These include: mud bonded bricks/stone, cement bonded bricks/stone, wood/planks, bamboo, unbaked brick, and other materials. Of all these mud bonded bricks/stone appear to be more common and 41 percent houses had their outer wall made up of mud-bonded bricks/stone. Cement bonded bricks/stone as material used for outer wall ranked second and 29 percent houses had used this material for outer wall. The use of bamboo as outer wall material was also notable and one in every five houses had used bamboo as outer wall material in the nation as a whole. Table 20 displays the distribution of households by outer wall of the house/housing unit. Of all the spatial units the difference by settlement categories are paramount. In the rural settlements, more than 47 percent houses used mud bonded bricks/stone as their outer wall material. On the contrary, in the urban settlements, more than 69 percent houses used cement bonded bricks/stone as their outer wall material.

Difference in the use of materials for outer wall is also notable by ecological regions. In the mountain, nearly 90 percent houses had their outer wall material made up of mud bonded bricks/stone and the corresponding proportion in the hill was 62 percent. On the contrary, less than 14 percent houses in the Terai had used this material for outer wall of their houses. Rather bamboo came out as the outer wall material for largest proportion of houses in Terai. In the case of development regions, with an exception of central region (urban influence), the pattern of use of outer wall materials were fairly similar.

Distribution by Year of Construction of Houses

Distribution of households by year of construction of their houses suggests that about 27 percent houses were constructed over the last 11-20 years. Similarly, almost 22 percent were constructed over the last 6-10 years and 21 percent for less than 5 years. Very limited proportions of houses were constructed more than 50 years ago (3.3 percent). Table 21 provides detail distribution of households by year of construction of house/housing

Table 20: Households by Outer Wall of House/Housing Unit, 2011

Spatial Unit	Total	Type of outer wall						Not stated
		Mud bonded bricks/ stone	Cement bonded bricks/ stone	Wood/ planks	Bamboo	Unbaked brick	Others	
Nepal	**5,423,297**	**41.4**	**28.8**	**5.3**	**20.2**	**1.1**	**2.1**	**1.1**
Settlement category								
Urban	1,045,575	17.5	69.4	2.4	7.1	0.7	1.0	1.9
Rural	4,377,722	47.1	19.0	6.0	23.4	1.2	2.3	1.0
Ecological region								
Mountain	363,698	89.5	4.6	1.5	3.0	0.2	0.5	0.8
Hill	2,532,041	62.4	28.8	3.5	3.5	0.4	0.4	1.1
Terai	2,527,558	13.4	32.2	7.7	39.5	2.1	4.0	1.2
Development region								
Eastern	1,230,743	26.8	21.8	6.5	42.9	0.2	1.0	0.9
Central	1,962,238	30.4	40.0	4.1	22.5	0.5	0.9	1.7
Western	1,065,599	56.7	32.7	2.3	4.3	0.6	2.6	0.8
Mid-western	695,014	66.2	11.9	4.4	5.3	5.8	5.6	0.8
Far-western	469,703	54.1	16.1	15.7	9.4	0.4	3.5	0.9

Source: PHC 2011.

Table 21: Distribution of Households by Year of Construction of House/Housing Unit, 2011 (in percent)

Spatial Unit	Total	Age of the houses by year of Construction								
		Less than 5	6-10	11-20	21-50	51-100	101-150	151-500	More than 500	Not stated
Nepal	**5,423,297**	**21.2**	**21.7**	**26.5**	**17.3**	**2.9**	**0.2**	**0.2**	**0.0**	**9.9**
Settlement category										
Urban	1,045,575	20.8	22.4	26.7	17.0	3.0	0.2	0.2	0.0	9.6
Rural	4,377,722	21.3	21.5	26.5	17.4	2.9	0.2	0.2	0.0	10.0
Ecological region										
Mountain	363,698	16.7	17.9	28.7	23.8	5.2	0.4	0.3	0.0	7.1
Hill	2,532,041	17.7	19.1	27.7	23.0	4.6	0.3	0.2	0.0	7.5
Terai	2,527,558	25.5	24.8	25.1	10.7	1.0	0.1	0.1	0.0	12.7
Development Region										
Eastern	1,230,743	24.1	22.6	25.7	15.5	2.6	0.2	0.2	0.0	9.2
Central	1,962,238	18.4	21.6	27.0	16.7	2.9	0.2	0.2	0.0	13.0
Western	1,065,599	18.2	19.6	27.9	22.4	3.8	0.2	0.2	0.0	7.8
Mid-western	695,014	25.1	23.4	27.1	15.4	1.9	0.2	0.1	0.0	6.8
Far-western	469,703	26.7	21.9	23.1	16.0	3.4	0.2	0.2	0.0	8.6

Source: PHC 2011.

unit used for various spatial units. Unlike materials used, the foundations and ownerships where large differences were found, the difference by urban rural settlements was very small in the case of year of construction of houses.

Among ecological regions, Terai had relatively larger proportion of households whose houses were constructed within less than 5 years. More than 75 percent household had their houses constructed within the last 20 years and more than 50 percent over the last 10 years. However, in the Hill the corresponding proportions were 64.5 percent and 36.8 percent respectively. The scenario of mountain region was similar to that of the hill. The proportion of houses constructed over the last 10 years was higher in the Far-western, Mid-western and Eastern region compared with Central and Western region.

Distribution by Roofs and Number of Floor of House

Seven categories of roof of houses have been reported by PHC 2011. These are: i) thatch/straw, ii) galvanized iron, iii) tile/slate, iv) RCC, v) wood/planks, vi) mud and vii) others. At the national level, largest proportion of houses has roofs of galvanized iron (28.3 percent). Likewise 27 percent houses have their roofs of tile/slate and 23 percent with that of RCC. Nearly one out of every five houses in the country has thatch/straw roof. Table 22 presents distribution of households by roof of houses by settlement categories and regions. The proportions of houses with roofs of tile/slate, galvanized iron, and thatch/straw are far higher in rural settlements than in urban settlements. On the contrary, three out of every five houses in urban settlements has RCC roof and one-fourths had galvanized iron roofs.

Very limited houses in mountain region have RCC roof but the proportion with mud roof is considerably high (13 percent). Houses with their roofs of galvanized iron and tile/slate are common in all three ecological regions. Of all five development regions Far-western region is unique in roof of houses where 65 percent houses have tile/slate roof.

Table 23 presents the distribution of households by number of floor of house/housing unit. Normally one or two floor houses are common. Houses with more than two floors are limited to 19 percent at the national level. Obviously largest proportion of houses in rural settlements has one floor. In the urban settlements one-thirds of the total houses have three or more floors.

Table 22: Distribution of Households by Roof of House/Housing Unit, 2011 (in percent)

Spatial Unit	Total	Roof of the house (in percent)							
		Thatch/ straw	Galvanized iron	Tile/ slate	RCC	Wood / planks	Mud	Others	Not stated
Nepal	**5,423,297**	**19.0**	**28.3**	**26.7**	**22.5**	**0.8**	**1.1**	**0.4**	**1.2**
Urban/rural									
Urban	1,045,575	3.6	25.2	8.7	59.8	0.3	0.0	0.3	2.1
Rural	4,377,722	22.7	29.0	31.0	13.6	0.9	1.3	0.4	1.0
Ecological region									
Mountain	363,698	20.4	24.9	32.9	2.4	4.2	13.0	1.4	0.9
Hill	2,532,041	19.0	31.6	22.1	24.7	0.5	0.5	0.3	1.2
Terai	2,527,558	18.9	25.4	30.3	23.2	0.6	0.0	0.4	1.3
Development region									
Eastern	1,230,743	33.2	44.0	8.5	11.5	1.0	0.0	0.8	0.9
Central	1,962,238	10.0	22.6	31.5	32.9	0.9	0.0	0.2	1.8
Western	1,065,599	13.7	37.2	18.7	28.4	0.6	0.3	0.3	0.9
Mid-western	695,014	31.6	15.7	31.8	11.3	0.8	7.6	0.5	0.8
Far-western	469,703	13.3	8.9	64.6	10.7	0.5	0.5	0.6	1.0

Source: PHC 2011.

Table 23: Percentage Distribution of Households by Number of Floor of House/Housing Unit, 2011

Spatial unit	Total	Number of floor (distribution in percent)					
		One	Two	Three	Four to five	Six to seven	8 and above
Nepal	**5,423,297**	**44.0**	**37.0**	**15.2**	**3.5**	**0.2**	**0.0**
Settlement category							
Urban	1,045,575	37.9	28.3	19.3	13.4	1.0	0.1
Rural	4,377,722	45.5	39.1	14.2	1.2	0.0	0.0
Ecological region							
Mountain	363,698	10.6	47.5	40.8	1.1	0.0	0.0
Hill	2,532,041	19.1	48.6	24.9	6.9	0.4	0.0
Terai	2,527,558	73.7	23.9	1.8	0.5	0.0	0.0
Development region							
Eastern	1,230,743	57.0	32.4	9.8	0.7	0.0	0.0
Central	1,962,238	39.3	32.9	18.6	8.5	0.5	0.1
Western	1,065,599	43.0	44.1	11.8	1.1	0.0	0.0
Mid-western	695,014	41.2	40.3	18.1	0.4	0.0	0.0
Far-western	469,703	36.1	45.0	18.6	0.4	0.0	0.0

Source: PHC 2011.

An overwhelming majority of houses in Terai has one floor but in the hill and mountain. the largest proportions of houses had two floors (nearly 50 percent). With respect to development regions, central region has relatively higher proportion of houses with three or more floors. In Eastern region majority of houses has one floor only.

National Building Code

Department of Housing and Urban Development has developed several building codes for construction of houses. Table 24 gives the list of Nepal national Building Codes that are meant for adopted in the construction of housing. It has also specified the monitoring requirements together with specification of contents. However, its implementation has not been as successful as expected. The recent earthquake disaster of April 25, 2015 and May 12, 2015 has made people realize the importance of implementation of building codes seriously in urban settlements.

Source of Lighting and main Fuel used for Cooking

Electricity, kerosene, bio-gas and solar are the usual sources of lighting in the households. Of all the households, electricity is the usual source of lighting for 67 percent. Kerosene and solar power are reported as usual source of lighting by 18.3 percent and 7.4 households respectively. Table 25 provides information on usual source of lighting for settlement categories and regions. Despite 61 percent households reporting electricity as usual source of lighting in rural settlements the proportion using kerosene is also significant. Almost 22

Table 24: Nepal National Building Code, 2003

S. N.	Building Code No.	Contents	Remarks
1	NBC 000	Requirements for State of the Art Design: An Introduction	Building for Foreign Donor Organizations
2	NBC 001	Materials Specifications	> 1,000 sq. ft. plinth area and more than 3 flats. Building designer and monitoring by Architecture Engineer
3	NBC 002	Unit Weight of Materials	
4	NBC 003	Occupancy Load (Imposed Load)	
5	NBC 004	Wind Load	
6	NBC 005	Seismic Design of Building	
7	NBC 006	Snow Load	
8	NBC 007	Provisional Recommendation on First Safety	
9	NBC 008	Site Consideration for Seismic Hazards	
10	NBC 009	Masonry : Unreinforced	
11	NBC 010	Plain and Reinforced Concrete	
12	NBC 011	Steel	
13	NBC 012	Timber	
14	NBC 013	Aluminum	
15	NBC 014	Construction Safety	
16	NBC 201	Mandatory Rule of Timber : Reinforced Concrete Buildings with Masonry Infill	< 1,000 sq. ft plinth area and less than 3 flats. Building designer and monitoring by Architecture Sub-Engineer
17	NBC 202	Mandatory Rule of Timber : Load Bearing Masonry	
18	NBC 203	Guidelines for Earthquake Resident Building Construction : Low Strength Masonry	
19	NBC 204	Guidelines for Earthquake Resident Building Construction : Earthen Building (EB)	
20	NBC 205	Mandatory Rule of Thumb : Reinforced Concrete Buildings without Masonry Infill	
21	NBC 206	Architectural Design Requirements	> 1,000 sq. ft plinth area and more than 3 flats. Building designer and monitoring by Architecture Engineer
22	NBC 207	Electrical Design Requirements for (public Buildings)	
23	NBC 208	Sanitary and Plumbing Design Requirements	

Source: Department of Housing and Urban Development.

Table 25: Distribution of Households by Type of Lighting facilities, 2011 (in percent)

Spatial unit	Total	Usual source of lighting (%)					
		Electricity	Kerosene	Bio-gas	Solar	Others	Not stated
Nepal	**5,423,297**	**67.3**	**18.3**	**0.3**	**7.4**	**6.1**	**0.6**
Settlement category							
Urban	1,045,575	94.1	4.0	0.4	0.2	0.5	0.8
Rural	4,377,722	60.8	21.7	0.3	9.2	7.4	0.6
Ecological region							
Mountain	363,698	49.2	14.0	0.2	20.8	15.2	0.5
Hill	2,532,041	67.3	11.9	0.3	11.0	9.0	0.5
Terai	2,527,558	69.8	25.3	0.3	2.0	1.8	0.8
Development region							
Eastern	1,230,743	63.6	25.8	0.4	7.3	2.4	0.6
Central	1,962,238	77.1	17.4	0.2	3.2	1.2	0.9
Western	1,065,599	78.0	15.0	0.2	4.5	1.7	0.5
Mid-western	695,014	42.3	13.8	0.2	20.0	23.2	0.5
Far-western	469,703	48.1	16.4	0.4	13.7	20.7	0.6

Source: PHC 2011.

Table 26: Distribution of Households by Type of Main Fuel Used for Cooking, 2011 (in percent)

Spatial unit	Total	Usual type of fuel used for cooking (%)							
		Wood / firewood	Kerosene	LP gas	Cow dung	Bio gas	Electricity	Others	Not stated
Nepal	**5,423,297**	**64.0**	**1.0**	**21.0**	**10.4**	**2.4**	**0.1**	**0.4**	**0.6**
Urban/rural									
Urban	1,045,575	25.7	2.0	67.7	1.5	1.8	0.1	0.4	0.8
Rural	4,377,722	73.1	0.8	9.9	12.5	2.6	0.1	0.4	0.6
Ecological region									
Mountain	363,698	94.8	0.5	3.1	0.4	0.2	0.3	0.1	0.5
Hill	2,532,041	67.0	1.1	29.4	0.1	1.6	0.1	0.2	0.5
Terai	2,527,558	56.5	1.0	15.2	22.1	3.5	0.0	0.7	0.8
Development region									
Eastern	1,230,743	60.9	1.0	13.6	20.7	2.6	0.1	0.6	0.6
Central	1,962,238	50.3	1.6	33.9	11.0	1.6	0.1	0.6	0.9
Western	1,065,599	65.4	0.7	22.0	7.6	3.6	0.1	0.2	0.5
Mid-western	695,014	87.8	0.4	7.7	1.5	2.0	0.0	0.1	0.5
Far-western	469,703	91.1	0.5	4.1	0.2	3.3	0.0	0.2	0.6

Source: PHC 2011.

percent houses in rural settlements still use kerosene as usual source of lighting . In urban settlements, 94 percent houses use electricity for lighting and 4 percent use kerosene for the same.

The use of kerosene for lighting is more evident in Terai region than the other two regions. Solar is more notable in the mountain region and 21 percent houses use solar as their usual source of lighting and this is against 2 percent reporting the same in Terai and 11 percent in the hill respectively.

Firewood, kerosene, LP gas, cow dung, bio-gas and electricity are the types of main fuel used for cooking. Table 26 presents the distribution of households by main fuel used for cooking for various spatial units. At the national level

wood/fuel wood has been the main fuel used for cooking for 64 percent households. Likewise LP gas has been the main fuel for cooking for 21 percent households. Furthermore, as yet, more than 10 percent households use cow dung as their main fuel for cooking.

The proportion using wood/firewood as main fuel used for cooking increases from south to north with mountain region showing 95 percent dependent on firewood for cooking. In Terai, 22 percent households still use cow dung as main fuel for cooking. With an exception of Central region, the proportion of households using wood/firewood as main fuel for cooking increases from east to west. LP gas is more common in the Central region than any other regions.

Road Network

Road Length, Influenced Population and Road Density

According to Statistics of Strategic Road Network 2009/10, there is a total road network of 10,835 kilometer in the country. Dolpa and Mugu did not record any length of strategic road network (SRN) by then. Of the total network 45.7 percent road is blacktopped, 19.1 percent gravel, and 35.2 percent is earthen road. The figure for population influenced per kilometer road is 2,445 persons. The road density is 7 km per hundred sq km of the national territory. Table 27 shows the length of total strategic road network, influenced population and road density by districts. Of all the districts Dang, Kailali and Makwanpur are among the top ranking districts with their total length of strategic road network of 361 km, 302 km and 290 km respectively. Kathmandu and Morang ranked 12th and 13th respectively. On the other hand Manang, Humla and Myagdi are at the bottom with total road lengths of 29 km, 30 km and 31 km respectively.

With respect to black-topped road length Makwanpur, Kailali and Nawalparasi appear in the forefront and Morang Banke and Kathmandu follow them respectively. Eighteen districts did not record any blacktopped road network. In the case of earthen road length Khotang, Sindhuli, Dailekh, Ilam and Gorkha rank among the top five districts.

The district scenario is different with respect to population influenced per km. road. Parsa, Kathmandu, Rautahat Rupandehi and Morang appear on the list of top five districts with their values of 13,177, 7,896, 7,819, 5,377 and 4,465 persons respectively. Manang, Mustang, Rasuwa, Panchthar and Dadeldhura are at the bottom respectively.

Of all the districts road density is highest in Bhaktapur. It has 94 km road per 100 sq km of its total land area. Kathmandu ranks second with 56 km road per 100 sq km land area. Lalitpur ranks third with corresponding figure of 34 km road. Mahottari, Saptari and Dhanusha came next with corresponding values of 18 km each for the former two and 17 km for the later. Of the rest, Dailekh, Panchthar, Sunsari and Dhankuta are among other top 10 districts.

Urban Settlements by Road Length

The average road length of 58 municipalities was 97 km. Table 28 presents the urban settlements by road lengths and respective urban population. Of all the municipalities, road length was highest in Biratnagar (468 km). Butwal, Ilam, Bharatpur and Dhangadhi are among others belonging to top 5 municipalities on road length respectively. Similarly Pokhara, Hetauda, Itahari, Ghorahi and Mechinagar are among the remaining top 10 municipalities in road length. No black topped and/or gravel road is recorded for Dasharathchand. Khandbari, Madhyapur Thimi, Dipayal, Bhaktaapur and Amargadhi appear on the bottom in the list of road lengths respectively.

Urban population per kilometer of road is 804 persons for all 58 municipalities. Madhypur records the highest value and Ilam records the lowest. There are 22,201 urban people per km in Madhyapur Thimi. With urban people of 12,117 and 10,405 per km, Khandbari and Kathmandu rank second and third respectively. Among others in the list of top 10 include Bhaktapur, Lalitpur, Dipayal, Damak, Tansen, Amargadhi and Panauti. Among municipalities with least number of urban people per km road include, in addition to

Table 27: Total Strategic Road Network Length, Influenced Population and Road Density by District

District	Total Population 2011	Total Area in Sq.km.	Type of Road				Population Influenced per km. Road	Road Density (km./100 sq.km.)
			Black Topped	Graveled	Earthen	Total		
Taplejung	127,461	3,646	0.00	25.50	7.60	33.10	3,851	1
Panchthar	191,817	1,241	34.86	57.00	107.00	198.86	965	16
Ilam	290,254	1,703	108.75	12.10	127.10	247.95	1,171	15
Jhapa	812,650	1,606	139.92	39.68	17.00	196.60	4,134	12
Morang	965,370	1,855	150.52	25.50	40.20	216.22	4,465	12
Sunsari	763,487	1,257	115.03	66.00	10.00	191.03	3,997	15
Dhankuta	163,412	891	76.68	49.00	9.00	134.68	1,213	15
Terhathum	101,577	679	8.42	0.00	76.25	84.67	1,200	12
Sankhuwasabha	158,742	3,480	47.70	25.00	62.00	134.70	1,178	4
Bhojpur	182,459	1,507	0.00	7.50	108.50	116.00	1,573	8
Solukhumbu	105,886	3,312	0.00	0.00	37.20	37.20	2,846	1
Okhaldhunga	147,984	1,074	0.00	8.79	62.91	71.70	2,064	7
Khotang	206,312	1,591	0.00	0.00	196.76	196.76	1,049	12
Udayapur	317,532	2,063	90.86	42.00	111.00	243.86	1,302	12
Saptari	639,284	1,363	135.00	65.50	46.00	246.50	2,593	18
Siraha	637,328	1,188	111.93	19.00	14.00	144.93	4,397	12
Dhanusa	754,777	1,180	104.15	47.50	43.50	195.15	3,868	17
Mahottari	627,580	1,002	99.79	59.00	26.50	185.29	3,387	18
Sarlahi	769,729	1,259	58.22	85.20	38.00	181.42	4,243	14
Sindhuli	296,192	2,491	42.50	29.60	129.90	202.00	1,466	8
Ramechhap	202,646	1,546	2.00	25.70	49.30	77.00	2,632	5
Dolakha	186,557	2,191	86.68	30.00	20.00	136.68	1,365	6
Sindhupalchok	287,798	2,542	107.31	19.84	69.10	196.25	1,466	8
Kavrepalanchowk	381,937	1,396	111.09	33.73	4.30	149.12	2,561	11
Lalitpur	468,132	385	61.37	36.04	33.20	130.61	3,584	34
Bhaktapur	304,651	119	81.50	23.09	7.00	111.59	2,730	94
Kathmandu	1,744,240	395	149.59	34.10	37.20	220.89	7,896	56
Nuwakot	277,471	1,121	94.71	21.00	25.00	140.71	1,972	13
Rasuwa	43,300	1,544	0.00	50.50	15.70	66.20	654	4
Dhading	336,067	1,926	114.88	20.00	30.20	165.08	2,036	9
Makwanpur	420,477	2,426	174.97	44.57	70.20	289.74	1,451	12
Rautahat	686,722	1,126	71.83	9.00	7.00	87.83	7,819	8
Bara	687,708	1,190	83.34	68.00	16.00	167.34	4,110	14
Parsa	601,017	1,353	30.61	13.00	2.00	45.61	13,177	3
Chitawan	579,984	2,218	136.25	54.00	39.00	229.25	2,530	10
Gorkha	271,061	3,610	23.84	34.00	119.40	177.24	1,529	5
Lamjung	167,724	1,692	19.17	1.00	51.87	72.04	2,328	4
Tanahu	323,288	1,546	118.09	9.32	34.08	161.49	2,002	10
Syangja	289,148	1,164	97.94	10.00	57.00	164.94	1,753	14
Kaski	492,098	2,017	87.46	5.00	20.50	112.96	4,356	6
Manang	6,538	2,246	0.00	0.00	29.00	29.00	225	1
Mustang	13,452	3,573	0.00	0.00	59.00	59.00	228	2
Myagdi	113,641	2,297	0.00	10.00	21.00	31.00	3,666	1
Parbat	146,590	494	24.11	0.00	26.50	50.61	2,896	10

District	Total Population 2011	Total Area in Sq.km.	Type of Road				Population Influenced per km. Road	Road Density (km./100 sq.km.)
			Black Topped	Graveled	Earthen	Total		
Baglung	268,613	1,784	6.34	5.79	89.00	101.13	2,656	6
Gulmi	280,160	1,149	44.54	0.00	79.00	123.54	2,268	11
Palpa	261,180	1,373	108.59	0.00	39.00	147.59	1,770	11
Nawalparasi	643,508	2,162	151.07	23.80	29.00	203.87	3,156	9
Rupandehi	880,196	1,360	130.19	19.00	14.50	163.69	5,377	12
Kapilbastu	571,936	1,738	139.97	54.00	29.00	222.97	2,565	13
Arghakhanchi	197,632	1,193	58.91	3.00	84.00	145.91	1,354	12
Pyuthan	228,102	1,309	68.00	12.00	80.43	160.43	1,422	12
Rolpa	224,506	1,879	33.40	61.00	94.02	188.42	1,192	10
Rukum	208,567	2,877	0.00	20.00	38.90	58.90	3,541	2
Salyan	242,444	1,462	4.00	101.66	70.00	175.66	1,380	12
Dang	552,583	2,955	148.22	169.00	44.00	361.22	1,530	12
Banke	491,313	2,337	149.81	42.50	34.10	226.41	2,170	10
Bardiya	426,576	2,025	121.43	60.99	29.00	211.42	2,018	10
Surkhet	350,804	2,451	112.14	66.70	56.30	235.14	1,492	10
Dailekh	261,770	1,502	78.09	37.77	128.37	244.23	1,072	16
Jajarkot	171,304	2,230	0.00	0.00	89.00	89.00	1,925	4
Dolpa	36,700	7,889	0.00	0.00	0.00	0.00	0	0
Jumla	108,921	2,531	0.00	0.00	85.00	85.00	1,281	3
Kalikot	136,948	1,741	0.00	0.00	77.00	77.00	1,779	4
Mugu	55,286	3,535	0.00	0.00	0.00	0.00	0	0
Humla	50,858	5,655	0.00	0.00	30.00	30.00	1,695	1
Bajura	134,912	2,188	0.00	0.00	43.00	43.00	3,137	2
Bajhang	195,159	3,422	15.60	14.82	48.36	78.78	2,477	2
Achham	257,477	1,680	42.00	0.00	85.00	127.00	2,027	8
Doti	211,746	2,025	115.46	6.00	28.00	149.46	1,417	7
Kailali	775,709	3,235	165.35	61.25	75.00	301.60	2,572	9
Kanchanpur	451,248	1,610	44.32	89.00	22.10	155.42	2,903	10
Dadeldhura	142,094	1,538	77.08	0.00	64.00	141.08	1,007	9
Baitadi	250,898	1,519	136.53	1.10	43.29	180.92	1,387	12
Darchaula	133,274	2,322	0.00	0.00	75.42	75.42	1,767	3
Nepal	26,494,504	147,184	4,952.11	2,065.14	3,817.76	10,835.01	2,445	7

Source: PHC 2011 and Department of Roads (Statistics of Strategic Road Network SSRN 2009/10.

Ilam municipality, Butwal, Ghorahi, Mechinagar and Dhangadhi municipality.

Vehicle Registration Trend

Vehicle registration trend is increasing and so is the number of vehicles in the country. Table 29 provides registration details of various types of vehicles plying on the roads since 1989/90 to 2012/13. Up to 1989/90 a total 84,248 vehicles were registered and among them the number of motorcycle was highest (42.5 percent) and car/jeep/van came next (28.6 percent). No pick-ups and micros were registered till then. Over the last 25 years, the vehicle registration has increased from 84,248 to 1,557,478. This is an increase of almost 19 fold.

Of the total vehicles registered to date, motorcycles constituted 77.3 percent and car/jeep/van constituted 9 percent. The year 2009/10 appeared as special and it recorded an abrupt upsurge in the registration of vehicles. For example, during 2008/09 a total of 102,570 vehicles were registered but in 2009/10 this figure almost doubled and reached 201,787. Again in the following

Table 28: Road Lengths in Urban Settlements, 2013

Municipality	Type of Road (length in km)			Population 2011	Urban Population per km Road
	Black Topped	Graveled	Total		
Biratnagar	148	320	468	204,949	438
Butwal	307.6	133.5	441.2	120,982	274
Ilam	8.0	350.0	358.0	19,427	54
Bharatpur	182.8	160.4	343.1	147,777	431
Dhangadhi	118.4	193.9	312.3	104,047	333
Pokhara	241.9	0.2	242.1	264,991	1094
Hetauda	107.5	112.3	219.8	85,653	390
Itahari	36.8	179.9	216.6	76,869	355
Ghorahi	30.5	167.0	197.5	65,107	330
Mechinagar	20.8	153.5	174.3	57,909	332
Tikapur	24.9	132.5	157.4	56,983	362
Birgunj	53.9	80.7	134.6	139,068	1033
Siddharthanagar	48.8	85.1	133.9	64,566	482
Triyuga	41.3	88.7	129.9	71,405	550
Bhimdatta	25.2	96.2	121.3	106,666	879
Janakpur	70.0	50.0	120.0	98,446	820
Dharan	85.3	28.8	114.1	119,915	1051
Gulariya	23.2	77.5	100.7	57,232	569
Kathmandu	96.1	0.3	96.4	1,003,285	10405
Tulsipur	4.8	81.0	85.8	52,224	609
Nepalgunj	30.8	48.6	79.4	73,779	929
Ratnanagar	13.7	64.5	78.2	46,607	596
Birendranagar	19.0	58.9	77.9	52,137	669
Byas	30.5	42.0	72.5	43,615	602
Kapilvastu	30.7	39.4	70.1	30,890	441
Lalitpur	57.1	10.8	67.9	226,728	3340
Inaruwa	28.4	37.9	66.4	28,923	436
Kalaiya	17.5	46.6	64.1	43,137	673
Kirtipur	31.4	30.1	61.5	67,171	1092
Kamalami	17.0	43.2	60.2	41,117	683
Lahan	20.6	35.2	55.7	33,927	609
Bhadrapur	38.2	10.7	48.8	18,646	382
Siraha	5.8	42.6	48.4	28,831	596
Gorkha	29.8	18.6	48.3	33,865	701
Bhimeshwor	36.1	11.0	47.1	23,337	496
Lekhnath	20.1	23.8	43.9	59,498	1355
Gaur	24.4	17.6	42.0	35,370	841
Banepa	22.3	19.4	41.8	24,894	596
Ramgram	9.4	31.1	40.4	28,973	717
Rajbiraj	8.6	31.6	40.1	38,241	954
Baglung	25.3	13.2	38.5	30,763	799
Putalibazar	15.6	16.9	32.5	31,338	965
Malangawa	7.7	22.4	30.1	25,143	836
Damak	10.7	17.4	28.1	75,743	2696

Municipality	Type of Road (length in km)			Population 2011	Urban Population per km Road
	Black Topped	Graveled	Total		
Jaleshwor	12.4	11.0	23.4	24,765	1058
Dhankuta	18.9	3.1	22.0	28,364	1287
Dhulikhel	8.7	12.6	21.3	16,263	764
Bidur	7.1	10.3	17.4	27,953	1606
Waling	13.9	2.4	16.3	24,199	1481
Panauti	7.2	8.6	15.8	28,312	1791
Narayan	12.9	0.0	12.9	21,995	1710
Tansen	10.9	1.5	12.4	31,161	2515
Amargadhi	5.6	5.0	10.6	22,241	2098
Bhaktapur	5.6	3.0	8.6	83,658	9728
Dipayal	6.7	1.5	8.2	26,508	3233
Madhyapur Thimi	1.5	2.3	3.8	84,142	22201
Khandbari	1.7	0.5	2.2	26,658	12117
Dasharathchanda	0.0	0.0	0.0	17,427	0
Total	**2339.4**	**3286.5**	**5625.9**	**4523820**	**804**

Source: Ministry of Federal Affairs & Local Development and PHC 2011.

Table 29: Number of Vehicles Registered, 1989/90 - 2012/13

Year	Number of Vehicles Registered by Type										
	Bus	Mini bus	Truck/Crane/ Dozer/ Excavator	Car/Jeep/ Van	Pick-up	Micro	Tempo	Motor-cycle	Tractor/ Power Tailor	Others	Total
Up to 1989/90	4159	2064	8969	24050	-	-	2359	35776	6769	102	84248
1990/91	458	226	800	1893	-	-	856	4954	788	1549	11524
1991/92	413	148	1524	2115	-	-	1207	8154	548	358	14467
1992/93	606	185	1491	2266	-	-	62	7608	262	381	12861
1993/94	1168	77	1740	3049	-	-	154	8653	1396	372	16609
1994/95	850	83	1629	3043	-	-	241	9401	1814	353	17414
1995/96	486	82	1151	5261	-	-	117	13855	2183	58	23193
1996/97	608	175	907	2993	-	-	185	12633	1257	352	19110
1997/98	899	130	1291	4139	-	-	344	12306	1265	51	20425
1998/99	872	19	978	2507	-	-	388	17090	2248	37	24139
1999/00	494	122	829	3647	-	-	789	19755	2542	102	28280
2000/01	1203	250	1271	5152	-	-	232	29291	3519	77	40995
2001/02	868	475	1798	4374	-	-	248	38522	3189	86	49560
2002/03	432	298	1212	2906	581	232	17	29404	2485	43	37610
2003/04	732	237	1477	7079	478	884	16	26547	2191	58	39699
2004/05	753	285	1592	4781	-	584	48	31093	1374	21	40531
2005/06	1528	663	2263	5114	36	66	60	45410	635	-	55775
2006/07	1564	806	3278	5156	736	138	12	72568	2942	1535	88735
2007/08	1419	1179	3594	4741	1588	31	18	69666	3297	206	85739
2008/09	1843	593	3643	6857	1287	128	20	83334	4663	202	102570
2009/10	1888	780	4524	12268	1975	145	9	168707	11460	31	201787
2010/11	1610	1370	1969	8510	3087	115	2	138907	7937	133	163640
2011/12	2085	1170	1333	8711	2981	155	10	145135	8413	91	170084
2012/13	3263	1328	3332	9595	5422	158	57	175381	9795	152	208483
Total No.	**30201**	**12745**	**52595**	**140207**	**18171**	**2636**	**7451**	**1204150**	**82972**	**6350**	**1557478**
%	**1.9**	**0.8**	**3.4**	**9.0**	**1.2**	**0.2**	**0.5**	**77.3**	**5.3**	**0.4**	**100**

Source: Department of Transport Management.

year the total registration went down to 163,640. In fact it is only in 2012/13 that the recorded figure of 2009/10 has been exceeded.

With increasing number of vehicles in the country and limited road length especially in the urban settlements of Kathmandu valley, the problem of traffic congestion, accidents, air and noise pollution have become serious issues especially in the built-up areas of urban settlements.

Rural Settlement Situation: A Case of Jumla

This section presents a case of settlement situation in Jumla district. For the purpose of this paper, the Central Bureau of Statistics (CBS) has provided its preliminary data on settlements of this district. CBS is the state authority for collecting, compiling and publishing population data. Its latest census operation is Population and Housing Census (PHC) 2011. It has published population and housing data at the national, regional, district and VDC level. The lowest unit for publication of data is the VDC/Municipality. At the ward level, the household and population disaggregated by male and female are reported and no further details are published. More importantly, for various technical and practical reasons, it has not been able to bring all these settlement level data to the public. The PHC 2011 household questionnaire contains space to report information of the respondent households by small village *(gaun)* or settlement *(basti)* or *tole* but according to CBS sources, this information is yet to be processed. A VDC is divided into 9 Wards but wards do not have any administrative setting and formal role except there are representatives from the wards in the VDC level political set-up. In the mean time their completeness are not regorously verified because these information are not published yet.

Ecologically, Jumla district lies in the mountain region. Politico-administratively, it is part of Mid-western Development Region. It is one of the five districts of Karnali zone. With an area of 2,531 sq km, the district has a total of 108,921 people according to PHC 2011. Population density is 43 persons per sq km and sex ratio of 101.6 persons. Census records 19,303 households and the average household size is 5.64 persons. The government of Nepal has declared Chandannath municipality by incorporating Chandannath and other VDCs. During 2011 census administration and its publication, there was no municipality in the district and thus the discussion below considers all settlements there as rural settlements. Jumla is expected to provide a general picture of settlement pattern in the mountain region and similar studies for districts of other regions are expected in the near future.

Setting the Context

The lowest recognized unit of public dwelling in Nepal is *gaun* or *basti*. This translates as village or settlement. A geographic area comprising one or more *gaun* or *basti* is called a Ward of a Village Development Committee. This is a common practice in the hills and the Terai/Madhesh and these Wards are the subdivisions of officially recognized politico-administrative division known as VDC. In the mountain region of the country, sometimes a single settlement may be divided into more than one Ward and this happens in VDCs with limited number of households and/or population. Because data made available is preliminary, a few missing cases are reported. Further works by the CBS is expected to address such limitation. For the purpose of presenting an overall picture of the district at the settlement level, the available information is considered to be adequate. This is the first time that settlement level analysis is being done based on information available from census returns.

Before analyzing the settlement situation, a note on conceptual aspect of data is essential. The concept of settlement (as a unit) is based on the naming of a particular village or *basti* or *tole.* Within the boundary of VDC or municipality, single dwellings or assemblage of dwellings within a particular place have their place names and people from outside recognize the place or settlement by this name. Likewise, the residents normally use this place name in their personal documents and to refer their place identity in their daily lives. Sometimes an isolated single dwelling has been referred by a particular name and other times more than

100 households living in a compact settlement has been referred by a single name. Thus, settlement sizes vary and it is a common feature of rural settlements throughout the country. The enumerators in the census 2011 were asked to record this information in the household survey form of the census administration. Geographic boundaries of settlement are as per the residents' "demarcation" of the extent of area to be covered by the name. As long as the households use the particular name of the settlement in their documents and the name is recognized by the neighboring localities, that particular geographic entity is considered a settlement. This definition has some limitations with respect to clear boundary demarcation in a strict sense but for the absolute lack of further information, there is no alternative at this time.

Figure 2: A Sample Image of Rural Settlement Distribution in Jumla

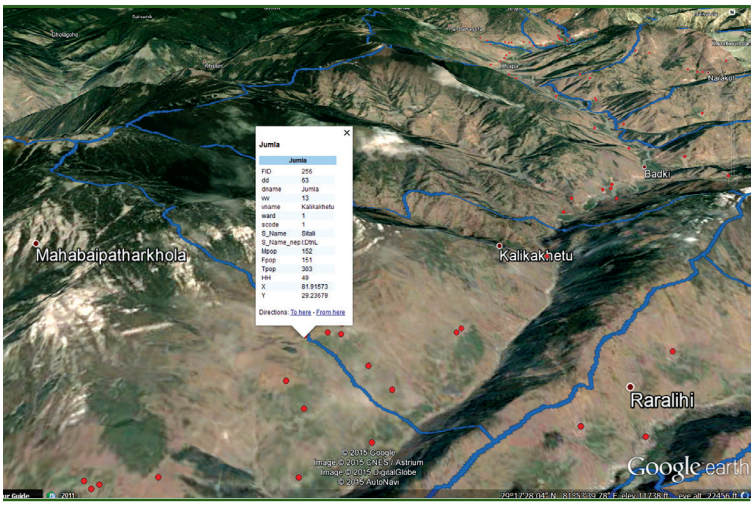

Table 30: Distribution of Settlements by Size Class and Average Households, Jumla

Settlement size	No. of settlement	Total households in the settlement	Average HH per settlement	Percent share of settlement size
<5 HH	25	53	2.1	6.4
5-9 HH	21	143	6.8	5.4
10-19 HH	60	889	14.8	15.5
20-29 HH	31	754	24.3	8.0
30-39 HH	51	1,807	35.4	13.1
40-49 HH	43	1,887	43.9	11.1
50-59 HH	45	2,450	54.4	11.6
60-69 HH	27	1,764	65.3	7.0
70-79 HH	23	1,685	73.3	5.9
80-89 HH	13	1,095	84.2	3.4
90-99 HH	20	1,866	93.3	5.2
100 & +	29	3,712	128.0	7.5
Total	**388**	**18,105**	**46.7**	**100**

Source: Based on preliminary data of PHC 2011 obtained from CBS.

Settlement Pattern

A total of 388 settlements of different sizes in 30 VDCs are recorded in Jumla by PHC 2011. The settlement sizes range from single dwelling to more than 210 households. At least 11 smallest settlements with single dwelling are recorded. Larger settlements include Bharatiwada (Chandan Nath VDC) with 212 households and Bijayanagar (Mahat VDC) with 176 households. "A sample image map of distribution pattern of rural settlements in Jumla district is presented in Figure 2."

Table 30 provides information on distribution of settlements by size of households, total population in the households and average households per settlement based on its size. It also provides information on share of particular settlement size on total settlements. Settlements have been classified into 12 categories based on the number of households in the settlement. In a settlement classification with 10 intervals, largest proportion of settlements (15.5%) belongs to the size class of 10-19 households. Nearly 12 percent settlement has less than 10 households within their premises. Of the total settlements, almost 60 percent settlements has less than 50 households and only about eight percent has 100 or more households. Among 29 settlements with more than 100 households, eight of them are from Chandan Nath VDC, four each from Dillichaur and Talium and two each from Tamti and Tatopani VDCs. Most of these relatively larger settlements are located in the middle part of the district, in and around district headquarters and close to river basins such as Tila and its tributaries. Lately, the Government of Nepal has declared Chandan Nath a municipality in Jumla, which includes Chandan Nath, Mahatgaun, Talium and Kartikswami VDCs. This implies that 14 out of 29 larger settlements are now part of the municipality (including Mahat 176 HH and Kartikswami 100 HH).

A total of 100,974 people live in 388 settlements identified by the census data. The overall sex ratio is 99.5. This means an almost a balance of male and female though the number of female exceeds male marginally. This sex ratio is higher than the national average of 94.5 and regional scales of Mountain region (93.8) and Mid-western region (92.7). Relatively larger settlements show a slight tendency of having high sex ratio. Otherwise, in general no particular pattern of sex ratio by settlement size is observed (Table 31). Of the total 12 settlement size classes, females outnumber males in seven and males in five class sizes. It is obvious that with increase in settlement sizes the population size increases.

The average household size of 388 settlements is 5.6 persons. This is high by national (4.9 persons) and regional (4.9 persons) averages. In general, settlements with average household sizes of 5.7 persons were more common than others. Settlements with more than 100 households demonstrated small household sizes. Otherwise, no any noticeable sequence of increase or decrease in the household size was observed by size class progression (Table 32). Despite large number of settlements in the lower class sizes, their overall share in population is small. Of all the size classes those with 100 and more households share the largest proportion. Every two out of five people in the district live in settlements with less than 40 households. On the contrary, almost equal proportion of population lives in settlements with over 100 households. Moreover, nearly one-fourth population lives in settlements with household sizes between 50 to 70 households.

Considering 388 settlements of various sizes, the average population per settlement is 260 persons. The average population by size class ranges from 12 persons in settlements of smallest size class to 668 persons in settlement of largest size class i.e., 100 or more households.

Settlements, Their Sizes and Average Settlement per Ward in the VDCs

As noted earlier, Jumla district has 30 VDCs. On an average, there are 13 settlements per VDC. But the number of settlements ranges from nice in the minimum to 30 in the maximum. Table 30 presents number of settlements by size classes for each of the 30 VDCs in the district. It is important to note that 12 percent settlements have less than 10 households in the settlement unit and 16 percent has households between 10 and 19. Altogether, the share of settlements with less than 20 households is 28 percent in the total settlement scenario of the district.

Settlements of the VDCs with more than 70 households are very limited. Only 13 percent settlements had households over 90. Only 13

Table 31: Settlement Sizes, Population and Sex Ratios

Settlement size	No. of settlement	Total population in the settlement	Male	Female	Sex ratio
<5 HH	25	298	145	153	94.8
5-9 HH	21	776	408	368	110.9
10-19 HH	60	4,950	2,442	2,508	97.4
20-29 HH	31	4,347	2,146	2,201	97.5
30-39 HH	51	10,389	5,251	5,138	102.2
40-49 HH	43	10,668	5,292	5,376	98.4
50-59 HH	45	13,871	6,874	6,997	98.2
60-69 HH	27	9,459	4,712	4,747	99.3
70-79 HH	23	9,635	4,823	4,812	100.2
80-89 HH	13	6,348	3,195	3,153	101.3
90-99 HH	20	10,866	5,382	5,484	98.1
100 & +	29	19,367	9,695	9,672	100.2
Total	388	100,974	50,365	50,609	99.5

Source: Based on preliminary data of PHC 2011 obtained from CBS.

Table 32: Household Size and Population Distribution by Settlement Size

Settlement size	No of settlement	No. of households	HH size	Population share (%)	Average population/ settlement
<5 HH	25	53	5.6	0.3	12
5-9 HH	21	143	5.4	0.8	37
10-19 HH	60	889	5.6	4.9	83
20-29 HH	31	754	5.8	4.3	140
30-39 HH	51	1,807	5.7	10.3	204
40-49 HH	43	1,887	5.7	10.6	248
50-59 HH	45	2,450	5.7	13.7	308
60-69 HH	27	1,764	5.4	9.4	350
70-79 HH	23	1,685	5.7	9.5	419
80-89 HH	13	1,095	5.8	6.3	488
90-99 HH	20	1,866	5.8	10.8	543
100 & +	29	3,712	5.2	19.2	668
Total	388	18,105	5.6	100	260

Source: Based on unpublished data of PHC 2011 obtained from CBS.

Table 33: VDCs by Total Settlements, Households, Size Class Distribution and Average Settlements by Wards

Name of the VDC	Settlement size (number of households in the settlement)											Total	Average settlement / Ward
	<10 HH	10-20	20-30	30-40	40-49	50-60	60-69	70-79	80-89	90-99	>100		
Badki	1	0	3	2	1	0	1	1	1	2	1	13	1.4
Birat	2	4	4	0	3	2	2	0	0	1	0	18	2.0
Bumramadichaur	1	9	1	0	1	0	0	0	0	0	0	12	1.3
Chandan Nath	3	8	1	2	3	0	4	0	0	1	8	30	3.3
Chhumchaur	0	0	1	3	1	3	1	0	0	0	0	9	1.0
Depalgaun	1	0	0	2	2	0	1	1	1	0	0	8	**
Dhapa	0	1	1	3	0	0	0	3	1	1	0	10	1.1
Dillichaur	2	0	2	0	1	0	2	1	0	1	4	13	1.4
Garjyangkot	8	6	0	4	2	1	0	1	0	1	0	23	2.6
Ghode Mahadeva	0	0	1	5	2	0	1	0	0	0	0	9	1.0
Guthichaur	0	0	0	1	1	2	2	1	1	1	0	9	1.0
Hanku	1	1	0	2	2	3	0	0	1	0	0	10	1.1
Kalikakhetu	2	2	1	1	1	4	0	0	0	0	0	11	1.2
Kanakasudari	1	2	0	3	2	1	0	1	0	1	0	11	1.2
Kartik Swami	0	0	3	0	1	3	1	0	0	0	1	9	1.0
Kudari	1	3	3	4	2	1	2	0	1	1	1	19	2.1
Lamra	1	2	0	1	4	1	1	1	0	0	1	12	1.3
Raralihi	0	0	0	2	6	1	0	1	0	0	0	10	1.1
Mahabaipatharkhola	3	3	1	3	0	5	0	0	0	0	0	15	1.7
Mahat	1	0	1	2	0	1	3	0	2	1	1	12	1.3
Malikabota	8	4	4	2	0	0	0	0	0	0	0	18	2.0
Malikathanta	0	0	1	1	2	1	0	1	1	2	0	9	1.0
Narakot	1	1	1	2	3	4	0	0	1	0	0	13	1.4
Pandawagufa	1	4	1	2	1	1	0	1	0	2	1	14	1.6
Patarasi	1	2	0	0	1	2	1	3	0	0	1	11	1.2
Patmara	0	2	0	1	1	2	1	3	0	1	0	11	1.2
Sanigaun	0	0	0	0	0	3	1	0	2	1	2	9	1.0
Taliun	1	1	0	1	0	1	1	0	1	0	4	10	1.1
Tamti	5	4	0	2	0	0	2	2	0	1	2	18	2.0
Tatopani	1	1	1	0	0	3	0	2	0	2	2	12	1.3
Total No.	**46**	**60**	**31**	**51**	**43**	**45**	**27**	**23**	**13**	**20**	**29**	**388**	**1.4**
Percent	**11.9**	**15.5**	**8.0**	**13.1**	**11.1**	**11.6**	**7.0**	**5.9**	**3.4**	**5.2**	**7.5**	**100**	**NA**

Note: The census return found that there were unreported cases of gaun/basti/tole in some of the household questionnaire. As a result, the above table may not be considered as exhaustive. However, it captures 94% of population and equal percent of households of the district. Institutional population is excluded.

* *Data for Depalgaun is incomplete e.g. Ward 5 is missing.

Source: Based on unpublished records of PHC 2011 obtained from CBS.

VDCs had one or settlements with 100 or more households. On the whole, settlement sizes of the VDCs in Jumla are not only small but also the number of settlements is limited.

Conclusion

Ever since human beings began to spend extended time in a particular location, human settlements developed in an organized manner. History of settlements in Nepal is unlikely to be an exception but we know very little about it. Information on settlement situation in Nepal is extremely limited. The state mechanism is guided by political administrative divisions where lowest level of data reporting is the VDC. Ward level information is limited to total households and population by male and female. Small settlements that are below the Ward level are overlooked with respect to being unit of data collection and/or analysis to date. Therefore, discussion on human settlements in Nepal has to be limited to urban, rural and regional categories. These are macro-categories and thus provide broader picture only.

Nepal's population increased rapidly till the end of 20th century and by the first decade of 21st century, the trend of growth appears towards stability as demonstrated by significant decrease in growth rate and age composition in a state of obtaining benefit of demographic dividend. The country's population is almost evenly divided between the highland (hill and mountain) and the lowland (Terai) with a slight tendency towards plain dominated demography.

The density of population is on the rise in general, in Terai and in the urban areas in particular. Regional disparities are evident in population size, sex ratio, household size, growth rates, distribution, density and other demographic indicators. In all these, Terai and central region appear distinct compared with the rest of the ecological and development regions.

Based on the definition of urban area adapted in the country, currently almost two out of every five citizen in this country live in urban settlement and three out of five in rural settlements. By international standards, Nepal may appear less urbanized (50 percent urban in the world) but given the rural character of the country demonstrated by housing characteristics (foundation, materials used, roof, outer wall etc) and types and extent of access to basic facilities to the households, Nepal remains as the country with overwhelming dominance of rural settlements. Rural settlements are poorly served as demonstrated by the limited road length in the districts. Urban settlements are relatively better in this respect but the service provisions there are also not adequate.

The case of Jumla suggests predominance of small settlements in the district and their locations guided by river valleys and safer sites. Most of the relatively large settlements are located close to or along the river valleys. In the mountain, due to limited availability of suitable land, settlements show a tendency of concentration on particular areas rather than evenly spreading in the whole district area. The VDCs constitute limited number of settlements and in some cases a single settlement has been divided into several wards of the VDC. Further studies on distance related measures, inter-linkages and efficiency of existing patterns of settlements for service provisions are needed.

The concept of *Nagarpalika* i.e., political administrative unit referring urban locations used in Nepal does not agree with the concept of "urban" as standard literature use it to relate to towns and cities (Johnston, Gregory, Pratt and Watts, 2003). Furthermore, the latest declaration of 133 municipalities has further reinforced confusion than clarity in this respect. This is because the spatial extent, the demographic, economic and social characteristics of majority new municipalities are hardly different from ordinary rural areas. Space criteria reflected through high population densities, minimum spacing of settlement blocks and landscape domination by built-up areas are essential features of urban landscape and thus to be considered as urban. Likewise, the functional characteristics of settlements, proportion of population in non-agricultural activities and the non-rural way of living are also important criteria to be considered an area as urban settlement. Declaration of municipalities without proper consideration of

these features raises questions on what constitutes urban and how an urban settlement differs from a rural settlement. Therefore, there is a clear need to revisit the process of designating municipalities. In the mean time, for all practical purposes there is also a need to further classify the territory within municipality as urban, semi-urban and rural like or so in order not to overburden its "rural" citizens of taxation and other revenues of urban government.

Over all, measured on the basis of available information, human settlement situation in the country is not satisfactory in both - with respect to locational characteristics and basic service provisions and with respect to knowledge about the settlements per se. There is an absolute dearth of information at the settlement level in the country. For the purpose of providing public services, settlements are the primary units. Poor or lack of information at this level is not a welcoming situation. The state mechanism, academia and other stakeholders need to pay attention to this so that we can plan the future of human settlements in a better manner.

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Disaster Management System in Nepal: Time for Policy to Action

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Nepal is prone to various types of disasters[1] such as: earthquakes, floods, landslides, fires, epidemics, avalanches, windstorms, hailstorms, lightning, glacier lake outburst floods, droughts and extreme weather events. Losses from disasters are increasing due to lack of proactive disaster management planning and policies. Among all these disasters – earthquake is the most scary and damaging. A number of government reports have shown that each year, the disasters kill thousands of people and destroy property worth billions of dollars. They also have a negative impact on the nation's development agenda. In addition to the natural factors, the losses from disasters are increasing due to the human activities and absence of proactive legislations. The scopes of the existing laws are limited to mitigate and respond to disasters. This situation demands complete approaches of disaster management planning, preparedness and recovery. The effects of a disaster, whether natural or human induced, are often far reaching. Thus, proactive disaster management legislation focusing on disaster preparedness is necessary. The disaster management sector of Nepal needs to refine policies and other legal instruments essential for efficient management of disasters. Political commitment and government prioritization of disaster management is required to attain these goals, with creation of a separate Ministry or Council for disaster management being highly desirable. This paper aims to identify deficiencies in disaster management in Nepal and suggest appropriate policy and technical measures.

Introduction

Due to extreme topographic and climatic condition compounded by weak economic base, Nepal is prone to many of natural and human induced disasters. It lies in one of the most fragile geographical regions of the world. Thus, the country is highly prone to natural hazards such as earthquakes, floods, landslides, fires, epidemics, avalanches, windstorms, hailstorms, lightning, glacier lake outburst floods, droughts and extreme weather events (e.g. climate change). On account of its multi-layered vulnerability, Nepal has witnessed an increase in the frequency and intensity of disasters in the past resulting in widespread devastation. Factors contributing to the risk and impact include its rugged yet fragile geophysical terrain, active tectonic processes, high altitude, variable climate, unplanned settlements, increasing population, poor economic condition, and low literacy rate. The earthquakes of 1934, 1980, 1988 and 2015 and the floods of the summer of 1993, 2008, 2013 and 2014 are among the most devastating disasters that Nepal has experienced so far. Such disasters have had a negative impact on the nation's development.

Various government reports over the last 32 years have shown that earthquakes, floods, landslides, fires, avalanches and epidemics kill thousands of people and destroy property worth millions of rupees every year. Disasters are exacerbated by poor governance. There is limited coordination between government agencies and other stakeholders. The roles and responsibilities of various agencies are unclear, and managerial skills are

[1] Disasters are major incidents which cause serious disruptions to life, arising with little or no warning, causing deaths or serious injuries and rendering people homeless.

lacking, as are resources. Low levels of awareness and lack of technological skills further intensify adversity, as does the lack of capacity for conducting hazard mapping, vulnerability assessment and risk analysis. In addition to the above factors, the losses from disasters are increasing due to the reactive approach of the government and other disaster management stakeholders. As a result such approach is limited to disaster response and relief rather than complete approaches including planning, preparedness and recovery.

Disasters affect everyone; particularly the poor and vulnerable people. Disasters can set back the achievement of development targets, such as the Millennium Development Goals (MDGs). Since 1980, low income countries have accounted for only 9% of disaster events but 48% of the fatalities indicate that the impact of disasters are enormous in poor and developing nations. The 2011 Tohoku Earthquake in Japan and Hurricane Sandy in New York area are gloomy events that shows no country – rich or poor – is immune from the impacts of disasters.

Table 1: Types of Natural & Human-Induced Hazards in Nepal

Types of Hazard	Prevalence
Natural Hazards	
Earthquake	All parts of Nepal is a high-hazard earthquake zone
Flood	Tarai (sheet flood), Middle Hills
Landslide and landslide dam breaks	Hills, Mountains
Debris Flow	Hills and Mountain, severe in areas of elevations greater than 1700 m that are covered by glacial deposits of previous ice-age
Glacier Lakes Outburst Floods (GLOF)	Origin at the tongue of glaciers in Higher Himalayas, Higher Mountains, flow reach down to middle Hill regions
Avalanche	Higher Himalayas
Fire (forest)	Hills and Tarai (forest belt at foot of southern-most Hills)
Drought	All over the country
Windstorms	All over the country
Hailstorm	Hills
Lightening	All over the country
Human-Induced Hazards	
Epidemics	Tarai and Hills, also in lower parts of Mountain region
Fire (settlements)	Mostly in Tarai, also in mid-Hill region
Accidents	Urban areas, along road network
Industrial/Technological Hazards	Urban / industrial areas
Soil erosion	Hills
Social Disruptions	Follows disaster-affected areas and politically disturbed areas

Source: Nepal Country Report: ISDR Global Assessment Report on Poverty and Disaster Risk 2009.

Statement of Problems Associated with Disasters

With a predominantly agrarian economy where about 85 percent of over 26 million people reside in rural areas, traditional, self-sustaining hills and mountain farming systems have been disrupted by increased population and fertile top soil erosion. In addition - deforestation, migration from the hills and mountains to the fertile Tarai[2] region and haphazardly developed urban centres are increasing at an unprecedented scale. Consequently, the poor, uneducated and unemployed people are compelled to make a living by settling in flood and land slide prone areas in the hills as well as the plains and urban areas. Lack of effective land use and settlement regulations has contributed to increased vulnerability to floods and other hazards caused by both natural and anthropogenic factors.[2]

The types of natural and human induced disasters that occur in Nepal and the locations are given in the following Table 1.

It is an unpleasant fact that the vulnerability of human settlements to natural disasters is continuously rising because of misappropriation of natural resources by deforestation, encroachment of the flood plains, environmental degradation, haphazardly planned development projects and heavy influx of population to the urban areas in search of employment and livelihood. However, we have learnt from the past disasters that we can significantly reduce the impact of natural disasters through disaster mitigation efforts. Such efforts must be integrated into development projects in order to build a culture of preparedness and prevention.2As Benjamin Franklin said, 'An ounce of prevention is worth a pound of cure,' why not commit to putting more effort into building capacity before a disaster strikes and on an ongoing

[2] Tarai is a flat and fertile land mass of Southern part of Nepal that extends from East to West. It covers 23 percent of the total land of Nepal.

basis, versus putting such an enormous amount of effort and expense at response/recovery efforts (Drager and Robertson, 2014).

The following image 1 shows the floods in Tarai, landslides in the hills and mountains and earthquake in the mid hills and Tarai.

The great havoc and destruction brought about by the devastating floods and landslides in central and southern part of Nepal in 1993 awakened the country to some extent from our traditional attitude toward natural disasters and their management. Despite our enhanced awareness of the gravity of the problem, we have barely managed to break the tip of the ice-berg as far as our institutional, managerial, technical, and resource capabilities are concerned. However, the Government of Nepal has integrated Disaster Risk Reduction (DRR) and set development goals in its national development planning and National Policy on Environmental Adaptation to Climate Change.[21]

Being a developing country, Nepal lacks strong mechanism to widely share knowledge and information to the poor communities. More importantly, the vulnerable communities have not been able to reduce the impact of disasters for want of resilience of poor and vulnerable people, particularly women, children, elderly and disadvantaged persons to mitigate, prepare for, effectively respond and overcome the impact of multiple hazards in various parts of the country. Therefore, it is highly necessary to build the capacity of the vulnerable communities in order to reduce the losses of human lives and physical properties in the time of disasters.

The Table 2 clearly shows that, losses from disasters are in increasing trend for want of proactive disaster management legislation, policies, preparedness, and risk reduction programs. Existing laws focus more on immediate disaster response which limits their applicability to disaster response and relief, rather than comprehensive approaches including planning and preparedness.

Flood in Tarai 2014

Image 1:

Source: DIPECHO 6TH ACTION PLAN, 2012

Jure Landslide 2014

Table 2 : Loss of Lives, Livestock and Other Effects by Type of Disaster,1983-2010
(Disasters: Flood, Cold, Landslide, Avalanches, Earthquake, Fire, Epidemic, Windstorm, Hailstone & Thunderbolt)

Year	Number of People		Number of Livestock Loss	Number of Houses Destroyed	Number of Affected Family	Land Affected (Ha.)	Public Infrastructure	Estimated Loss (Million Rs.)
	Dead	Injured						
1983	579	NA	248	12	NA	NA	NA	240
1984	941	NA	3547	10597	NA	1242	869	49
1985	1387	NA	3399	7166	NA	1355	436	23
1986	1512	NA	6566	3370	NA	1315	436	23
1987	881	162	1852	36220	97036	18858	421	2005
1988	1584	12538	2788	108801	70197	NA	4365	6099
1989	1716	3014	4240	7648	NA	NA	NA	4172
1990	913	196	867	6352	8462	1132	NA	139
1991	971	43	642	5510	6426	283	39	43
1992	1318	17	1586	13997	11535	135	66	52
1993	1524	246	NA	21911	90911	NA	NA	5189
1994	765	155	1329	3234	11701	392	NA	184
1995	873	1937	2053	10275	134216	41867.26	NA	1933
1996	895	1527	2480	30014	58329	6063.4	NA	1579
1997	1160	1120	1191	4825	46054	6063.4	NA	410
1998	1190	117	1179	15082	36987	326.89	NA	1230
1999	1466	146	650	4304	17842	182.4	NA	509
2000	377	162	1017	6886	24900	889	NA	1141.5
2001	415	132	665	6103	15908	NA	NA	526.65
2002	458	287	2126	19856	40935	10078	NA	525.56
2003	310	160	1125	6819	11730	2360	NA	989.93
2004	192	220	888	4818	16997	0	NA	341.09
2005	242	153	955	3169	4315	0	NA	387.21
2006	132	88	10098	3765	19023	3396.84	NA	392.31
2007	274	144	21861	37984	117203	513.65	NA	1928.55
2008	171	55	7066	13864	21600	21315	NA	1633.28
2009	641	117	228	1050	3028	NA	4.88	420.25
2010	448	261	1526	23370	19026	200 no	2.85	1398.19

Source: Department of Water Induced Disaster Prevention (Disaster Review,2010).

Gorkha Earthquake of 25 April 2015

An earthquake is one of the most terrifying disasters in Nepal. There have been many occurrences of earthquake disasters in Nepal that have caused heavy casualties and physical property damages, adversely affecting the overall development of the country. Nepal's proximity to earthquake hazards is mainly due to its young and fragile geology. Haphazard and unplanned settlements and poor construction practice are other reasons that have made it highly vulnerable to earthquake impacts. Nepal may have encountered many earthquakes throughout history; it has the record for the greatest loss of life dating back to the 12th century. Since then Nepal has encountered 16 major earthquakes, including the recent devastating earthquake of 25 April 2015.

A 7.8 magnitude earthquake struck Nepal on 25 April 2015 (11:56am local time). The epicenter was in Barpak Village of Gorkha district which is 81 km northwest from Kathmandu

(the capital city). It killed nearly 9,000 people, injured over 22,000 and rendered millions homeless. The earthquake was followed by a number of aftershocks throughout Nepal, with one shock reaching a magnitude of 6.7 on 26 April at 12:54 am local time. In addition to a number of human casualties, Centuries-old buildings were destroyed at more than five different UNESCO World Heritage sites in the Kathmandu valley. This earthquake was the largest to hit Nepal since the 1988 Nepal earthquake and the Nepal–Bihar earthquake of 1934. This earthquake also affected some parts of India, Bangladesh, and the Tibet Autonomous Region of China. Tremors were also felt in Bhutan and Pakistan.[11]

On 12 May 2015 at 12:50 local time another strong earthquake measuring 7.3 magnitude struck with the epicenter being in Sunkhani of Dolkha district. The epicenter was 76 km northeast of Kathmandu. This area was already affected by the 25 April quake. The initial quake was followed by several aftershocks including a 5.6 magnitude. This quake toppled already weakened buildings, triggered a series of landslides, which further hampered relief efforts. This quake alone killed more than 100 people.[11]

On 26 April 2015, the Government of Nepal declared an emergency in the worst affected districts and requested for international humanitarian support.

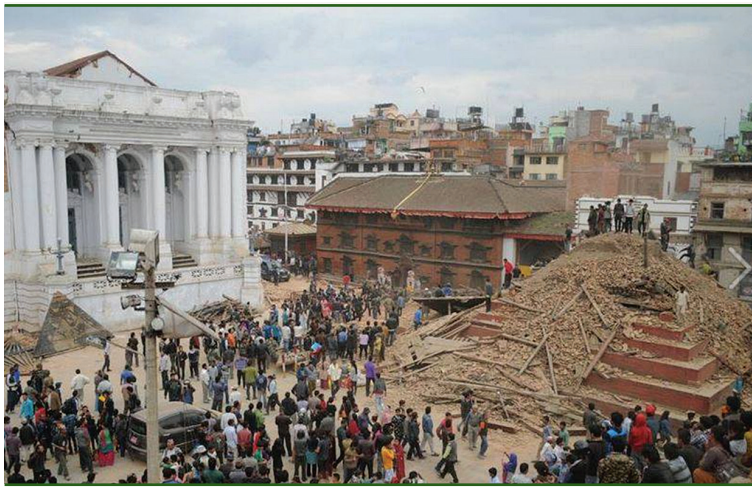
Another interesting phenomenon is that the movement of tectonic plates that triggered massive earthquake in the country on April 25 caused the altitude of Kathmandu Valley to increase by 80 centimeters, according to the Department of Survey of the Government of Nepal. 355 numbers of aftershocks with Local magnitude>= 4 have been recorded till 24 July 2015 and the course of aftershocks is still continuing.

The 2015 Gorkha earthquake affected 31 districts out of which 14 districts namely; Gorkha, Sindhupalchowk, Dhading, Kavre, Dolakha, Nuwakot, Ramechhap, Sindhuli, Rasuwa, Kathmandu, Lalitpur, Bhaktapur, Makwanpur and Okhaldhunga were hard hit.[35]

Please see five images for the ramification of the 25 April 2015 earthquake:

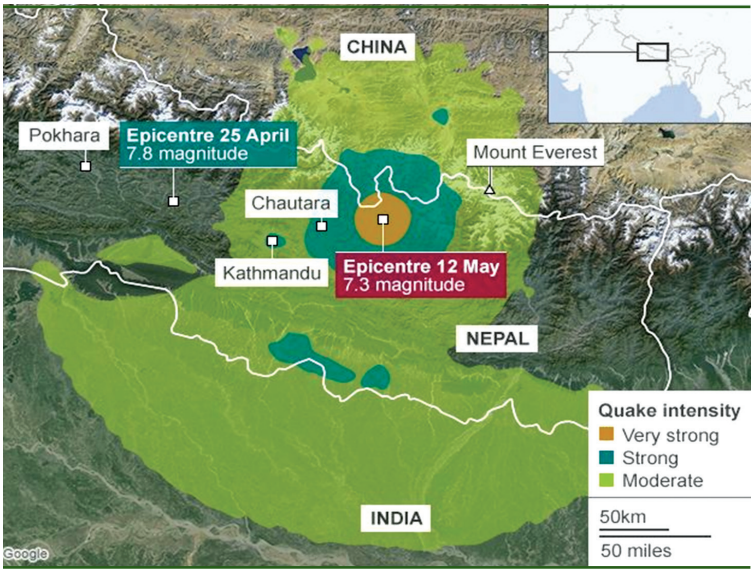
"Dharahara"—The Icon of Kathmandu Ruined Down into Pieces

"Kathmandu Durbar Square"—The Cultural Heritage—Severely Damaged



"Agony—Lets Hope it will not Happen Again

Avalanche in Mt. Everest where Dozens of People Killed



Source: USGS

Table 3: Losses due to the Earthquake (As of 27 May 2015)

Particulars	Nos.
Persons dead	8,844
Missing	755
Injured	22,307
Affected Families	11,24,358
Displaced Families	6,51,675
Houses Damaged (Fully)	5,98,401
Houses Damaged (Partially)	2,83,553

Source: Ministry of Home Affairs, the Government of Nepal

Until now, this devastating earthquake caused 8,844 deaths and 22,307 injuries, flattened hundreds of thousands of homes, and disrupted community lives. Please see Table 3 for detail data.

Dimensions of Institutional and Sustainability Aspects of DRR Actors[3]

Advent of Disaster Management Legislation

Before 1980, Disaster Management was not as important for the government of Nepal. Response works were being carried out in an ad-hoc basis and there was no separate nodal agency to respond and prepare for disasters. When 1980 earthquake occurred in eastern part of Nepal, the government started thinking seriously about the disaster management system. Still, disaster management has mostly remained neglected except during the occurrence of a disaster. The growing concerns of the national and international partners set a tone for the emergence of a legal system to handle disaster management activities in the country. As a result, a pioneering Act on this sector was promulgated by the Government of Nepal in 1982 namely; Natural Calamity Relief Act (NCRA), 1982.[14]

The NCRA, 1982 is, in fact, the first and foremost disaster management legislation in the whole South Asian Region. It tried to improve the processes of handling disasters through well-structured institutional arrangements. So far, NCRA, 1982 is the main legal instrument in handling disasters in the country. Though there are several measures yet to be adequately addressed - the Act has some specified standards based on the extent of impact.

This Act was amended twice in 1989 and 1992. However, there was no significant change, except the latter change broadened the scope of the Act to include human induced disasters such as industrial accidents as well as the preparedness and rehabilitation aspects of disaster management. The Act has not been able to adequately and appropriately address the areas of prevention, preparedness, rehabilitation and reconstruction as well as rescue and relief.

[3] This section is adopted from the Post Doctorate Dissertation of Dr.Meen B. PoudyalChhetri who is the author of this article.

Formation of Reconstruction Authority

An Act on Reconstruction of the Structures Damaged by Earthquake -2015 has been promulgated to carry out post-earthquake reconstruction works. According to the Act, an 11-member Reconstruction Authority would be formed under the chairmanship of Prime Minister, including four ministers nominated by PM, a Chief executive officer, Vice-chairperson of the National Planning Commission, Chief secretary and three experts having 15 years of experience in related field after completing post-graduate degree in infrastructure engineering, law, economics, management, economic or social development as members. The tenure of the authority will be five years and the government can either extend its term by a year if the tasks of reconstruction remained incomplete or assign any other body for the same. The CEO can recommend chairman to appoint secretary of the authority from among government officers. Laws related to acquiring and registering land, public procurement and Environment Impact Assessment will not be applicable in the quake-hit areas to accomplish the task of reconstruction rapidly.

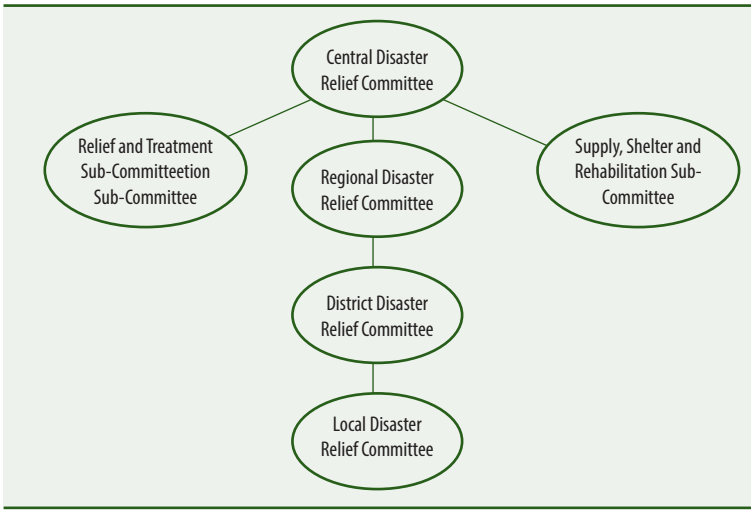
A separate 11-member Development Assistance Coordination and Facilitation Committee will be formed with a CEO at helm and include national and international development partners and civil society representatives.

Reconstruction Authority's Salient Tasks

- To determine total loss due to earthquakes
- To acquire necessary land following legal procedures
- To order authority concerned to remove physical structures after providing compensation to owners
- To coordinate with different bodies for effective implementation of reconstruction work
- To order owners to remove their damaged structures or to remove them at their cost.

The authority would direct the concerned ministries to accomplish necessary work of reconstruction providing them with necessary budget from a separate fund created for reconstruction work.

Figure 1: Disaster Management Structure 1982[4]



Institutional Arrangements

The NCRA, 1982 has initiated institutional arrangements at different levels through the respective Disaster Relief Committees to oversee natural calamities, especially relief and rescue works. The Committees at the central, regional and district level are functional but local level Committees have yet to be formulated and operated. The NCRA 1982 is silent about the composition of the Local Disaster Relief Committee. The existing disaster management structure as stipulated in the NCRA, 1982 is given in Figure 1.

The government representatives, 19 out of 24 members, overpower Central Disaster Relief Committee (CDRC), which formulates as well as guides the implementation of policies on disaster management activities. The notable omissions in the Committee are some important Government Ministries and agencies such as Agriculture, Local Development, Education, Science and Technology, Environment and Armed Police Force. CDRC does not meet frequently and is often found to have engaged in formulating short-term directives and approaches. Apart from Nepal Red Cross Society and Nepal Scouts the Non-governmental Organizations (NGOs) and the community orga-

[4] Adopted from the book titled "Mitigation and Management of Floods" by Dr.MeenChhetri and Mr.DamodarBhattarai.

nizations are not represented in the CDRC. The two temporary Committees namely; Supply, Shelter and Rehabilitation and Relief and Treatment Sub-Committees need permanent status should be and made active in the district levels as well.

Regional Disaster Relief Committee (RDRC) is responsible for regional level policy and is normally activated when the disaster area extends beyond one or more districts. The 75 District Disaster Relief Committees (DDRCs) are the main actors and real contributors at the field level and to work in all aspects of the disaster management cycle. However, the Local Disaster Relief Committee (LDRC), which could have been instrumental in actively engaging and mobilizing local volunteers in relief works, transferring victims to the treatment centres and secure shelters and distributing cash and relief materials to the victims has not yet been established in all parts of the country. However, some districts have Local Disaster Management Committee (LDMC) in disaster prone communities by involving Village Development Committee (VDC) Secretary, Ward Chairman and other concerned Disaster Risk Reduction short form already mentioned above actors.

In order to provide assistance to victims and expenditure on disaster related works, a Central Disaster Aid Fund (CDAF) is established under the supervision and control of the CDRC. Similarly, there is a less cumbersome Prime Minister Natural Calamity Aid Fund (PMNCAF) to provide cash assistance to disaster victims and to support rehabilitation, reconstruction and relief works caused by disasters. Similarly, Regional Disaster Aid Fund at the Regional level and District Disaster Aid Fund at the District level are put in operation. But the Local Disaster Aid Fund is not into operation. There are certain norms and basis developed by the CDRC for the distribution of relief assistance to the affected people and areas. Those norms shall be revised by the Committee as and when necessary.

Some Key Provisions in the NCRA

As per the provision made in the NCRA, the Government may declare hard hit disaster areas as the "Disaster Area" and can declare an emergency. After declaring the "Disaster Area," the government controls all activities including temporary takeover of public or private buildings; food, medicine and other commodities; vehicles and any other means or resources for the purpose of relief and rescue works. The entry of anyone in the disaster-affected area could also be controlled. Similarly, moving of the people and properties to safer locations; deputing any public officials for necessary relief works; sending aid volunteers to affected areas and undertaking suitable security measures during rescue and relief operation are others measures that can be taken by the designated authority during the disaster. There is also the provision of harsh punishment, if any one obstructs the rescue or relief works. A person who does not cooperate and hinders the response work during the emergency period may be imprisoned up to 3 months and fined up to Rs. 1,000.00.[14]

On 25 April 2015 when 7.8 magnitude earthquakes struck Nepal and caused enormous damage to the human lives and physical properties – the following day on 26 April 2015, the Government of Nepal declared an emergency in the worst affected 14 districts for a period of one month and requested for international humanitarian support.

Role of the Ministry of Home Affairs in Disaster Management

According to the NCRA, 1982, the Ministry of Home Affairs is the apex body for disaster management in Nepal. Formulation of national disaster policies and their implementation, preparedness and mitigation of disasters, immediate rescue and relief works, data collection and dissemination, collection and distribution of funds and resources are major responsibilities of the Ministry. There is National Emergency Operation Centre (NEOC) under the Ministry of Home Affairs (MoHA) to collect data and information on disaster from all over the country and disseminate them in due time. There are 5 Regions and 75 administrative districts in the country. In the five Regions there are 5 Regional Administrators and in each of the 75 districts there is Chief District Officer (CDO) as the district administrator who acts as the crisis manager at the time of natural disasters. The

MoHA has the nationwide network. Hence, it is the key agency for immediate response during disasters and has to play a leading role in managing the natural disasters in the country. Despite very limited funds and resources, the Ministry of Home Affairs is managing natural disasters in all respects. Of course, there are a number of problems in disaster management and much room for improvement.

Funding Arrangements

A Central Disaster Aid Fund has been established under the supervision and control of the CDRC as provided for by the NCRA, 1982. The fund can receive resources from any source, but its principal sources are:

- Cash and other resources contributions of the government of Nepal;
- Contributions from the Prime Minister's Disaster Relief Aid Fund (PMAF); and
- Assistance received from foreign countries, agencies and individuals;

The Act also provides for Disaster Relief Funds at the regional, district and local levels as the custodian of cash or other resources of the government, CDAF or any other source. However, the local level fund is not yet operational. Funds are provided from central to regional to district level based on necessity and justification of resources required for rescue or relief of victims.

To supplement the CDAF's efforts, the PMAF was established in 1993 following the catastrophic floods and landslides associated with that year's monsoon. The PMAF is larger than the CDAF, and is used not exclusively for rescue and relief, but also for rehabilitation and reconstruction.

Other Acts Related to Disaster Management

In addition to NCRA, 1982 - there are quite a few Acts related to the disaster management. Among others, the vital one is the Local Self-Governance Act (LSGA) which empowers local bodies to govern themselves and recognizes that local people and local bodies are best placed to know the development needs at the district, municipal and village levels. It aims to involve people in local level activities by providing full responsibility and authority to District Development Committees (DDCs), Municipalities and Village Development Committees (VDCs).[14]

In addition, Acts governing the Nepal Army (NA), the Nepal Civil Police (NCP) and the Armed Police Force (APF) assign their personnel to work closely in coordination with the MoHA during a disaster. Inventory of the DRR related legislations and documents are as following:

- Natural Calamity Relief Act 1982, amended in 1989 and 1992
- Nepal Water Resources Act (1992)
- Building Code (1994)
- National Action Plan for Disaster Management 1996
- The Environment Protection Act 1996
- The Environment Protection Rules 1997
- Local Self Governance Act 1999
- The Building Act 1998
- Nepal Water Resources Strategy (2002)
- Des-Inventar Database System Introduced in 2003
- Rural Water Supply and Sanitation Sector Policy, 2004
- National Water Policy 2005
- Water Induced Disaster Management Policy 2006
- National Urban Water Supply and Sanitation Policy 2009
- Draft Disaster Management Bill 2007
- Draft Disaster Management Policy 2007
- The Tenth-Plan (2002–2007)
- The Building Regulation 2009
- National Strategy for Disaster Risk Management (2009)
- Climate Change Policy 2011
- Three Year Interim Plan (2008- 2010 and 2010- 2013)
- Hyogo Framework for Action (HFA 2005-2015)
- NRRC's Flagship Programmes (5 Flagship Areas- US$ 195.8 Mil for 5 years)
- Focal Points- CC and DRM established in the key ministries and departments
- Local and District Disaster Risk Management Planning Guidelines - 2011

- Disaster Preparedness and Response Plan-2011
- National Strategy for Early Warning System (Proposed)- 2010
- Disaster Response Framework, U-SAR Plan and Open Spaces 2013
- Networks- such as DPNET and others
- Dead Body Management Guidelines
- Medium Term Expenditure Framework (MTEF).

Local Self-Governance Act, 1999

The Local Self-Governance Act short form already mentioned above, 1999 empowers local bodies to govern themselves, and recognizes that local people and local bodies are best placed to know the development needs at the district, municipal and village levels. It aims to involve people in local level activities by providing full responsibility and authority to DDCs, municipalities and VDCs.[6] The Act also provides for disaster related management works under the domain of the VDCs, municipalities and the DDCs. However, the duties and responsibilities are stated in such general terms that the authority of the institutions mentioned in LSGA is duplicated within the local level offices of administration and other developmental offices of the government. Unfortunately, the duties and responsibilities of each of the three local bodies are stated in such general terms that it appears that they are all vested with the authority to do exactly the same thing.

National Plans on Disaster Management

The United Nations (UN) declared the decade of the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) in 1989. In conformity with the IDNDR, Nepal drafted the National Action Plan on Disaster Management (NAPDM)[16] in early 1994 which was reinforced by the occurrence of the 1993 disastrous floods and landslides in the central region of Nepal. The Plan was prepared through extensive central and local consultations. Finally, the National Committee for the International Decade for Natural Disaster Reduction (NCIDNDR) was established and chaired by the Home Minister. The committee struggled in part because of the lack of coordination and a failure of implementation of plans. However, the government presented the aforementioned preliminary National Action Plan in the International Decade for Natural Disaster Reduction World Conference held in Yokohama, Japan in 1994. This plan was then revisited and improved by incorporating the Yokohama Strategies. Thus, the Government of Nepal (GoN) adopted the country's first-ever National Action Plan on Disaster Management in 1996. This Action Plan has spelled out time bound actions and responsible executing agencies on disaster preparedness, response, reconstruction, rehabilitation and mitigation. Among others, this Action Plan includes important policy and institutional perspectives such as the establishment of the National Disaster Management Council (NDMC) and National Disaster Information System, which were supposed to be accomplished by the year 2000 but have not yet materialized.

Later, the National Action Plan was re-examined among all key stakeholders and presented in the World Conference on Disaster Reduction held in Kobe, Japan in 2005. In this revision, as in the past, the government showed national commitments on disaster preparedness, response, mitigation, reconstruction and rehabilitation by identifying responsible executing agencies. Among others, it was also stated that the pending establishment of a high level National Disaster Management Council, as proposed in the National Action Plan, will be constituted at the earliest. But it did not materialize.

However, the concentration of the policy makers towards the disaster management has been gradually improving. Although the subject matter of disaster management was mentioned in the concept paper of the Ninth Plan (1997-2002), that was unnoticed in the main volume of the same.[19] Nevertheless, disaster management received visible attention of the planners for the first time in the Tenth Plan, (2002-2007)[29] and Three Year Development Plan (2007-2010).[30] The two Plans allocated a separate sub-chapter on disaster management and has dealt with the necessary pre-disaster mitigation and preparedness,

proper implementation of the programs and effective mobilization of the resources to contribute to the safety of the people and the physical properties. Attempts have also been made to establish linkages between disaster and development programs. The government tried to follow the resolutions adopted from the Hyogo Framework of Action (HFA) 2005-2015. HFA was formulated at the UN World Conference on Disaster Risk Reduction held in Kobe in 2005. The National Strategy for Disaster Risk Management in Nepal (NSDRMN) which came out in December 2009 from the government of Nepal is also guided by the HFA and UN "Cluster approach" principles and recommends creation of equivalent working groups getting members from appropriate organizations for coordination.

Now, we have Sendai Framework for Disaster Risk Reduction (2015 to 2030) to adopt a concise, focused, forward-looking and action-oriented post-2015 framework for disaster risk reduction.

Recent Initiatives taken for Disaster Risk Management

Draft Disaster Management Bill and Policy

It was felt since the early 90s that Nepal needed a proactive disaster management Act and Policy that covers the whole cycle of disaster management. In early 2007, the Nepal Centre for Disaster Management (NCDM)[5] drafted a new disaster management Policy and Bill and submitted to the government for consideration. The Policy and Bill drafted by the NCDM was an outcome of rigorous work done by the members of NCDM for more than 15 months. NCDM organized a series of meetings, workshops and interaction programs with the disaster management stakeholders from central to local level in Nepal in the process of finalization of the draft of the Policy and Act.

The Bill and Policy were revised by the relevant government agencies since then. After a series of campaigns and pressures from the civil society; particularly from NCDM and DPNet-Nepal, the Bill was forwarded to the Constituent Assembly in April 2012. Unfortunately the Constituent Assembly was dissolved on 27 May 2012. As a result, the Bill could not become an Act. Now either the present Constituent Assembly has to endorse it or it should come out as an Ordinance. The policy is still at large. Although at present, the Constituent Assembly is more focused in framing the new constitution for Nepal – the lessons learnt from the devastating earthquake demands for the need and importance of proactive Disaster Management Policy and Act. So, there is high pressure to the government from every sector of DRR to endorse the Policy and Bill. The Bill once passed, will help to establish new and more broadly representative disaster management institutions at national, regional, district and local levels. There is no doubt that the Bill will be instrumental to build more resilient communities in the future. The proposed Bill envisages a separate autonomous, powerful and resourceful body to oversee all aspects of disaster management. The Bill has also proposed for the composition of a Disaster Management Council that is to be chaired by the Prime Minister and represented by all most all ministers.

We hope that the Bill will be approved soon. The Bill when it becomes the Act and starts functioning will open avenue for effective disaster management system in Nepal.

National Strategy for Disaster Risk Management in Nepal[17]

The National Strategy for Disaster Risk Management in Nepal has been approved by the government in 2009. NSDRMN aims to achieve the goal of disaster resilient Nepal by providing guidance for improving the policy and legal environment and by prioritizing the strategic interventions. It also envisages to put forth suggestions for the institutional reorganization and development, and strategic improvement in the existing policy and

NSDRMN aims to achieve the goal of disaster resilient Nepal by providing guidance for improving the policy and legal environment and by prioritizing the strategic interventions.

[5] Nepal Centre for Disaster Management (NCDM) is a specialized agency in disaster management policy matters and education in Nepal which is represented by high level professionals from academia, bureaucracy, media etc.

legal environment for creating an enabling environment for encouraging DRR and preparedness planning at all levels as well as for mainstreaming DRR strategies into the national development and poverty reduction agenda. It can be taken as a commitment of the Government of Nepal to reflect the paradigm shift towards protection and safeguarding the human lives, properties, development investments, cultural heritage as well as to mitigate the disasters by improving the quality of life of the people.

As stated in earlier section, National Strategy for Disaster Risk Management has been developed based on the HFAin consultation with the relevant stakeholders across all levels. The Hyogo Framework for Action 2005-2015 was made not only because it recommends what every country should do for disaster reduction, but also because Government of Nepal had taken part in developing this framework and has made commitments to implement it. Hence, streamlining the National Strategy in line with the HFA was regarded as the most important approach to be adopted. The strategy is based on the ground realities and identified needs of Nepal. It has tried to capture the opportunities of Disaster Risk Management (DRM) in Nepal in line with the current international understanding, scientific progress and regional initiatives. The strategy is expected to provide the road map for all sectors to prepare sector specific programs for DRM and formulate the necessary policy decisions for facilitating mainstreaming DRM into the development process. The strategy has identified 29 cross-sectoral priority strategic actions and several sectoral activities for DRM. The cross-sectoral strategies are based on gaps and issues identified and are focused on addressing the identified gaps in particular sectors. They are divided into the five priority areas for Action.

The following sectors have been targeted to focus on:

- Agriculture and Food security
- Health
- Education
- Shelter, Infrastructure and Physical Planning
- Livelihood Protection
- Water and Sanitation
- Information, Communication, Coordination and Logistics
- Search and Rescue, and Damage and Needs Assessment

National Building Code (NBC), 1993

The Department of Urban Development and Building Construction (DUDBC) formulated and implemented Nepal National Building Code in 1993. The Building Act, Building Regulations and the Building Code provide the building construction legal obligations to be followed by the builders or owners through the local government. The salient features of National Building Code are building permit system, establishment of peer review, monitoring, certification of construction practices and implementation of land use planning measures.

National Disaster Response Framework (NDRF)

The National Disaster Response Framework has been prepared for the effective coordination and implementation of disaster preparedness and response activities by developing a National Disaster Response Plan that clarifies the role and responsibilities of the government and non-government agencies involved in disaster risk management in Nepal. The main purpose of this framework is to develop a clear, concise and comprehensive national disaster response framework for Nepal that can guide a more effective and coordinated national response in case of a large scale disaster. The national disaster response plan includes actions to be taken before, during and after the disasters.

National Adaptation Plan of Action (NAPA)

The National Adaptation Programme of Action represents the country's notable effort to assess and prioritize immediate and urgent needs to address climate change risks through a broad consultative process. The cabinet approved the NAPA on 28 September 2010. According to NAPA, the effects of climate change have been observed, while some parts of Nepal show increasing erratic and intense rains, and such climatic trends combined with fragile topography, deforestation and eroded soils are leading to landslides and flash flood hazards. It

has also been projected that rainfall intensity will increase across many areas of Nepal due to climate change and, therefore, vulnerable communities will have to increase their adaptive capacity to cope with climatic hazards. These hazards would also affect the availability of water resources particularly for household use and therefore water supplies need to be managed so they are climate proof. The major impacts of climate change in Nepal are: increased glacier-lake outburst flood (GLOF) hazards, increased variability of river runoff, increased sediments, increased evaporation from reservoirs and impacts on watershed. As a result glacier melt and precipitation patterns would occur. Nepal has wide variety of species. A study has found that 2.4% of biodiversity may be lost with climate change. Obviously climate change will affect agriculture. While majority of the people of Nepal depend on agricultural crops like rice, maize and wheat. Higher temperatures, increased evapo-transpiration and decreased winter precipitation may result into droughts. It should be considered as an early warning for food security.

Local Adaptation Plan of Action (LAPA)

Apart from the National Adaptation Programme of Action short form mentioned before the government has also prepared Local Adaptation Plan for Action. LAPA provides guidelines for the disbursement of at least 80 per cent of adaptation funds on the implementation at the local level. To support implementation, the Government of Nepal has developed a national framework for LAPA, which aims to make adaptation planning a bottom-up, inclusive, responsive and flexible processes that will identify the most climate vulnerable people and allow them to make informed decisions on priority adaptation actions. It provides an opportunity for undertaking developmental activities that are climate resilient with strong co-benefits for poverty reduction. The integration of local level Climate and Energy Plans with the LAPA could facilitate some triple-wins and produce low carbon climate resilient development (LCCRD). However, the biggest challenge to achieving these aims will be the quality of governance at all stages.

Local Disaster Risk Management Planning (LDRMP) Guideline, 2011

Keeping in view the need to develop disaster risk management from the central to local level and mainstream it with development plan, policy and programmes at all levels, and also in order to ensure the notion of sustainable development, the "Local Disaster Risk Management Planning Guideline, 2068" has been approved and put into effect. This was also done bearing in mind the main spirit and thrust of the National Strategy for Disaster Risk Management (NSDRM), 2009 and to make disaster management participatory, transparent, accountable, inclusive and responsible by optimally mobilizing local resources and capabilities, and by ascertaining the access and ownership of all affected communities and people.

Disaster Preparedness and Response Plan (DPRP) in Districts

The national workshop of 2010 recommended 21 points which was approved by the Central Natural Disaster Relief Committee (CNDRC) for an effective disaster preparedness initiative at district, regional and national levels. One of the recommendations was to create District Lead Support Agencies (DLSA) in 75 districts among the national and international agencies to support DDRC for preparing District Disaster Preparedness and Response Plan. It resulted into very positive feedbacks from all the DRR actors. As a result, so far, almost all districts have the DPRP. However, the implementation of the DPRP has many limitations. Particular problems are dearth of resources.

Nepal Risk Reduction Consortium (NRRC)

The Government of Nepal conceived Nepal Risk Reduction Consortium (NRRC) in 2009. The founding members of the Consortium are the Asian Development Bank (ADB), the International Federation of the Red Cross and Red Crescent Societies (IFRC), United Nations Development Programme (UNDP), UN Office for the Coordination of Humanitarian Affairs (OCHA), UN International Strategy for Disaster Reduction (ISDR) and the World Bank. The NRRC consists

of 21-member organizations including 13 Ministries of the Government of Nepalalready mentioned above. The Home Secretary is the Chair of NRRC. The Embassy of Japan and the Embassy of India joined the NRRC in 2012 as the observer. NRRC has identified 5 Flagship areas for sustainable disaster risk management.

The five flagship areas are as following:

1. School and hospital safety
2. Emergency preparedness and response capacity
3. Flood management in the Koshi River basin
4. Integrated community-based risk reduction
5. Policy/institutional support for disaster risk management

For each area, the lead role has been assigned to a government ministry while an international agency is designated as coordinator to support the concerned government lead. The Flagships are organised around specific functional areas of risk reduction, preparedness, and capacity building in DRR. They cover a range of DRR-related governance reforms, structural and non-structural mitigation measures, significant enhancement in preparedness and response capacities across government and international humanitarian actors for a major disasters, and enhancement of response and early warning capacities at community level.

The objectives of NRRC are to:

1. support the Government of Nepal in developing a long term DRR Action Plan building on the new National Strategy for Disaster Risk Management (approved October 2009);
2. initiate a multi-stakeholder participatory process with the Government of Nepal and civil society organizations, and;
3. identify short to medium term disaster risk reduction priorities that are both urgent and viable within the current institutional and policy arrangements in the country.

Nepal Risk Reduction Consortium has enabled the establishment of a coordinated approach to areas of DRR that have been prioritized based on risk assessment and brings together humanitarian and development actors, essential for a long-term approach. It has brought together a range of diverse actors together around the issue of risk reduction. It holds together the actors, principles and approaches from the humanitarian and development systems, the NRRC is innovative and an interesting case study. The engagement of the government is another essential factor that allows for national ownership and sustainability. The progresses of flagship areas are rather slow. At this point of time the future course of NRRC is uncertain as it was set forth for the period of 2009 to 2015.

National Emergency Operation Centre (NEOC)

The National Emergency Operations Centre started on the 17 December 2010, by the Minister of Home Affairs and is operated under the Disaster Management Division. The objectives of the NEOC are to work as a coordination and communication point for disaster information across Nepal, including government agencies and other response and recovery stakeholders such as Nepal Red Cross Society, UN agencies, INGOS and NGOs.

The NEOC is a pre-fabricated building situated in the premises of the Ministry of Home Affairs in Singha Durbar. The building is considered earthquake resistant. It is completely self-contained, including multiple back up power supplies. The NEOC's working time is round o' clock particularly during the disaster period to collect information. It has been running by a nine-member personnel team under the leadership of Under-Secretary. As part of MoHA's strategy to further develop Nepal's emergency preparedness and response capacity, it is planning to establish district emergency operation centres (DEOCs) in all 75 districts. In the first phase, 11 districts namely; Arghakhanchi, Kaski, Mahottari, Sunsari, Jhapa, Banke, Rukum, Kailali, Achchham, Dolakha and Sankhuwasabha have been selected to setup DEOC.

Additional Initiatives

In addition to the above, few more noteworthy achievements in disaster management activities in the country include formulation and implementation of Building Codes in Lalitpur and Kathmandu municipal area; functioning of the Sec-

toral Working Groups in Food and Agriculture, Health and Logistics; implementation of separate Emergency Preparedness and Disaster Response Plans in Health, Agriculture and hospital sectors. Also, almost all districts have now developed District Disaster Risk Management plans. DPNet-Nepal-Nepal, Red Cross Society, Nepal Center for Disaster Management and a number of INGOs have been instrumental in developing the district level plans. Some districts have developed disaster related Action Plans as well. Department of Water Induced Disaster Prevention (DWIDP) has prepared detailed hazard maps in 4 districts.

A detailed study on Earthquake Disaster Mitigation in the Kathmandu valley was carried out in 2001 which identified most vulnerable areas in Kathmandu valley and suggested various ways and means for safety measures. Although the findings and suggested measures of the study were very useful, the implementation part was too weak while the concerned authorities did not take them seriously. As a result, the earthquake of 25 April 2015 and following aftershocks caused the losses of thousands of human lives and physical properties worth billions of rupees. Actually, the areas which were identified as vulnerable by this study were found more damaged by the 2015 Gorkha earthquake. The earthquake truly confirmed the validity and importance of that study.

The Government of France has provided assistance to the Department of Mines and Geology (DOMG) to establish 21 micro-seismic stations to record the magnitude of the earthquake. Optimum Seismic Monitoring System is also established in the Department of Mines and Geology and the National Emergency Operation Centre which has been established at the Ministry of Home Affairs in December 2010. Similarly, the International Federation of Red Cross Society and Red Crescent Societies are also actively engaged in Nepal, through the Nepal Red Cross Society, in community-based activities and raising disaster awareness and capacity building at the district levels. International Centre for Integrated Mountain Development (ICIMOD) has developed hazard maps for the Hindu Kush area. The Government of Nepal has established Disaster Management Cell (DMC) in some Ministries, introduction of disaster management in school and partly in University education particularly the establishment of the Centre for the Disaster Studies and commencement of Master's Degree Course at the Institute of Engineering, Tribhuvan University (TU) can be noted as remarkable achievements. Master's level degree course on Crisis and Disaster Management has been started since 2014 at the Institute of Crisis Management Studies (ICMS) which is affiliated with Tribhuvan University.

Major Disaster Management Stakeholders

So far, the government agencies are the key players in disaster management activities in Nepal. The major contributors from the non-government sector are the Nepal Red Cross Society and Nepal Scout who are providing invaluable support during the occurrence of disasters. The NGOs and the community organizations have not yet been recognized as the major stakeholders particularly in disaster rescue operations. Of course, some of the NGOs have been contributing by providing relief materials in the event of some disasters. However, the contribution made by the non-governmental organizations to mitigate the disaster impacts and making people aware of the consequences of the disasters may erode any time as there is no legal and or government control as well as support over their plan and programs. Such organizations include National Society of Earthquake Technology (NSet), Nepal Centre for Disaster Management (NDCM), Disaster Preparedness Network-Nepal, Nepal Geological Society (NGS), Nepal Land Slide Society (NLSS), Rural Reconstruction Nepal (RRN) and many others who have contributed significantly by conducting research and capacity building programs to enhance public awareness in the country.

There are few partners in the international community who have been engaged in the disaster prevention and mitigation works. These institutions include Japan International Cooperation Agency (JICA), Korea International Cooperation Agency (KOICA), Asian Disaster Reduction Cen-

tre (ADRC), Asian Disaster Preparedness Centre (ADPC), International Centre for Integrated Mountain Development, United Nations Development Program, United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO), United Nations International Strategy for Disaster Reduction (UNISDR), United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), United Nations Disaster Assessment and Coordination (UNDAC), Department of International Development/UK Aid (DFID), United States Agency for International Development (USAID), SAARC Disaster Management Centre, United Mission to Nepal (UMN), Cooperation for American Relief Everywhere (CARE), Caritas Nepal, Water Aid Nepal, World Food Program (WFP), Save the Children Fund (SCF), Technical Cooperation of the Federal Republic of Germany (GTZ), Lutheran World Federation (LWF), Action Aid Nepal (AAN), Adventist Development and Relief Agency (ADRA), Caritas, International Federation of Red Cross Society and Red Crescent Societies, OXFAM, etc.

Gaps in Policy, Program and Practice

There are two aspects of disaster mainstreaming, one is integrating DRR in all sectoral development plans and another is mainstreaming in district and local development plan. Sectoral development covers the specific thematic areas while local development addresses the community development including basic needs of thematic/sectoral area. The local development unit i.e. Village Development Committee has different policies and guideline regulated through its own governing line ministries and simultaneously it would also look after guidelines of other sectoral ministries. Each guideline and policies are prepared prioritizing its own priority development issues along with showing scope of integrating disaster risk reduction. Due to the provisions made in policies and guidelines of different line ministries, different development plans like local development plan, local Disaster Risk Reduction Plan (LDRMP), Climate Change Adaptation Plan for Action (CAPA), Local Adaptation Plan for Action, School Improvement Plan (SIP) and others there being operationalized in VDC. This has created difficulties in implementation with actual sense of DRR mainstreaming which simultaneously requires additional resources.

Thus, there is clear need of harmonizing the existing policies with developing a common operational approach in complete approach with integrating above mentioned plans so that it would give synergic result in risk reduction and sustainable development.

Different ministries have their own guidelines like Ministry of Federal Affairs and Local Development (MoFALD) has LDRMP and DDMP guidelines likewise Ministry of Environment (MoE) has CAPA, LAPA and NAPA related to climate change adaptation. Based on all these guidelines, each sectoral units and programs are preparing their own working document at Community, district and VDC level. There are no any linkages and correlations among them. This has hampered in resource mobilization for their implementation. It is also a very concerning situation that there is no any linkage between LDRMP and DDMP. Government organizations and different non-governmental organizations have prepared disaster management plans in a mechanical way. They are not practical and user friendly. Their implementation was minimal during the occurrences of disasters. Moreover, they have no inter-linkage between district to VDC and community.

Although, the government agencies, development partners, non-governmental organizations and civil society have shown keen interest and initiated actions for Disaster Risk Reduction/ Management and its mainstreaming in development programming they are still inadequate. Because, mainstreaming is a process of integration of components of Disaster Risk Reduction into national and local development planning processes like the poverty reduction strategies and schemes, socio-economic development plans and schemes, environmental assessments, and so on. These are

taken up by the Government for long term development and all these processes are essentially aimed to reduce poverty and increase the socio economic resilience of the country and the communities. To some extent, the program framework and tools developed by Flagship 4 have helped and directed DRR actors to adopt common approach in the programs they are implementing. The indicators set for the resilience building have made the programs to drive in common path. Likewise, the guidelines, LDRMP, DDMP have dragged the attention of local authorities and government bodies to initiate the plans, programs and projects to reduce the disaster risk.

The above mentioned policy gap demands for an independent, powerful and resourceful separate organization for the management of disasters in Nepal.

Deficiencies in the DRR Legal System

There are specific shortcomings and challenges in governance (organizational, legal and policy frameworks), risk identification, damage assessment, monitoring, early warning, public awareness, preparedness, mitigation, rehabilitation and reconstruction. Action in these areas will help the government improve its legal instruments and policy frameworks. The country has gained considerable experience in risk management, vulnerability reduction and increasing preparedness and response capabilities at the community level, but these experiences have not been shared, analysed or used to update policies (Dr. Chhetri 1999).

There are significant deficiencies in the disaster management legal system in Nepal, which can be outlined as following:

1 The government has not yet formulated rules and regulations to back up the NCRA, 1982. There are no standing orders, procedures or codes similar to Fire Codes. A code of conduct for the disaster responders is also lacking.

2 The adopted definition of disaster is too narrow: it does not include plane crashes, bus accidents, cold waves, heat waves, animal attacks, terrorism etc.

3 The Act does not clearly state the roles and responsibilities of disaster management organizations.

4 The Act is focused more on rescue and relief efforts than on preparedness, rehabilitation and reconstruction.

5 Relief and Treatment Sub-committee and Supply, Shelter and Rehabilitation Sub-committee are dormant. Similarly, the government has not yet formulated Local Disaster Relief Committees, which are vital for disaster management at the grass roots level.

6 Command, Control and Coordination System (CCCS) and/or Incident Command System (ICS) have not been introduced.

7 INOGs, NGOs and social organizations willing and committed to work in disaster risk reduction have not been well organised.

8 The Act has no provision for compensation of volunteers and emergency workers in case of serious injury or death.

9 Provision of insurance system is lacking in the existing Act.

10 The Act fails to mention the need for Research and Development (R&D).

11 The Government has not been able to solve the problem of inundation in Tarai area.

12 Disaster management has not been adequately addressed in the Government periodic plans.

13 The provisions of the LSGA are inadequate. It does not clearly spell out the roles of local bodies in disaster management.

Measures to Address the Deficiencies in the DRR

Although we can find a well-structured institutional arrangement in the coping mechanism of Nepal, there are two main shortcomings in their activities: inadequate proactive policy formulation and poor implementation. There is a need to incorporate disaster risk reduction measures into

post-disaster recovery and rehabilitation processes, and a need to use the recovery phase of disasters to develop the capacity to reduce risk. Knowledge and lessons learned need to be shared across the board. At the same time, rules and regulations to back up the NCRA should be formulated. In addition, standing orders, codes, guidelines and manuals should be prepared.[23]

In particular, the following measures can be adopted to address the deficiencies in DRR:

1 The government should formulate rules and regulations to back up the NCRA, 1982. Standing orders, codes, guidelines and manuals should also be prepared.

2 As disaster mitigation is a multi-sectoral activity, the government should ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation.

3 The two dormant sub-committees, namely the Relief and Treatment Sub-committee and the Supply, Shelter and Rehabilitation Sub-committee should be activated. Their temporary nature should be converted into permanency, and they should also be incorporated at the district level. Similarly, Local Committees should be formed immediately.

4 Establishment of a separate agency for disaster management in the form of a multi-sectoral national platform is necessary for disaster risk reduction. This agency may facilitate policy coordination and take action on disaster risk reduction.

5 A command, control and coordination mechanism or incident management system should be adopted.

6 A disaster management cell should be established in each DRR related ministry.

7 The role of local government should be made clear in the LSGA, 1999.

8 Special emphasis should be given for the integration of disaster risk reduction measures into sustainable development policies, and planning and programming at all levels, with due emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction.

9 It is necessary for relevant agencies and officials to be aware of the importance of disaster risk reduction policies and to be accountable for their implementation.

10 R&D activities should be carried out for the development of inland and trans-boundary waterways. While poverty alleviation should be supported by creating a suitable environment through structural intervention and regulatory measures for increased economic activities in the flood and landslide prone areas.

11 To solve the common flood and inundation problems among the riparian countries regional cooperation and mutual understanding will play a very crucial role.

12 Well trained human resources, technical capacity and institutional setup are the key pillars to address the challenges in a sustainable way. It is strongly felt that there is inadequate information based on empirical research on various DRR components such as flood, landslides, fire, earthquake, debris flow, avalanche, etc. Therefore, well trained human resources should be produced in order to address the above shortcoming.

13 It is also necessary for the media to participate in creating a culture of disaster resilience and strong community involvement in sustained public education campaigns and public consultations at all levels of society.

14 Back-up communication system should be developed, because managing disasters relies on communications and information be it before, during or after an event has occurred. While most of the time, communications are the first thing lost after a disaster, technologies to manage information can be put in place beforehand and managed locally offline and online by others throughout the world.

15 There should be clear-cut and definite policies on the role of INGOs, local communities and the private sector. They should be

streamlined and guided by the government, and, public awareness should be encouraged and enhanced.

16 Disaster management courses should be incorporated more in school and university curricula.

17 Community participation in disaster risk reduction and management through the formulation and implementation of specific policies, promotion of networking, strategic management of volunteer resources, attribution of roles and responsibilities, and delegation and provision of the necessary authority and resources is vital.

18 Adoption of indigenous knowledge may result in simple, cost effective, adaptable and easily understandable disaster mitigation. Therefore, it is necessary to share effective practices and lessons learned to further disaster reduction and sustainable development.

19 The construction of warehouses to hold critical resources in strategic locations is needed. Relevant officials must be trained in warehouse management and supply of relief materials..

20 Stock-piling of supplies, equipment and personnel in strategic locations is necessary, to provide for easily mobilized in an emergency.

21 Evacuation plans and exercises should be conducted periodically.

The above analysis shows the need of immediate review and refinement of disaster management sector policy, strategy and legislations. The government should prioritize disaster management without further delay. At the same time, firm political commitment with integrity and determination is an indispensable precondition to attain the above goals.

Way Forward[6]

The national institutional mechanism needs to be able to trigger and support the process of DRR, decentralize the responsibility, involve and engage all stakeholders and coordinate the actions nationally at all levels – from the community to the level of the national government. At the same time, the new structure should have the authority as well as the capacity to integrate DRR into the national governance and development efforts and force/facilitate program-level synergy and coordination. Considering these facts, and also based upon the lesson-based institutional restructuring implemented recently by neighbouring countries and to be able to develop compatible structure for being able to play active role in the SAARC level initiatives in DRM – Nepal needs an autonomous, resourceful and authoritative institution for disaster risk management. Hence, the government should immediately start the process to establish such institution. The long awaited Disaster Management should commensurate with the following components:

- A standardized approach to incident/crisis management that is scalable and flexible;
- Well-organized cooperation and interoperability among responders;
- All-inclusive all-hazards preparedness;
- Efficient resource coordination among the stakeholders and authorities;
- Integration of best practices and lessons learned for continuous improvement.

It is to be noted here that without a proactive disaster management policy and other legal framework the above goals cannot be achieved. At the same time, all agencies (central, regional, district and local) and other government and non-government organizations should perform in a collaborative way in the field of DRR. Disaster management should be factored into policies, planning and programming related to sustainable development with clearly delineated responsibilities of government organization, NGOs, community and private sector. Risk assessment should also be made compulsory while formulating development programs. Although, at present most of the districts have prepared district level DRR plans and programs, every district should develop a comprehensive disaster management policy, supported by appropriate legislation, standards,

[6] These Recommendations and Way Forward have been partly taken from the Post Doctorate Dissertation of Dr. Meen Chhetri

guidelines, manuals and clearly defined roles of all concerned organizations.

Participation of local community in DRR is very important. So the local communities all over the country should be encouraged through the promotion of networking, strategic management of resources, assignment of distinct responsibilities and sufficient resources. Country's own community based capability in managing risk, reducing vulnerability, increasing preparedness and response capabilities should be adapted as priority in the macro-level policies. Developing a replicable model of community based disaster management programs are highly desirable and can lead to the use and dissemination of the optimal use of indigenous knowledge, skill and available best practices in the community.

More importantly, an all hazard approaches must be taken together with the following five principles which form the basis of the proactive disaster management system. The five main principles should be:

(a) Comprehensive approach;
(b) All hazards approach;
(c) All agencies approach;
(d) Local disaster management capability; and
(e) A well prepared -- resilient community.

Based on the above five principles the government can establish a separate agency at the central level in order to support down below the local government disaster management activities. The Local Community is supported by the relevant District Agency, as and when disaster management activities exceed the capacity of a Local Group or Community. The functions of the Local Group include (but are not limited) to:

1. Develop, regularly review and assess effective disaster management;
2. Assist local government for its area to prepare a local disaster management plan;
3. Ensure the community is aware of ways of mitigating the adverse effects of an event, and preparing for, responding to and recovery from a disaster;
4. Identify, and coordinate the use of resources that may be used for disaster operations;
5. Manage disaster operations in the area under policies and procedures decided by the District Committee or Agency; and
6. Ensure disaster management and disaster operations in the area are consistent with the Standard Operating Procedure (SoP) planned by the government.

The above analysis and evaluation over again denotes that in order to reduce the loss of human lives and properties in Nepal, a separate Ministry or Council or Authority for disaster management is highly desirable. Such agency is required for effective disaster prevention, preparedness, response and recovery works as well as for the transformation of Nepal from vulnerable to a safer place.

The mission of the new agency should be to support the people of the country and responders to ensure that as a nation all should work and contribute together to build, sustain and enhance the capability to prepare for, protect against, respond to, recover from and mitigate all hazards. Finally, as stated earlier, an all hazard approach must be taken together with the above five principles.

Conclusion

Among the many challenges for Nepal is the wide variety of disasters it faces. Some, like monsoon flooding recur regularly, but at various times and places. Others, like earthquakes, occur intermittently and at long intervals. In this case the lessons learned may not remain in local or institutional memory. Nepal also needs to build institutions and local capacity to minimize the impact of disasters. For any given disaster risk reduction activity to succeed, specific risks need to be targeted. Success in responses to disaster depends on factors including access to safe drinking water, reliable communication, transport and mobility, access to finances, social support, and risk minimizing strategies. Government agencies at national and local levels must coordinate the support they provide to help the affected rebuild their lives. Equally important is that agencies evaluate and

learn from the success of specific interventions, especially given the complications raised by climate change. The government cannot act alone: disaster risk reduction strategies need to be developed and maintained through private and community based approaches.

Nepal faces an enormous challenge from major disasters like the devastating earthquake of 25 April 2015. Although disaster management and risk reduction may be considered expensive in the light of competing demands for resources in a developing country like Nepal, this is high time for the government to invest on considerable activity and resources into preparing for and responding to familiar and unexpected emergencies and disasters before the human and economic consequences of inaction are extensive, unmanageable and more expensive.

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Glossary

Abiotic: non- living, e.g. rocks or minerals.

Abatement: technology applied or measure taken to reduce pollution and/or its impacts on the environment. The most commonly used technologies are scrubbers, noise mufflers, filters, incinerators, waste-water treatment facilities and composting of wastes.

Agenda 21: the plan of action to achieve sustainable development that was adopted by world leaders at the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil, in June 1992.

Algae: simple non-vascular plants with unicellular organs of reproduction. Algae are found in fresh and salt water. They range from unicellular forms, usually microscopic, to multi cellular forms up to 30 m in length.

Afforestation: artificial establishment of forests by planting or seeding in an area of non-forest land.

Acidification: increase of hydrogen ions, usually expressed as the pH value of environmental media.

Airborne Disease: disease that is generally transmitted by nasopharyngeal discharges and by respiratory secretions, through coughing and sneezing, though it may also be conveyed through close contact. Respiratory diseases include the common childhood infections, measles, whooping cough, chickenpox, mumps, diphtheria and acute sore throat, as well as diseases of the respiratory tract, influenza and other acute viral infections, the pneumonias, and pulmonary tuberculosis (WHO, 1992).

Air Pollution: the presence of contaminant of pollutant substances in the air that do not disperse properly and that interferes with human health of welfare, or produces other harmful environmental effects.

Air Pollution Index (API) : quantitative measure that describes ambient air quality. The index is obtained by combining figures for various air pollutants into a single measurement.

Air Quality Standards: levels of air pollutants prescribed by regulations that may not be exceeded during a specified time in a defined area.

Air Pollutants: substances in air that could, at high enough concentrations, harm human beings, animals, vegetation or material. Air pollutants may thus include forms of matter of almost any natural or artificial composition capable of being airborne. They may consist of solid particles, liquid droplets or gases, or combinations of these forms. See also hazardous air pollutants.

Acid Precipitation / Rain: any form of precipitation (rain, snow, hail or fog) whose acidity has been increased through the uptake of acid pollutants from the air.

Alternate Energy: energy sources other than the traditional forest product and commercial energy items. They are: Direct Solar Insulation, Wind, Micro-hydro, Geothermal, Bio-gas plants.

Assets: Assets are entities that must be owned by some unit, or units, and which economic benefits are derived by their owner(s) by holding or using them over the period of time.

Ambient: surrounding, environmental.

Annual Average: average of concentrations measured over one year.

Annual Rainfall (mm): total rainfall in a year

Average Daily Sunshine Hours: average of daily sunshine hours measured over one year.

Acidity: acidity as applied to water is defined as the quantitative capacity of aqueous media to react with hydroxyl ions. The determination of acidity may provide an index of the severity of pollution or may indicate the probable behavior of water in treatment processes.

Alkalinity: the alkalinity of a solution may be defined as the capacity for solutes it contains to react with and neutralize acid. In water the alkalinity is produced by the dissolved carbon dioxide species, bicarbonate and carbonate. There are three types of alkalinity methyl-orange alkalinity, total alkalinity, and phenolphthalein alkalinity.

Ammonia: the term ammonia includes the non-ionized ammonia molecule and ionized ammonium ion species. Ammonia in water is an indicator of possible bacterial, sewage and animal waste pollution. No health related guidance value for drinking water has been set by WHO but concentration above 1.5 mg/l creates odour and taste problems.

Aquifer: underground geologic formation, or group of formation, containing ground water that can supply wells and springs.

Amphibians: class of cold-blooded vertebrates comprising frogs. They live both in water and on land. Most amphibians have to become temporarily aquatic for the purpose of reproduction.

Angiosperm: flowering plants, which produce one or more seeds enclosed in a fruit.

Bacteria: single- celled micro-organisms. Some are useful in pollution control because they break down the organic matter in water and land. Other bacteria may cause disease.

Baseline: The baseline (or reference) is any datum against which change is measured. It might be a current baseline in which case it presents observable present-day condition. It might also be a future baseline ,which is a projected future set of condition excluding the driving facer of interest Alternative interpretation of the reference conditions can give rise to multiple baseline.

Base Period: the period that provides the weights for an index is described as the base period

Biodiversity: the range of genetic differences, species difference and ecosystem difference in a given area.

Biomass: total living weight (generally in dry weight) of all living organisms in a particular area or habitat. It is sometimes expressed as weight per unit area of land or per unit volume of water.

Bryophytes: non-vascular and non-flowering plants comprising mosses and liverworts, widely distributed on moist soil and rocks.

Biological diversity: the variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystems diversity.

Biochemical Oxygen Demand (BOD): the biochemical oxygen demand is the mass of dissolved molecular oxygen, which is needed by micro organisms for the aerobic oxidation of organic substances to CO2 and water. Generally in water analysis BOD is determined at 20oc with 5 days incubation period. It depends on the amount of organic substances present in water and is useful in expressing stream pollution load. Generally, effluents having BOD value greater than 4 mg/l are not allowed to be discharged into water courses.

Bio-gas: mixture of methane and carbon dioxide in the ratio of 7:3 that is produced by the treatment of animal dung, industrial wastes and crop residues. It is used as an alternative source of energy.

Biogeography: the scientific study of the geographic distribution of organisms.

Biota: All the organisms, including animals, plants, fungi and microorganisms in a given area.

Chromosome: body found in the nucleus of living cells, composed mainly of DNA and protein, in a linear sequence of genes, Exchange of genes during sexual reproduction is facilitated by splitting of chromosomes during fertilization.

Carbon Dioxide (CO_2): It is a chemical compound consisting of one atom of carbon and two atoms of oxygen. A colorless, odorless, non-poisonous gas, which results from fossil fuel combustion and burning of materials, and is normally a part of ambient air.

Carbon Monoxide (CO): It is a chemical compound consisting of one atom of carbon and one atom of oxygen. It is a colorless and odorless gas formed whenever carbon or substances containing carbon are burned with an insufficient air supply (incomplete fuel combustion). It is poisonous to all warm-blooded animals and to many other forms of life. Automobile - exhaust gases contain harmful quantities of carbon monoxide.

Catchments Area: area from which rainwater drains into river system, lakes and seas.

Climate: Climate in a narrow sense is usually defined as the average weather or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of millions of years. These quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state including a statistical description of the climate system. The classical period of time is 30 years, as defined the World Meteorological (WMO).

Climate change: Climate change refers to a change in the state of the climate that can be identified (e.g. using statistical test) by changed in the mean and /or the variability of its properties, and that persists or extended period, typically decades or longer. Climate change may be due to natural internal processes of external forcing, or to persistent anthropogenic change in the composition of the atmosphere or in land use.

Community Soil: It is a practice of managing the conservation of soil erosion or soil quality by community participation.

Consumption: consumption is an activity in which institutional units use up goods or service, consumption can be either intermediate or final

Chloro-fluorocarbons (CFCs): inert, non-toxic and easily liquefied chemicals used in refrigeration, air-conditioning, packaging and insulation or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone. They are also among the greenhouse gases that may affect climate change. See also aerosol propellant.

Chemical Oxygen Demand (COD): chemical oxygen demand (COD) is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. It is a measure of the total amount of oxygen required for oxidation of waste to CO_2 and water and is used to determine pollution or oxidizable material loads quickly.

Coliform: coli form organisms are defined as Gram-negative, rod-shaped, non- sporing bacteria capable of growing in the presence of bile salts or other surface - active agents and of fermenting lactose within 48 hours at 35-37oC. This group of bacteria includes organisms originating from intestinal tract of warm-blooded animals and also from soil and vegetation. Its presence in water indicates probable contamination from human waste. Recent health related WHO guideline value for drinking water does not permit the presence of even a single coliform bacterium in drinking water.

Color: the term color is used to mean true color, that is, the color of water from which turbidity has been removed. Color in water may result from the presence of natural metallic ions (iron & manganese) humus and peat materials, plankton, weeds, and industrial wastes.

Dicotyledon: flowering plants with two seed leaves in embryo plant. Includes many forest and fruit trees, food plants and ornamentals.

Decibel (dB): unit of sound measurement on a logarithmic scale, with sound approximately doubling in loudness for every increase of 10 decibels.

Dust: particles light enough to be suspended in air.

Deforestation: clearing of tree formations and their replacement by non-forest land uses.

DNA: deoxyribonucleic acid, chief constituent of chromosomes.

DNA (deoxyribonucleic acid): fhe genetic material of most living organisms, which is a major constituent of the chromosomes within the cell nucleus and plays a central role in the determination of hereditary characteristics by controlling protein synthesis in cells.

Degraded Land (natural): land deteriorated through a reduction in soil depth or quality as a result of water or wind erosion, landslides or water logging etc. This excludes land in the process of desertification.

Degraded Land (man made): this refers to the land deteriorated through a reduction in soil depth or quality as a result of deforestation, de-vegetation faulty irrigation system, excessive chemical fertilizers in localized area, unwise use of marginal land, road building in the hills etc. This also excluded land in the process of desertification.

Denudation: 1. erosion by rain, frost, wind or water of the solid matter of the earth. The term often implies the removal of soil down to the bedrock; 2. Removal, by natural or artificial means, of all vegetation and organic matter.

Depletion (in natural resource accounting): for renewable resources, the part of the harvest, logging, catch and so forth above the sustainable level of the resource stock; for non-renewable resources, the quantity of resources extracted. In the SNA it is defined as the reduction in value of deposits of subsoil assets, natural forests, fish stocks in the open seas and other non-cultivated biological resources as a result of the physical removal and using up of the assets.

Drop Out Rate: the percent of children entering a level of education who do not successfully complete that level in due course.

Domestic Output: domestic output is output produced by residence enterprises.

Dissolved Oxygen (DO): dissolved oxygen is an important parameter of water quality. The water when comes in contact with air dissolves oxygen depending on, or according to atmospheric pressure, the temperature, and the content of dissolved salts. Its presence is essential to maintain the higher forms of biological life and the effect of a waste discharged on a river is largely determined by the oxygen balance of the system. Aquatic animals require certain amounts of DO depending upon their species, stage of development, level of activity and the water temperature.

Domestic Waste: domestic waste consists of solid and liquid wastes originating from residential, commercial and institutional buildings. These are both biodegradable and non-biodegradable.

Environment: the totality of all the external conditions affecting the life, development and survival of an organism.

Environmental Assets: all natural assets which are not economic assets. Environmental assets are non-produced natural assets that do not function as providers of natural resource inputs into production but as providers of environmental services of waste absorption, ecological functions such as habitat or flood and climate control, and other non-economic amenities such as health and aesthetical values. See natural assets.

Environmental Costs: cost connected with the actual or potential deterioration of natural assets due to economic activities. Such costs can be viewed from two different perspectives, namely as (a) costs caused, that is, costs associated with economic units actually or potentially causing environmental deterioration by their own activities or as (b) costs borne, that is, costs incurred by economic units independently of whether they have actually caused the environmental impacts.

Environmental Expenditures: capital and current expenditures related to characteristic activities and facilities specified in classifications of environmental protection activities.

Environmental Impact: direct effect of socio-economic activities and natural events on the components of the environment.

Environmental Impact Assessment (EIA): analytical process that systematically examines the possible environmental consequences of the implementation of projects, programmes and policies.

Environmental Indicator: parameter, or a value derived from parameters that points to, provides information about and/or describes the state of the environment, and has a significance extending beyond that directly associated with any given parametric value. The term may encompass indicators of environmental pressures, conditions and responses (OECD, 1994).

Environmental Media: abiotic components of the natural environment, namely, air, water and land.

Environmental Protection: any activity to maintain or restore the quality of environmental media through preventing the emission of pollutants or reducing the presence of polluting substances in environmental media.

Environmental taxes: a tax whose tax base is in physical unit (or a proxy of it) that has a proven negative impact on the environment.

Environmental Statistics: statistics that describe the state and trends of the environment, covering the media of the natural environment (air/climate, water, land/soil) the biota within the media and human settlement. Environment statistics are integrative in nature, measuring human activities and natural events that affect the environment, the impacts of these activities and events, social responses to environment impacts and the quality and availability of natural assets. Broad definition includes environmental indicators, indices and accounting.

Environmental Accounting: the term usually refers to environment auditing, but may also include the costing of environmental impacts caused by the corporation.

Ecology: totality or pattern of relationships between organisms and their environment.

Exotic: species introduced from one locality to another locality.

Ecosystem: a dynamic complex of plant, animal, fungal and microorganism communities unit.

Ecological processes: which play an essential part in maintaining ecosystem integrity. Four fundamental ecological processes are the cycling of water, the cycling of nutrients, the flow of energy, and biodiversity (as an expression of the process of evolution).

Emission: discharge of pollutants into the atmosphere from stationary sources such as smokestacks, other vents, surface areas of commercial or industrial facilities and mobile sources, for example, motor vehicles, locomotives and aircraft.

Endemic Disease: disease that is only, or regularly, found among a specified population or in a specified locality.

Effluent: liqui waste product (whether treated or untreated) discharged from an industrial process or human activity that is discharged into the environment.

Eutrophication: when water bodies like lakes, reservoirs streams, & estuaries receive effluents rich in nutrients (phosphorous and nitrogen) growth of water plants (algae) is stimulated as a result of which deoxygenating of the water, major ecological changes, increase in turbidity, increase in rate of sedimentation occur. An insidious form of water pollution that causes progressive deterioration of water resources on a wide scale by the overabundance of plant life as a result of over enrichment with the nutrients is known as Eutrophication.

Earthquake: sudden shaking or trembling of the earth caused by faulting or volcanic activity.

Ecoregion / eco-zone: homogeneous area of one or more ecosystems that interact with relatively self-contained human activities.

Erosion: wearing away of the land by running water, rainfall, wind, ice or other geological agents, including such processes as detachment, entrainment, suspension, transportation and mass movement. Geologically, erosion is defined as the process that slowly shapes hillsides, allowing the formation of soil cover from the weathering of rocks and from alluvial and colluvial deposits. Erosion is often intensified by land-clearing human activities related to farming, resident and industrial development and it has as effect increasing run-offs, decline of arable layers, siltation in lakes, lagoons and oceans.

Environmental Disease: disease that is, at least in part, caused or aggravated by living conditions, climate and water supply or other environmental conditions. Environmental factors that may affect health include psychological, biological, physical and accident-related factors. Environmental diseases include in particular communicable diseases, such as respiratory diseases, and vector-borne diseases such as malaria, schistosomiasis and onchocerciasis. See also airborne disease and waterborne disease.

Epidemic: widespread outbreak of a disease that affects a large number of individuals at a particular time.

Enrollment Ratio (gross): the ratio of the number of students, regardless of age, enrolled at a particular level of education to population of specified age.

Enrollment Ratio (net): the ratio of the number of students specified age enrolled in a level of education to total population of that age for the level.

Endangered: plant and animal species which are under threat and likely to become extinct if casual factors continue operating. They may be abundant over their range but are endangered because of such factors as habitat deterioration, trade or the onset of disease.

Endemic: plants or animals prevalent in or peculiar to a particular locality, region or people.

Extinct Species: the endangered or threatened plant and animal species lost for ever because of their habitat being destroyed through a change in land use or some use for them resulted in mass slaughter/over use or export.

Family: a taxonomic group of genera, which have certain characteristics in common.

Fauna: all of the animals found in a given area.

Flora: all of the plants found in a given area.

Fungi: simple plants including moulds and mushrooms with thread like cells and without green chlorophyll. Fungi have no roots, stem, or leaves like flowering plants and ferns.

Forested Land: these are areas of forest vegetation, having at least of ten percent crown covers, which also includes small pockets of plantation and burned areas.

Faecal Coliform: faucal coli forms are that part of the coli form group which is present in the intestines and faeces of warm-blooded animals. These bacteria are capable of producing gas from lactose and form blue colonies within 24 hours when incubated at 44.5oC ± 0.2oC on M-FC medium. It should be nil in potable water according to WHO guideline.

Global Warming: phenomenon believed to occur as a result of the build-up of carbon dioxide and other greenhouse gases. It has been identified by many scientists as a major global environmental threat. See also greenhouse effect.

Gross Domestic Product (GDP): gross domestic product is a measure of net aggregate of the total value of output produced within the boundary of a country or territory in a specified period of time.

Greenhouse Effect: warming of the earth's atmosphere caused by a build-up of carbon dioxide and other greenhouse or trace gases that act like a pane of glass in a greenhouse, allowing sunlight to pass through and heat the earth but preventing a counterbalancing loss of heat radiation.

Genus (genera): a category used in the classification of organisms that consists of a number of closely related species.

Gene: hereditary factor, transmitted from generation to generation of plants and animals, that is responsible for the determination of a particular characteristic, for example, color, height or sex.

Gymnosperm: Plants that have naked seeds, which form an intermediate group between the cryptogams and the angiosperms. Examples: cicadas and conifers. They are primitive seed plants with many fossil representatives.

Gross National Product (GNP): gross national product is the sum of GDP and net factor income from abroad.

Gross Saving: gross saving is gross disposable income less final consumption expenditure

Green GDP: popular term for environmentally adjusted gross domestic product. See also environmentally adjusted net domestic product.

Herbs: plant with soft stem that dies down to the ground after each season's growth, as distinguished from shrubs and trees. Also any plant used as a medicine or seasoning, e.g. thyme, surpentine.

Herbarium Identification: collection of preserved plant specimens for scientific study or research and reference purposes.

Hydroxyl Ion: a hydroxyl ion consists of one atom of hydrogen and one atom of oxygen and carries one unit of negative charge.

Habitat: the place type of site where an organism naturally occurs.

Human Settlements: integrative concept that comprises (a) physical components of shelter and infrastructure and (b) services to which the physical elements provide support, that is to say, community services such as education, health, culture, welfare, recreation and nutrition.

Hardness: this is the property of water, which prevents lather formation with soap and produces scale in pipelines. It is due mainly to dissolved calcium and magnesium ions. Carbonate hardness (temporary hardness) is due to the presence of these metals associated with bicarbonate while non-carbonate hardness (permanent hardness) is due to the presence of these metals associated with sulphate/chloride or nitrate.

Hazardous Waste: hazardous wastes include toxic chemicals, biological and medical wastes, flammable wastes, corrosive wastes, radioactive wastes, and explosives. They usually are produced in industrial operations or in technical institutions.

Hazen: the Hazen scale, which is also known as platinum-cobalt units, is generally used in the determination of color in water samples

Hydrological cycle: water cycle, involving the exchange of water between the atmosphere, water-bodies, the Earth's crust and living organisms. Operates on a global to microcosm level.

Homology: the condition of being homologous. Homologous refers to organs of structures deriving from the same evolutionary origins. For example, the forelimb of a quadruped, the human arm and the wing of a bird are said to be homologous.

Industrial Wastes: solid, liquid and gaseous wastes originating from the manufacture of specific products.

Infant Mortality Rate: the annual number of deaths of infants under one year of age per 1000 live births during a year.

Incinerator: furnace for burning wastes under controlled conditions.

Lichens: species formed from the symbiotic association of algae and fungi. Commonly occur on tree - trunks, old walls, on the ground, exposed rocks. They are the primary colonizers of bare areas.

Landslide: downward mass movement of earth or rock on unstable slopes.

Land Use / Classification: land categories, reflecting quality classes, capability classes or grade, depending upon the characteristics of the land and/or its potential for agricultural use.

Land Degradation: reduction or loss of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest or woodlands resulting from natural processes, land uses or other human activities and habitation patterns such as land contamination, soil erosion and the destruction of the vegetation cover.

Land Affected by Desertification (man made): the area of land which is in the degrading process by the removal of forest vegetation, grassland vegetation and other natural resources.

Lead (Pb): a heavy metal whose compounds are highly poisonous to health. It is used enormous quantities in storage batteries, paints, sheathing electric cables, lining pipes etc. Lead compound is the chief constituent of gasoline and is considered a significant contributor to air pollution.

Life Expectancy at Birth: the expected number of years for a new born baby would live if prevailing patterns of mortality at the time of its birth would remain the same throughout its life.

Labour Force Participation: the ratio of population who are employed and seeking employment in the age group 15-64 to total population in working age.

Literacy Rate: percent literate population 6 years and above. " Literate Person " is the one who can read and write with understanding simple notes of every day life

Monocotyledons: flowering plants having single seed leaf (cotyledon) in the seed.

Major Anions: anions generally found in significant concentrations in natural waters are known as major anions. These include ions of carbonate, bicarbonate, sulphate, and chloride.

Major Cations: cations generally found in significant concentrations in natural waters are known as major cations. These include ions of calcium, magnesium, sodium, and potassium.

Methane (CH_4): colorless and odorless gas composed of one atom of carbon and four atoms of hydrogen. It is non-poisonous and flammable gaseous hydrocarbon created by anaerobic decomposition of organic compounds. It occurs in natural gas, as fire damp in coal mines, and as a product of decomposition in swamps.

Mercury: heavy metal that can accumulate in the environment and is highly toxic if breathed or swallowed.

Monthly Average Wind Speed (km/hr): average of the daily wind speed in a month.

Monthly Mean Temperature: it is the mean temperature of the month calculated from all daily means of months, where daily mean temperature is the average mean of maximum and minimum temperature in a day.

Monthly Rainfall (mm): total rainfall in each month of a year.

Maternal mortality Rate: the annual number of deaths of women from pregnancy related causes per 1,00,000 live births.

National Park: A legally established area for the conservation, management and utilization of flora and fauna, and landscape, together with natural environment.

Nutrient: substance, element or compound necessary for the growth and development of plants and animals.

National Accounting: physical and monetary accounts of environmental assets and the costs of their depletion and degradation;

Natural Resources: natural assets (raw materials) occurring in nature that can be used for economic production or consumption. See also renewable natural resources and non-renewable natural resources.

Nitrogen Oxides (Nox): these are compounds of nitrogen and oxygen combined in various ratios. The major human-caused source of NO2 is fuel combustion in motor vehicles, utility and industrial boilers. The gas is toxic in high concentrations, a lung irritant and lowering resistance to respiratory infection. It is a major contributor to acid deposition and the formation of ground level ozone in troposphere.

Natural Disaster: sudden calamitous such as earthquakes, tsunamis, floods, volcanic eruptions, cyclones and landslide, of ongoing misfortune as in conditions of processes such as drought and desertification.

Noise: audible sound from traffic, construction and so on that may generate unpleasant and harmful effects (hearing loss). It is measured in decibels.

Noramal: The name given to the average value over a period of years of any meteorological element such as pressure, temperature, rainfall, ete. World Meteorological Organization defined the average period as 30 years.Currently 1971-2000 is as the normal period.

Noise Pollution: sound of excessive levels that may be detrimental to human health.

Nutrients: Nutrients include phosphorous, nitrogen, carbon, and silica in their various chemical forms. The degree of eutrophication in lakes is dependent largely on nutrient concentrations in the lake waters.

Nitrates: already cover in Water Resources component. In the context of soil, it is nitrogenous fertilizer in the form of nitrate.

N.P.K. Content in Soil: N.P.K. stands for nitrogen, phosphorous and potassium compounds, which are also called nutrients as these compounds are essential for growing crops and, hence, are added to soil in the form of fertilizers.

Ozone (O_3): pungent, colorless, toxic gas that contains three atoms of oxygen in each molecule. It occurs naturally at a concentration of about 0.01 parts per million (p.p.m.) of air. Levels of 0.1 p.p.m. are considered to be toxic. In the stratosphere, ozone provides a protective layer shielding the earth from the harmful effects of ultraviolet radiation on human beings and other biota. In the troposphere, it is a major component of photochemical smog, which seriously affects the human respiratory system.

Other Lands: this refers to his land type which is catch-all for other uses of land and may include rocky areas, lakes, ponds, water ways or settlements etc.

Ozone Depletion: destruction of ozone in the stratosphere, where it shields the earth from harmful ultraviolet radiation. Its destruction is caused by chemical reactions in which oxides of hydrogen, nitrogen, chlorine and bromine act as catalysts.

Organism: any living plant, animal or human being.

Organic Constituents: there are the substances found in water which have originated from organic sources or which have organic nature (e.g. hydrocarbons, pesticides etc.).

Pesticide: any substance or mixture of substances that is used to prevent, destroy or control pests - including vectors of human or animal disease, and unwanted species of plants or animals. Pesticides may cause harm during, or otherwise interfere with, the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs - or that may be administered to animals so as to control insects, arachnids or other pests in or on their bodies.

Popualtion-land ratio: a measure to express population pressure on land i.e. population divided by land area (sq. km.).

Protected Area: a legally established area for achieving specific conservation objectives.

Pteridophytes: non-flowering vascular plants with root stem and leave e.g. ferns, horsetails. Widely distributed group attaining its development in the tropics.

Peak Daily Average: the highest 24-hour (daily) average concentration level of average daily concentration levels measured over one year.

Peak 1-Hour Average: the highest one-hour average concentration of all one-hour average concentrations monitored for one year.

Peak 8-Hour Average: The highest 8-hour average of all 8-hour average concentrations measured over one year. p.p.m./p.p.b./p.p.t. (parts per million/parts per billion/parts per trillion), measures of the concentrations of pollutants in air, water, soil, human tissue, food or other products.

pH Value: measure of the acidity or alkalinity of a liquid. A pH value in the range of 0 to 7 indicates acidity, a pH value in the range of 7 to 14 indicates alkalinity, and a pH value of 7 signifies neutrality.

Pollutant: substance that is present in concentrations that may harm organisms (humans, plants and animals) or exceed an environmental quality standard.

Pollution: 1. presence of substances and heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects; 2. activity that generates pollutants.

pH: It is used as a measuring unit of the intensity of acidity or alkalinity of a sample. In other words, the pH is defined as the negative logarithm of molar hydrogen-ion activity or hydrogen-ion concentration (in dilute solutions).

Population Density: total number of inhabitants per square unit of surface area.

Price: The price of a goods or service is the value of one unit of a particular goods or service.

Production: Production is a physical process, carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transform inputs of goods and service into output of other goods and service.

Potable Water: water that is safe for drinking and cooking according to defined standards.

Pollution Abatement: technology applied or measure taken to reduce pollution and/or its impacts on the environment. The most commonly used technologies are scrubbers, noise mufflers, filters, incinerators, waste-water treatment facilities and composting of wastes.

Recombination: the rearrangement of genes that occurs when reproductive cells

Red Data Book: a document containing information on threatened, rare or endangered species in a given habitat.

Residual: amount of a pollutant that remains in the environment after a natural or technological process has taken place.

Richter Scale: scale with a range extending from 0 to 10 for measuring the strength of an earthquake.

Rare Species: species occurring in small populations throughout its range. They are sparsely distributed over a large area. They may be endangered or threatened with extinction if their regeneration or reproduction is slow.

Relative Humidity: It is defined as a ratio of actual water vapor pressure to the saturation vapor pressure and is expressed in percentage. It is the measure of the water vapor content in the air.

Sustainable Development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). It assumes the conservation of natural assets for future growth and development

System of integrated Environmental and Economic Accounting (SEEA): satellite system of the System of National Accounts (SNA) proposed by the United Nations (1993a) for the incorporation of environment concerns (environmental costs, benefits and assets) into national accounts.

Shrub: low, perennial woody plants with several permanent stems branching from or near ground rather than single trunk, usually less than 6 m high at maturity.

Selection: natural selection is the differential contribution of offspring to the next generation by various genetic types belonging to the same populations.

Species: a group of organisms capable of interbreeding freely with each other but not with members of other species.

Sanitation: improvement of environmental conditions in households that affect human health by means of drainage and disposal of sewage and refuse.

Sewage: organic wastes and wastes water produce by residential and commercial establishments.

Sulphate (SO4): sulphate ion consists of one atom of sulphur and four atoms of oxygen and carries two negative charge. Sulphur dioxide in the atmosphere ultimately gets converted into sulphate particles, and it combines with moisture in the air to form sulphuric acid (precursor to acid rain).

Sulphur Dioxide (SO2): A heavy, pungent with suffocating odour, colourless gas formed primarily by the combustion of fossil fuels such as gas, petroleum and coal. It constitutes one of the most troublesome air pollutants. In moist air it is slowly oxidized to sulphuric acid. It is harmful to human beings and vegetation and contributes to acidity in rain. It may be responsible for the decay of buildings and monuments.

Suspended Solid Particles or Suspended Particulate Matter: It consists of particles of a wide range of sizes varying from greater than 100 m to less than 0.1 m. Particles larger than 10 m mainly consists of dust, coarse dirt and fly ashes which settle rapidly. Small particles less than 10 m remain much longer in the air as Suspended Particulate Matter (SPM). Human - caused sources include a variety of combustion sources (vehicles, dryers), wood stoves, field burning, and dusts from mining, roads and construction. It causes breathing and respiratory symptoms (diseases) and premature mortality. Other effects are soiling and corrosion of building materials.

Soil pH: Already covered in Water Resources component. pH is measured in the aqueous extract of the soil.

Sodium Absorption Ratio (SAR) Component: Already covered in Water Resources.

Solid Waste: useless and sometimes hazardous material with low liquid content. Solid wastes include municipal garbage, industrial and commercial waste, sewage sludge, wastes resulting from agricultural and animal husbandry operations and other connected activities, demolition wastes and mining residues.

Solid Waste Disposal: ultimate disposition or placement of refuse that is not salvaged or recycled.

Saving: saving is a disposal income less final consumption expenditure (or adjusted disposable income less actual final consumption)

Solid Waste Management: supervised handling of waste material from generation at the source through the recovery processes to disposal.

Tolerance: 1. ability of an organism to endure unfavorable environmental conditions; 2. amount of a chemical in food considered safe for humans or animals.

Threatened: species having low fecundity (offspring production rate) or prone to extinction in human-dominated landscapes.

Toxic Substances: substances, which cause adverse effects on living organisms (e. g. pesticides, arsenic, mercury etc.)

Traffic Density: number of vehicles per km of road length in a given area..

Total Fertility Rate: the average number of children that would be born alive to a woman during her life time if she were to bear children at each age in accordance with prevailing age-specific fertility rate.

Turbidity: the presence of suspended and /or colloidal substance give liquid a cloudy appearance, which is, knows as turbidity. No health based guidance value for turbidity has been proposed but it makes the water unattractive and possibly harmful.

Taxon (pl.taxa): the named classification unit to which individuals, or sets of species, are assigned, such as species, genus, order etc.

Value added tax (VAT): a value added tax (VAT) is a tax on products collected in spot by enterprises

Vulnerable Species: taxa of various types, including (a) taxa believed likely to move into the "endangered" category in the near future if the relevant causal factors continue to operate. These factors may include overexploitation, extensive destruction of habitat and other environmental disturbances, (b) taxa with populations that have been seriously depleted and whose ultimate security has not yet been assured and (c) taxa with populations that are still abundant but are under threat from severe adverse factors throughout their range.

Weather: day-to-day or sometimes even instantaneous changes of atmospheric conditions over a given place or area. In contrast, climate encompasses the statistical ensemble of all weather conditions during a long period of time over that place or area. Atmospheric conditions are measured by the meteorological parameters of air temperature, barometric pressure, wind velocity, humidity, clouds and precipitation.

Waste-water Treatment: process to render waste water fit to meet environmental standards or other quality norms. Three broad types of treatment may be distinguished.

Water Quality: physical, chemical, biological and organoleptic (taste-related) properties of water.

Water Quality Index: weighted average of selected ambient concentrations of pollutants usually linked to water quality classes.

Wetland: area of low-lying land where the water table is at or near the surface most of the time. Wetlands include swamps, bogs, fens, marshes and estuaries.

Zero Population Growth (ZPG): absence of population growth in which equal birth and death rates create a stable human population.

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