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Analysis of Social, Economic, and Environmental Impacts of MWSP During the Construction of Transmission Part in Sundarijal, Nepal

Metropolia University of Applied Sciences

Degree: Bachelors of Engineering(B.Eng.)

Degree Programme: Environmental Engineering

Metropolia
University of Applied Sciences

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Title	Analysis of Social, Economic, and Environmental Impacts of MWSP During the Construction of Transmission Part in Sundarijal, Nepal
Number of Pages Date	45 pages + 2 appendices 29 April 2019
Degree	Bachelor in Engineering
Degree Programme	Environmental Engineering
Specialisation option	Water
Instructor(s)	Kaj Lindedahl, Senior Lecturer Ram Chandra Devkota, Executive Director of MWSP Minna Paananen-Porkka, Language Instructor

In Kathmandu Valley, there is a prolonged shortage of clean drinking water. Rapidly increasing population continue to exacerbate this problem. It has resulted in contaminated shallow wells and aquifers with serious environmental and health concerns. MWSP was therefore implemented to provide Kathmandu Valley residents with sustainable drinking water supply. Although considered the only viable alternative to prolonged water shortage in the capital, it has raised concerns related to social, economic, and environmental issues during its construction. The main arguments relate to land and property acquisition, resettlement and compensation, reduction in river water discharge, deforestation, noise and air pollution, waste generation, soil instability, and erosion, and also social issues due to the influx of workers. On the contrary, employment opportunities, access road construction, market accessibility, trade and investment flows, and development in health, education, and tourism sectors are some of the merits of the project.

This thesis analyses the wide dimensions of the project's impacts through the exploratory research methodology, particularly in Sundarijal tunnel outlet zone during the construction of the transmission part. The Likert scale survey conducted during the field study explores the project's effects in social, economic and environmental spheres. It also evaluates the mitigation measures incorporated during the project activities. A SWOT analysis is done to identify and categorize the project's strength, weakness, opportunity, and threat during its construction

The survey result showed that many of the anticipated project's impacts were not contained within the acceptable limits. It was largely due to poor implementation of mitigation measures during the project activities. Adverse impacts on biophysical environment, land and vegetation, in particular, were not effectively alleviated with mitigation measures. The survey also found that land acquisition, resettlement, and compensation were critically sensitive and complex issues which were further exasperated by insufficient local participation and consultation in the decision-making process. It is, therefore, highly recommended that mitigation measures be more comprehensive and action specific rather than general requirements for smooth implementation of the project.

Keywords	MWSP, Likert scale, SWOT analysis, Melamchi, Sundarijal

ACKNOWLEDGEMENT

First of all, I want to sincerely thank my supervisor, Mr. Kaj Lindedal for his guidance and knowledge in writing this thesis. His patience, motivation, and immense support greatly helped me to carry out this study.

Besides my supervisor, I would also like to thank my traineeship mentor, Er. Ram Chandra Devkota, who provided me with an opportunity to join the MWSP team as an intern. His precious support significantly helped in conducting the field survey and gather research materials for this thesis project.

I also thank my fellow friends who positively contributed to this thesis through their constructive feedback and suggestions.

Last but not least, my sincere thanks to my parents and brothers who have supported me throughout this thesis writing process and my academic life in general.

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ABBREVIATION

ADB	Asian Development Bank
CDC	Compensation Determination Committee
CIRT	Community Issue Resolution Team
DIZ	Direct Impact Zone
DWSS	Department of Water Supply and Sewerage
GoN	Government of Nepal
GRC	Grievance Redress Committee
IIZ	Indirect Impact Zone
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Programme
KUKL	Kathmandu Upatyaka Khanepani Limited
KVWSMB	Kathmandu Valley Water Management Board
MWSP	Melamchi Water Supply Project
MWSPB	Melamchi Water Supply Project Board
NDF	Nordic Development Fund
NWSC	Nepal Water Supply Corporation
OPEC	Organization of Petroleum Exporting Countries
PIU	Project Implementation Unit
PPP	Public Private Partnership
RAP	Resettlement Action Plan
RRA	Rapid Rural Appraisal
SDG	Sustainable Development Goal
SUP	Social Uplift Program
SWOT	Strength, Weakness, Opportunity, and Threat
UNICEF	United Nations International Children's Emergency Fund
VDC	Village Development Committee
WHO	World Health Organization
WTP	Water Treatment Plant
WUA	Water Users Association

1 Introduction

Nepal's largest urban economy lies in the Kathmandu valley and it is critical to the country's socioeconomic development. The wellbeing of the population and prosperity through their productive capacities are largely dependent on accessibility and availability of water. However, the present scenario of drinking water service in the valley is very inadequate and unreliable, with daily supply hours fluctuating between 0.5-2 hours (Khadka, 1994). This has forced the valley inhabitants to rely on dug wells, shallow and deep-aquifers and even bottled water and tanker supplies. These circumstances have raised serious environmental and health concerns. Different studies show that water from over 42% of tube wells in Kathmandu is contaminated with nitrate beyond the WHO limit(45mg/L) and fecal bacteria contamination is widely prevalent in shallow aquifers in the Valley (Wolfe, 2000; Jha et al., 1995; Khadka, 1993; Chettri & Smith, 1995). Poor quality of drinking water with bacterial indicators directly impacts general health, especially the poor and vulnerable. Over 50% of the water supplied in Kathmandu is extracted from groundwater sources (Khatiwada et al., 2002). This over-extraction of groundwater sources have depleted even the deep-aquifers, raising serious environmental concern.

Melamchi Water Supply Project (MWSP) aims to tackle this problem of insufficient and unreliable supply of safe drinking water in the metropolitan area on a feasible and viable basis. Overall, the project intends to provide potable water to 1.5 million residents in the Valley and thereby improve their quality of life (ADB, 2019). This project also expects to further Nepal's efforts towards achieving Sustainable Development Goals (SDG 6), i.e. "ensuring availability and sustainable management of water and sanitation for all" (UN, 2018).

Despite its good intention to alleviate the Valley's prolonged water shortage, Melamchi Water Supply Project has raised several controversies. Main arguments relate to the disruption and dislocation of the people due to land and property acquisition for the project. Reduction in river water discharge, deforestation, noise and air pollution, waste generation, risk of soil instability and erosion, and social issues related to the influx of workers are some of the adverse impacts during the construction of the project. Conversely, local employment, access road construction, market accessibility, and development in tourism, health, and education sectors are some significant benefits of the project.

To summarize, the project has wide dimensions of benefits and adverse impacts during the construction phase (JWRC, 2017). This thesis, therefore, is motivated to analyze the varied socio-economic and environmental issues in the Sundarijal tunnel outlet zone during the construction phase.

1.1 Objective of the thesis

The primary objective of this thesis was to analyze and explore the typical impacts of the MWSP project during the construction of its transmission part. The specific goal of the thesis was to evaluate and summarize key social, economic and environmental effects of the project in Sundarijal VDC 7 and 8 and its residents during the construction of water diversion component. The thesis report also evaluates the mitigation strategies included in the project design to minimize the adverse effects of project activities.

1.2 Methodology

This thesis has adopted exploratory study approaches to analyze the socio-economic and environmental impacts of MWSP. In order to meet the objective of the thesis, information was collected by reviewing documents related to main EIA reports, compensation and resettlement plan, environment management plan, and environmental impacts and mitigation measures. The desk study part of the thesis included reviewing of revised and updated project documents, annual and trimester progress reports published by Melamchi Water Supply Project Board(MWSPB) and Asian Development Bank(ADB). It also summarized key findings of previous case studies, public journals, web materials, and news articles in relation to MWSP.

Field level observation and discussions were performed to assess the management of natural resources, development of the community, execution of mitigation measures, and monitoring and auditing of the project. This field study was based on the research methodology approach to mainly describe the socio-economic and environmental impacts of MWSP during the construction of transmission part in Sundarijal VDC 7 and 8, Kathmandu.

1.3 Organization of the thesis

The introductory chapter of this thesis includes background knowledge on the Melamchi Water Supply Project and a brief discussion of its transmission part that includes the construction of the tunnel and the water treatment plant. Chapter one also sets the goals, scope, and the methodology of the thesis.

Chapter two follows the description of the physical, socioeconomic and biological environment of the study area and explores the adverse effects of project activities on the mentioned environments. It also includes an analysis of mitigation measures incorporated in project design.

Chapter three presents the Likert scale data obtained in the field study. Statgraphics18 and R-Studio are used to create and analyze the data in tabular and graphical forms. A SWOT analysis is used to analyze the strength, weakness, opportunity, and threat of project activities in the study area.

Finally, the thesis summarizes the results, draws conclusions from them and makes a recommendation for any future study.

2 Theoretical Background

This chapter mainly focuses on the literature research of the thesis project. First, the background of the water situation in Nepal is briefly explored together with Nepal's water policies. Furthermore, the current water supply situation in Kathmandu Valley is explained along with a brief introduction to Kathmandu Upatyaka Khanepani Limited, a public company that primarily manages water supply systems in Kathmandu Valley.

2.1 Water situation in Nepal

Water is an essential human necessity; yet, there is limited availability of potable water to a vast portion of the Nepalese population. The drinking water crisis is a global issue with Nepal being no exception. In a nation with richness in water resources, it sounds

somewhat paradoxical. In reality, Nepal has no physical water scarcity, but significantly lacks infrastructures and facilities to maintain and supply drinking water.

Nepal is a rapidly developing country with a population of 26.49 million and annual growth rate of 1.35 (CBS, 2012). With an exponential growth in population, the demand for water is rising in the same manner in Nepal. Although the Department of Water Supply and Sewerage (DWSS) reported that the national coverage for public water supply is 83.59% (NMIP, 2014), it raises questions as it does not reflect the actual widespread water shortage scenario it the country. The main argument is that the outdated operational status of the water facilities is not taken into account here. As per the WASH-RCNN report, over 92% of piped water and 25% of tube wells in Nepal are non-functional and need repair (WASH-RCNN, 2013). The other argument is that this figure does not address the quality of water services. The WHO/UNICEF's Joint Monitoring Programme(JMP) reported that 88% of Nepalese population use at least basic water services whereas only 27% use safely managed water services (WHO/UNICEF, 2015). Mainly the poor and marginalized rural communities make up the majority of the population without access to basic clean water.

Accessibility to safe drinking water plays a crucial role in improving a country's public health and well being. Contaminated water is one of Nepal's major causes of diseases and deaths, particularly in women and children. Every year, 7900 children die from water-related diseases in Nepal (CEAD, 2014).

Arsenic contamination in groundwater is another major concern in rural areas, especially in Tarai regions (Pokhrel et al., 2009). In urban environments, the surface and groundwater have deteriorated by natural and anthropogenic contaminants. Industrial effluents and domestic waste along with the discharge of untreated sewage are primarily responsible for contamination of groundwater in cities, including Kathmandu (Pant, 2011).

As illustrated in Figure 1, many people in Nepal's remote areas still rely on small brooks, lakes, and tube wells to get their drinking water. Although half of the household(49.6%) use piped water in Nepal, more than one third of the households(38%) still use hand pump/tube wells whereas 5.3% use spring water, 3% use open wells and 2.1% use closed wells as the primary sources of drinking water (CBS, 2016/17).

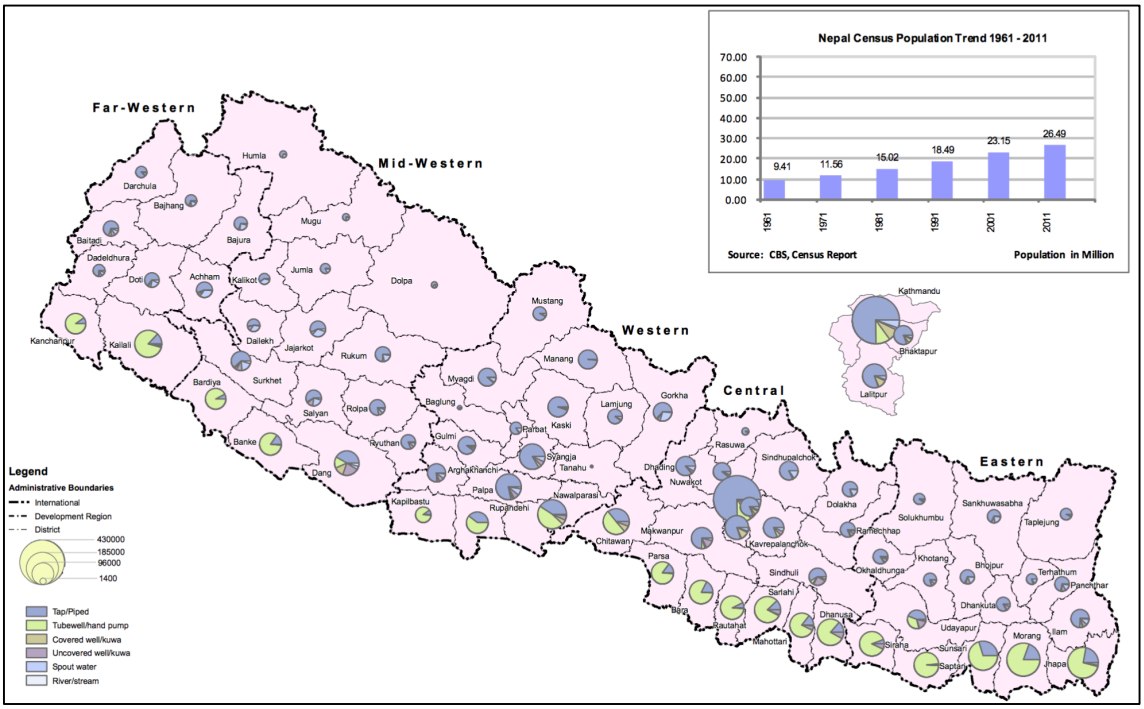

Figure 1. Drinking water status in Nepal 2011 (IMU/RCHCO, 2013)

Despite the recent few small-scale achievements, Nepal still faces the prolonged issue of the water shortage. Currently, 3.5 million Nepalese still live without direct access to proper and adequate water services (UNICEF, 2018). In order to tackle this crisis, Nepal primarily suffers from budget insufficiency, treacherous terrain, and political instability. Although the government of Nepal announced and promoted various programs for public water supply in recent years, none of the plans meaningfully alleviated the problem. The main reason being the sole focus of programs on increasing coverage rather than improving the quality of water supplied. Hence, the demand for safe drinking water in Nepal still remains significant.

To summarize, Nepal still needs to formulate concrete policies, legislation, and institutional arrangements to implement systematic and planned development programs for public water supply.

2.2 Water Acts in Nepal

This section provides a background on Nepal's most important drinking water laws and regulation. Legal guidelines and policies on water play a crucial role within the social,

cultural, and economic arrangements for water management and development. These laws also influence the way water is used, managed, and developed in Nepal (WaterAid, 2005).

2.2.1 Water Resource Act 1992

The Water Resource Act 1992 is regarded as a comprehensive and robust law governing the overall water resources of Nepal. It establishes an order of importance on water use. It prioritizes drinking water over any commercial use. This act also defines the proprietorship of water resources available within Nepal. It provides a legal procedure for the establishment of Water Users Association(WUA) and maintains a licensing system that requires WUAs to utilize water resources without any adverse effect on the environment (NLC, 2018).

2.2.2 Water Resource Regulation 1993

The Water Resource Regulation 1993 primarily covers the guidelines and directives for all water resource management in Nepal and outlines the standard procedures for enacting the Water Resource Act 1992. It specifies the procedural framework for registering and obtaining a Water User Association license and defines its rights and obligations. The regulation also deals with the acquisition of land and house in relation to water use and settles disputes related to water through compensation procedures (WaterAid, 2005).

2.2.3 Drinking Water Regulation 1998

The Drinking Water Regulation 1998 primarily administers drinking water quality and oversees drinking water distributors. It mainly deals with water quality control and upholds safety standards of drinking water. It also defines the conditions for consumers to use water services (WaterAid, 2005).

The Essential Commodity Protection Act 1995 is another important legislation that considers drinkable water as an indispensable natural resource and forbids its misuse, pilfering, spoiling or any use without authorization. The Nepal Water Supply Corporation

Act 1989 authenticates the Nepal Water Supply Corporation(NWSC) as an independent public agency responsible for delivering the urban public with drinking water. On the contrary, the Local Self Governance Act 1999 explains the executive powers, functionalities, and responsibilities of local authorities with respect to water resource management, including the use and preservation (WaterAid, 2005).

2.3 Water Supply in Kathmandu Valley

Kathmandu Valley is Nepal's most densely populated urban area and is spontaneously developing without proper land use planning. According to the National Population and Housing Census 2011, Kathmandu has the highest population density with 4416 people per square km and has the fastest decadal population growth rate in the country (CBS, 2012). The lack of adequate safe water availability remains a major problem in the Valley. Rapidly growing and poorly planned urban sprawl, lack of viable water supplies, insufficient past investment, and weak management have all contributed to low availability of drinking water in the capital.

The WHO standard sets 50 L/capita/day(lcpd) as the minimum amount of potable water for basic human requirement (OHCHR, 2010). However, the median water consumption rate of over 50% households in the Valley is 41 lcpd during the dry season and 48 lcpd during the wet season, well below the WHO's basic sufficiency limit (Raina, 2017). Likewise, the Bureau of Indian Standard calculates 135 L/capita/day as the minimum requirement of domestic water for social and economic growth (BIS, 1993). Using this BIS guideline, the water demand in Kathmandu Valley is 366 millions of liters per day(MLD) and is projected to reach 482 MLD by 2021 (Udmale et al., 2016). However, the daily water supply is only 69 MLD during dry months and 115 MLD during wet months (Thapa et al., 2018). These figures do not take into account the 20% leakage rate through the distribution network (KUKL, 2015). None the less, there is a huge year-round water supply deficit in the Valley with a substantial gap in supply and demand. Low supply rate coupled with the rapid population growth and excessive urbanization continues to heighten this supply-demand gap.

In order to address this long-lasting water shortage, the 2010 Capital Investment and Asset Management Program of the Government of Nepal plans to provide Kathmandu Valley residents with 135 L/capita/day(lpcd) of drinking water by 2025 (ADB, 2015). This,

with the onset of MWSP, appears to be a positive step towards addressing the capital's water shortage issue.

2.4 Kathmandu Upatyaka Khanepani Limited (KUKL)

KUKL is an authorized agency registered and licensed under the Nepal Government's Company Act 2069. It provides drinking water in Kathmandu Valley under the Public Private Partnership(PPP) system. The company's primary objective is to manage the Kathmandu Valley water and sanitation system. Under a rental agreement with the Kathmandu Valley Water Management Board(KVWSMB), it taps water from 22 surface water sources in mountain zones and supplies to its 10 service areas in Kathmandu Valley. As part of the lease agreement with KVWSMB, it is also responsible for the maintenance of infrastructure built by the Melamchi Water Supply Project (KUKL, 2019).

2.5 Melamchi Water Supply Project(MWSP)

Melamchi Water Supply Project is by far the most practical and feasible solution within Kathmandu Valley to alleviate its water shortage problem. The main purpose of this project is to provide the Valley inhabitants with a sustainable supply of safe drinking water and thereby improve their health and wellbeing. It also intends to establish a comprehensive and detailed organizational structure for urban water management within the valley.

2.5.1 Melamchi Diversion Scheme(MDS)

Melamchi Diversion Scheme covers major project construction works in the Melamchi Valley involving the construction of Water Diversion Tunnel(WDT) and Water Treatment Plant(WTP). This scheme mainly aims to divert and transmit 170MLD of unprocessed water to the Water Treatment Plant in Sundarijal, Kathmandu via 26.5 kilometers tunnel from Melamchi River in the district of Sindhupalchowk. This water treatment plant with a preliminary production capacity of 170MLD is expandable to treat 510 MLD of water from supplementary supply sources in the future. The Yangri and Larke rivers in the same region, therefore, are also being examined as potential sources. Figure 2 below shows the design layout of the Melamchi Water Supply Project.

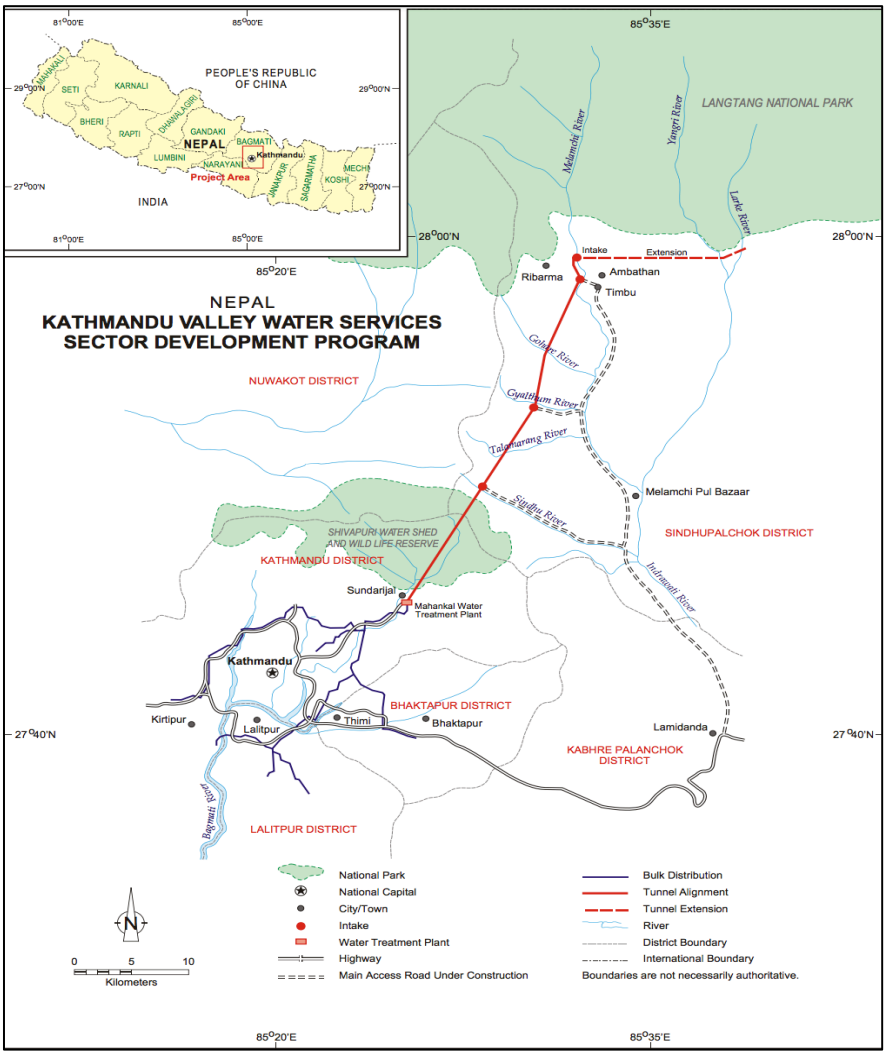

Figure 2. Melamchi Water Supply Project layout (ADB, 2008)

MDS also comprises the construction of 43 kilometers of new access roads and improvement of 29 kilometers of existing roads to assist in building and improving the project facilities. This component of the project, furthermore, includes implementation of social upliftment programs in the project areas, comprising the development of public health, enhancement of education sector, employment and skill development, and development of the buzzer zone. Buffer zone development mainly involves the preservation of the Langtang National Park environment from possible depredation due to external population influx during the project construction.

2.5.2 Kathmandu Valley Water Supply and Sanitation

Kathmandu Valley Water Supply and Sanitation mainly comprises distribution operations in Kathmandu Valley through constructing the bulk distribution system that comprises a water supply tunnel and small networks of pipelines. It also involves restoration and expansions of current water supply systems including transmission lines, intakes, and service reservoirs. In this component, the improvement of the wastewater system is also considered in a phased manner.

2.6 Technical Features of MWSP

The major technical components of the project consist of intake structures, water treatment plant, and distribution tunnel network. Intake structures primarily involve the construction of the intake and settling basin, river training, and diversion weir. Diversion weir, a low obstruction structure is usually constructed across the river to raise the water level and divert the water into the intake basin. River training structures are primarily built to modify the course of the Melamchi river and thereby lower the river gradient to reduce water velocity, which prevents river bed and bank erosion. Water from the intake basin is diverted to settling basins through pressurized settling structures that remove sand and turbidity from river water (Nippon Koei Co. Ltd., 2000).

The main diversion tunnel with 25.83 km length includes either a free flow tunnel or full flow tunnel. This tunnel with a general cross-sectional area of 10 m^2 is expected to bring 510,000 m^3 of water per day to the water treatment plant from the Melamchi river. The tunnel is excavated using drill and blast method after determining the geological conditions using modern techniques such as a probe drill and a geo-radar.

As illustrated in Figure 3, Melamchi Water Treatment Plant in Sundarijal is a conventional water treatment plant that diverts raw water from the Melamchi river to produce safe drinking water within WHO standards (WHO, 2011). Raw water is treated in the conventional method by coagulation, filtration, flocculation, and followed by disinfection. The water plant has an initial treatment capacity of 170,00 m^3 of raw water per day and is expandable to produce 510,000 m^3 of safe drinking water in the future. It is designed and built at 1400m elevation, which allows distribution of water to reservoirs tanks by gravitational flow (JWRC, 2017).

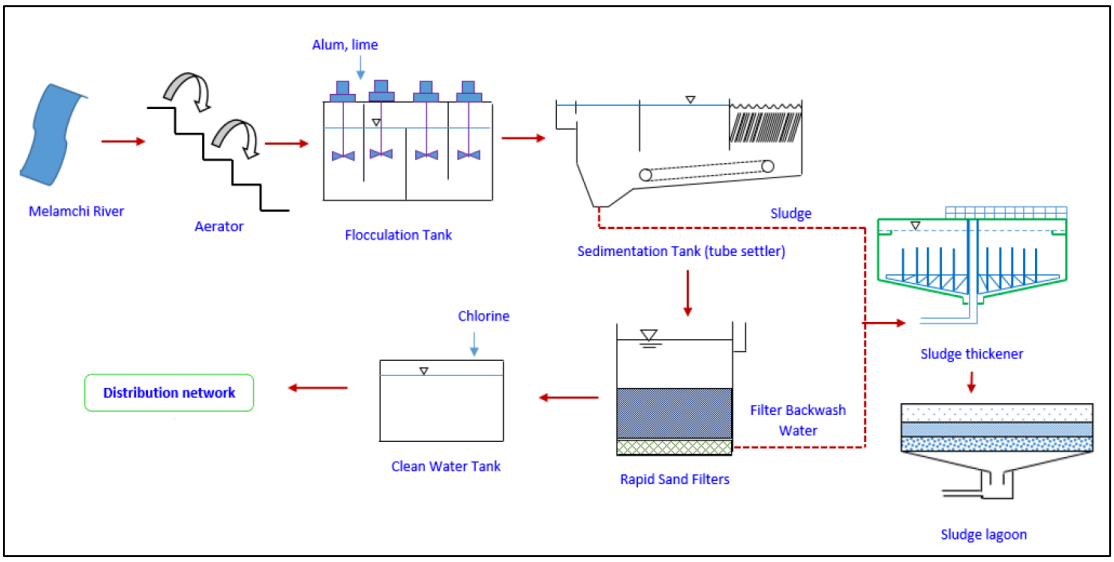

Figure 3. Water treatment process in WTP at Sundarijal (JWRC, 2017)

Bulk Distribution System distributes treated water from WTP to various service reservoirs in Kathmandu Valley. BDS consists of gravity-fed pipelines with a total length of 54km and diameters between 300mm and1400mm to match WTP capacity. The clean drinking water is supplied by the bulk distribution network to the Valley consumers. In secondary and tertiary levels, the distribution network comprises strategically located service reservoirs and inter-connected supply pipelines across the Valley.

2.7 Financial Features of MWSP

The cost of MWSP was estimated at USD 464 million in 2000. ADB and GoN primarily contributed to the overall budget with USD 120 million and USD118 million respectively. The World Bank, Japan Bank for International Cooperation(JBIC), Japan International Cooperation Agency(JICA), Nordic Development Fund(NDF), and Organization of Petroleum Exporting Countries(OPEC) are other major donors for the project. Government of Nepal has allocated 28.56% of the total budget in infrastructure development, social and environmental sector, and project implementation support (MWSDB, n.d.).

The approximate financial return rate for the overall project is 7.93%, slightly higher than the current estimated capital cost of 7.90%. This marginal financial return shows that the project's profitability is prone to the revenue decline. In order to minimize time and cost

overruns, close supervision and constant monitoring of the project is required to ensure progress on schedule. As stipulated in contract documents, the Project Implementation Unit(PIU), should penalize contractors for delays caused, especially for poor mobilization and procedural interruptions (JWRC, 2017).

2.8 Social, Economic and Environmental Impacts of MWSP

During the construction phase of any mega-project, several positive and negative impacts with low and high significance occur. Similarly, there was a wide range of impacts predicted for the project which were presented in detail in the main project EIA report (Nippon Koei Co. Ltd., 2000) . This chapter briefly discusses them below as a literature review.

The EIA report has classified the project area into two categories: Direct Impact Zone(DIZ) and Indirect Impact Zone(IIZ) based on the relative proximity of the area within/above 500m from the project site. According to the EIA report, 17 VDCs are classified as DIZ, including the study area in Sundarijal. The EIA report predicted the following socio-economic and environmental impacts during the construction phase.

Building access roads and transmission lines put the stability of the soil at risk. These impacts further lead to soil erosion and landslides, spoils generation, degradation of agricultural land, disruption of agriculture canal, relocation of households and destruction of local infrastructure (Khadka & Khanal, 2008). In Kathmandu-Naubise alternative road construction, for example, spoil disposal in hilly terrain resulted in slide erosion causing property destruction and disruption of water supply and irrigation systems in the valley side (Bhatta, 2015).

Disposal of spoil from tunnel excavation creates volatile slopes which jeopardize human and biological life. It also creates river pollution by erosion and sedimentation and triggers disruption of water flow along the tunnel route that mainly affects the fish population. Construction carried near parks and reserves present potential damage to the protected ecological system (Nippon Koei Co. Ltd., 2000).

Construction activities also result in noise and air pollution. As seen in Kaligandagi hydroelectric project, blasting for tunneling can severely damage houses and community

structures (ADB, 2012). Similarly, the MWSP EIA report predicted that blasting vibration can damage the mud motor rural houses within 500m from the project site (Nippon Koei Co. Ltd., 2000). It further suggested that gaseous and fugitive emissions from the construction activities and vehicular movement could increase considerably in/near the project site. The report also predicted that air pollutants, TSP and PM_{10}, in particular, could exceed the WHO permissible limit during the construction phase (WHO, UNAIDS, 2006). Although these impacts are short-term and only lasts for the construction period, the EIA report suggested special consideration during project activities.

The EIA report stated that the project construction requires the acquisition of land and property in/near the project sites. The report further pointed out that this process could significantly impact the livelihoods of many locals, especially the farmers living in marginal conditions. Agriculture being the primary source of livelihood of many farmers, the EIA report directly linked the land loss to food production and income generation in the area. Therefore, it recommended an adequate financial compensation for land acquisition (Nippon Koei Co. Ltd., 2000).

Social, cultural, and religious issues related to the influx of outside workers during the project construction were also anticipated in the EIA report. The report indicated that the workers are likely to indulge in prostitution, gambling, and alcoholism that could trigger societal issues. The EIA report, therefore, proposed the inclusion of prohibitory clauses as contractual obligations for workers to minimize these problems. The report also recommended police patrolling in construction affected areas and settlements to ensure adequate safety (Nippon Koei Co. Ltd., 2000).

2.9 Beneficial Features of MWSP

Besides the anticipated negative impacts, the MWSP EIA report also outlined beneficial merits of the project including local employment, access road construction, market accessibility, and physical infrastructure development.

The EIA report proposed that at least 30% of workers in which 5% of women should be local (Nippon Koei Co. Ltd., 2000). It also envisaged that the project would provide an opportunity for Nepali entrepreneurs to establish industries to produce the raw materials needed for the project.

The EIA report indicated that the construction of access roads would provide the general public with easy access to markets by drastically reducing travel time and cost. The report further suggested that the motorable roads would considerably enhance the local economy by providing larger markets to sell homegrown agricultural products and services (Nippon Koei Co. Ltd., 2000).

Furthermore, the EIA report suggested that the Social Uplift Program(SUP) incorporated in the project would significantly benefit the local people through the development of local health and education sectors. This project component incorporated plans and programs relating to workforce development, income generation, community engagement and general awareness (JWRC, 2017).

2.10 Mitigation Measures

As per the mitigation measures, the design and construction contracts included multiple provisions to reduce the detrimental effects of the project in the impact zones.

As learned in the recent development of Dharan-Dhankuta and Lamosangu-Jiri roads, proper implementation of mitigation measures can significantly maintain the adverse impacts within the acceptable limits. Here, environmental and geophysical features were addressed during the construction phase. Bio-engineering and structural interventions such as bush layers, fences, check dams, netting and matting, rock bolts, cascades, and gabions were used during road construction (DOR,GESU, 2009). Similarly, the MWSP EIA report also recommends the implementation of cutting and filling principles with the construction of side drains and embankments to reduce soil erosion and also minimize vegetation removal (Nippon Koei Co. Ltd., 2000).

Further, the EIA report suggests appropriate measures such as controlled blasting, safety training to workers, cradle to grave accounting for all explosives, limited construction hours, mock disposal in designated land, and watering of dust prone areas to alleviate the adverse effects during the construction phase (Nippon Koei Co. Ltd., 2000).

Air pollution mitigation measures include a periodic spattering of water in dusty roads, compression of disposal sites, compaction of gravel roads, limiting vehicle speeds, and

meeting mass emission(gaseous and fugitive) limits under the National Mass Emission Standards, 2056 B.S. (ADB, 2008)

To minimize ecological impact, the EIA report suggests that the trees only within the proposed area should be cut and river-bank buffer-zone trees should be planted as compensatory plantation measures. Appropriate compensation should also be paid to cut trees from private owners and community forests. The report also prohibits the harvesting of local trees for fire and timber and hunting wildlife for sport and meat in the project area (Nippon Koei Co. Ltd., 2000).

The EIA report proposed the Resettlement Action Plan(RAP) to compensate for the land and properties occupied by the project. The RAP outlined guidelines and measures to deal with the sensitive and complex nature of compensation and resettlement process. As seen in the Thankot-Chapagaun transmission line, Kaligandaki corridor, and Mid-hill highways, the land and property acquisition process can be very sensitive and complex (IBN, n.d.). To keep this issue under control, adequate financial compensation in cash is recommended in the mentioned scheme. This, as experienced in the Kulekhani hydroelectric project, may also lead to many farmers spending their compensation cash in unproductive ventures or comfort and enjoyment. With a low capacity to handle money, many could either use their compensation to pay loans or invest in various scams (Pokharel, 1985). To minimize these issues, the EIA report suggested incorporation of public awareness programs in financial compensation and resettlement scheme (Nippon Koei Co. Ltd., 2000).

2.11 Social Uplift Program

The primary goal of SUP is to achieve sustainable community development using participatory and capacity building approaches with project-affected people and thus improve their overall quality of life. Poverty alleviation and improvement in living standards of project-affected people are the primary objectives of this program. Development of health and well-being, Investment in education and training, job creation, rural electricity generation, and sustainable management of natural resources are outlined here. The rural electrification aspect has not yet been announced officially. It also aims to involve local participation in mitigation strategies to reduce the impacts of the project. This program is

divided into pre-construction, construction and post-construction phases to make it more effective and result-oriented (MWSDB, n.d.).

Buffer zone component of the program focuses on safeguarding the Langtang National Park environment from an external population influx. The main activities proposed under this component are catchment management plan, forest protection measures, forest user groups, monitoring of contractors, and environmental awareness programs.

Development in the health sector includes improving and upgrading of existing healthcare facilities and supply of basic medicines and equipment to local health care services. In order to improve the general healthcare of project area, the program also has a provision to train local healthcare staff and provide the general public with health awareness programs on reproductive health, sexually transmitted diseases, and transmittable disease control.

The education component of the program mainly includes building and upgrading of school facilities and supply of basic educational materials. This component also involves teacher training, grant and scholarships, programs for adult literacy, technical skill development, and women's awareness and child support programs.

Income generation component of the program provides guidance and funding for economic growth and workforce development through capacity building at the local level. It also involves setting up saving and credit groups and providing seed grant capital and agriculture and livestock development programs in the community.

2.12 Grievance Redress Mechanism

Grievance Redress Mechanism essentially gathers, reviews, and resolves the legitimate concerns, complaints, and resentments of project affected families. GRM includes Rapid Rural Appraisal(RRA), Household Surveys, Discussions and Key Informant Interviews to incorporate the views and concerns of the public into the decision making process for the project (DUDBC, 2015).

The Compensation Determination Committee(CDC), Community Issue Resolution Team(CIRT) and Grievance Redress Committee(GRC) are institutional arrangements

created to quickly and effectively consult, negotiate, and resolve public's concerns under Resettlement Frameworks and Resettlement Action Plan (GoN, 2015).

According to the EIA report, for the construction of project infrastructure, approximately 131 hectares of agriculture land will be acquired and 98 building structures will be damaged with the permanent displacement of 25 households (Nippon Koei Co. Ltd., 2000). In addition, local community facilities and common public properties such as irrigation channels, community forests, and community hall will also be affected. MWSDB and ADB have agreed to provide $15 million RAP fund in the MWSP budget to compensate for income losses resulting from the acquisition of agricultural land and rehabilitation assistance to project-affected households (ADB, 2000).

A regulatory framework is established to provide stakeholders and the general public with transparent information on project implementation, progress, and safeguard measures by updating the project website on a regular basis and issuing public notices on daily newspapers. In addition, the public consultation process involved formal and informal focus group discussions, workshops and meetings, public hearings and household surveys (Nippon Koei Co. Ltd., 2000).

3 Study Area

Sundarijal is a Village Development Committee located 15 km north-east of Kathmandu district. As per the National Population and Housing Census 2011, Sundrijal has a total of 547 households with a population of 2552 (CBS, 2011). This VDC consists of 9 Wards within a total area of 5.18km^2 (Khadka, 2005).

Buddhists and Hindus dominate the area with a majority of Tamang, Shrestha, and Brahmin/Chettri communities. Most of the land is covered in forests and hills that belong to Shivapuri National Park and the rest is agricultural land. Agriculture and tourism are the main economic sources for local residents. Nearly 90% of agriculture is predominantly practiced by Tamang communities in the area. These farmers mainly use traditional agricultural tools and techniques to cultivate prevalent crops such as maize, millet, barley, and wheat. Some of them are also engaged in livestock husbandry and small business such as shops and hotels. Besides agriculture and business, majority of Chettri/Brahmins and Newars are involved in government and non-governmental services (Khadka, 2005).

Tourism is a thriving industry in Sundarijal because of its pristine natural environment with waterfalls and rivers. In addition to canyoning and river rafting, Sundarijal is considered the gateway for famous 22km Sundarijal-Chisapani trek route along the Langtang range. It is also known for its cultural heritage as many internal tourists from Kathmandu and surrounding areas come to Shivapuri National Park to hike in the ancient forest and visit Hindi and Buddhist temples which are considered holy and sacred (deerwalk.org, 2014).

Sundarijal has transitional subtropical and temperate climate and the vegetation in the area includes deciduous forests with pine, oak and rhododendron trees. Wildlife in the area mainly consists of leopards, reed cats, black bears, and monkeys. This area's biodiversity comprises of 177 bird species including 9 exotic species, 102 butterfly species with numerous threatened species and 129 mushroom species (Khadka, 2005).

3.1 Method of Field Study

Field level information was collected by conducting a household survey. As shown in Figure 4, the study area, Sundarijal VDC 7 and 8 lies in the tunnel outlet zone. The field study was carried from 1st Feb to 3rd Feb 2018 as part of a field survey and reporting during my traineeship period in MWSPB. Participatory rural appraisal approach was used to obtain the responses of local people.

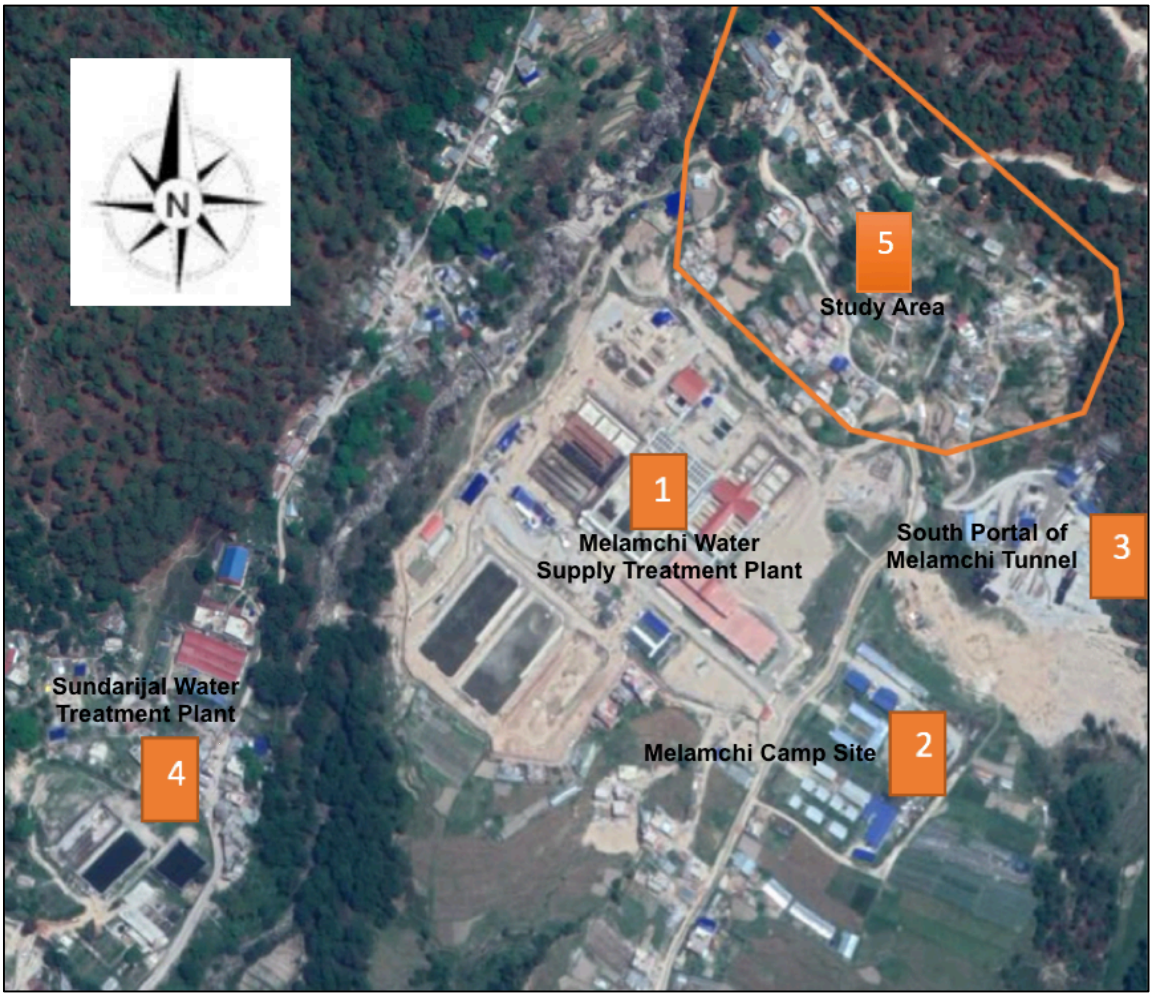

Figure 4. Satellite view of the study area in Sundarijal, Kathmandu (Google maps)

A total of 30 households in the direct impact zone in the tunnel outlet area were selected as respondents for the field survey. The survey was conducted by a simple random sampling technique within the VDC in order to represent the target population and eliminate sampling bias. A questionnaire on the Likert scale was used to gather the respondents' answers.

3.2 Likert Scale Survey

The Likert scale survey was used to measure the attitude of the respondents to a particular question in order to understand to what degree they agreed or disagreed with it. In the questionnaire, a typical 5-point scale offering a range of answers from *Strongly Agree, Agree, Neutral, Disagree*, and *Strongly Disagree* was used. Compared to binary

answers with *yes/no* options, a Likert scale survey provides answers in granular feedback levels in terms of degrees of opinion. This helps to better understand the interviewee's responses (Bertram, 2007).

Further analysis of the survey data from the Likert scale is presented and discussed in the Results and Discussion chapter. Statgraphics18 and R-Studio were used to create and analyze the data in tabular and graphical forms for analysis.

3.3 SWOT Analysis

SWOT assessment is a strategic analytical technique used for identifying and categorizing an organization or project's strength, weakness, opportunity, and threat. It is mainly used to assess comparative advantages for market competition by identifying internal and external elements for specific objectives. Four parameters of this tool are intrinsically linked, whereby strength and weakness are often linked to internal factors, while opportunity and threat tend to focus on external conditions (Pickton & Wright, 1998).

SWOT is commonly accepted as a performance indicator framework for its practicality and simplicity but is often criticized as a naive tool that could lead to significant strategic failures. Therefore, SWOT should never be used as a linear analytical tool with a focus on its output alone but rather as a part of a dynamic process for managing businesses and planning development processes. SWOT is used in this thesis to critically analyze the socio-economic and environmental factors for strategic project management and planning process.

Based on the survey responses, a SWOT analysis is presented and discussed in a tabular form in the Results and Discussion chapter. It primarily describes and analyzes the strength, weakness, opportunity, and threat of project activities in the study area.

4 Data Collection

The survey in the study area included 30 randomly selected households in Ward No. 7 and 8 of Sundarijal VDC. The survey was inclusive of different castes, genders, and ages. Of the total respondents in the survey, 17 were male and 13 were female. The survey included 60% Brahmin/Chettri and 40% Matwali that mainly included Tamang,

Shrestha, and Gurung. In total, 37% of respondents were between the age of 15-29, 50% were between the age of 30-59 and 13% were above 60 years of age. Figure 5 illustrates the pie-charts of gender, age, and caste categories of survey respondents.

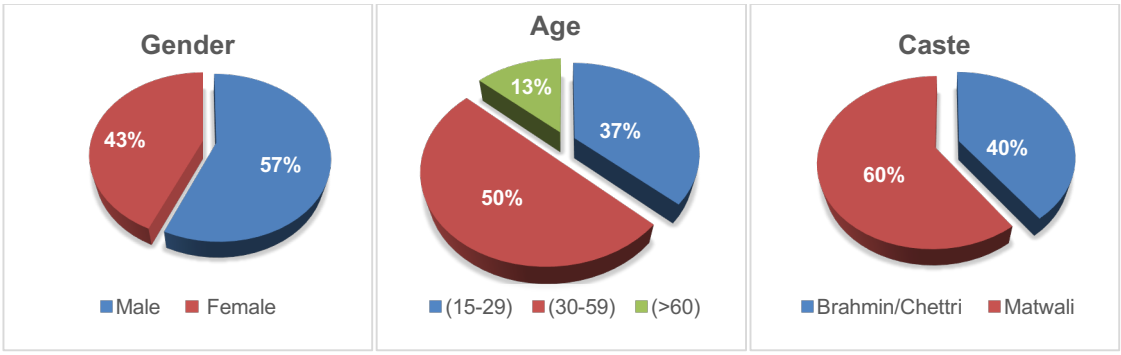

Figure 5. Pie charts of survey respondents in terms of Gender, Age, and Caste

Table 1 below provides a tabular representation of MWSP's social, economic, and environmental impacts in Sundarijal. Although the impact table is chronologically presented, the survey questionnaire as shown in Appendix 1 did not use impact questions categorically. The main intent of the survey was to determine the intensity and dimension of the project impacts in multiple domains. Therefore, while some questions were category-specific, others were more generic in nature. However, the questionnaire used several indicators in each impact description to determine the impact on a specific area. In addition to identifying the project impacts, the survey also attempted to promote effective and quality policy proposals to mitigate the adverse effects.

During the survey, each impact description was measured in the Likert scale qualitative scores. Each impact description was measured with a scale of five points ranging from *Strongly Agree* to *Strongly Disagree* with *Agree, Neutral, Disagree* in the middle. Raw survey data is shown in Table 2 below.

Table 1. Social, Economic and Environmental Impact table

Category	Area of Impact	Description	Indicators
Economic	Agricultural water supply	Impact of MWSP in the availability of agricultural water supply	Reduced river discharge, increased residual flow downstream, decline in off seasonal vegetable farming
Economic	Food security	Impact of MWSP in food security and sufficiency	loss of agricultural land, loss of grazing land, miscarriages of cattle from vibration effect, change in food prices, decline in fish population
Economic	Job opportunity	Contribution of MWSP in local employment generation	Local employment, workforce and skill development, revenue from local resources, market for local goods and products, distribution of income
Economic	Road construction	Contribution of MWSP in road construction	Market connectivity, increased mobility and transfer of goods, decreased travel time and cost
Economic	Tourism	Contribution of MSWP in tourism development	Trade and investment flows, increased mobility, development of facilities, employment opportunity
Environmental	Deforestation	Impact of MWSP in deforestation	Trees felling, forest fragmentation, change in land type, visual scars in aesthetic view, loss of ecological life
Environmental	Soil instability	Impact of MWSP on soil stability and erosion	Slope instability, erosion, vibration effect from blasting, deforestation, improper disposal of spoil
Environmental	Noise and Air pollution	Impact of MWSP in noise and air pollution	Use of explosives, high volume of heavy machinery, movement of heavy vehicles on earthen roads, dust particles, emission of air pollutants
Environmental	Waste generation	Impact of MWSP in waste generation	Construction spoil, material waste, packaging waste, explosive waste, camp waste
Environmental	Biodiversity	Impact of MWSP on biodiversity	Biodiversity and habitat loss, ecologically sensitive area, protected and endangered species, illegal wildlife hunting
Social	Public Health	Contribution of MWSP in public health	Upgrade of healthcare facilities, training of health personnel, supply of basic medicine and equipment to local health centers, sanitation programs
Social	Education	Contribution of MWSP in education development	Upgrade of physical facilities, supply of basic educational materials, grants and scholarships, adult literacy programs
Social	Loss of land and property	Impact of MWSP in land and property loss	Loss of land and property, resettlement, long and formal compensation process, sentimental issue, change in land price, over tax on local resources, congestion
Social	Safety and Security	Impact of MWSP in community life	Prostitution, spread of diseases, alcoholism, gambling, criminal activity
Social	Local participation	Contribution of MWSP in local participation	Social inclusion, gender equality, protection of the disadvantaged group, complain redress mechanism, non-discriminatory treatment and selection satisfaction

Table 2. Raw Likert scale data from the survey

Participant ID	Agricultural water supply	Food security	Job opportunity	Road construction	Tourism	Deforestation	Soil instability	Noise and Air pollution	Waste generation	Biodiversity	Public Health	Education	Loss of land and property	Safety and Security	Local participation
1	D	NA	D	A	SA	D	NA	SA	A	A	SA	A	NA	NA	D
2	A	D	NA	A	A	NA	D	A	A	A	A	A	NA	SA	SD
3	SA	A	A	SA	NA	A	NA	A	NA	NA	NA	D	SA	NA	NA
4	A	SA	D	SA	NA	A	SA	SA	A	NA	NA	D	A	NA	A
5	NA	SA	D	NA	D	SA	D	NA	A	NA	D	D	NA	NA	D
6	D	A	SD	D	SD	SA	D	A	A	SA	D	A	NA	NA	NA
7	D	D	A	SA	SA	NA	SA	SA	SA	SA	A	SA	NA	SD	A
8	NA	D	SA	SA	NA	SA	NA	NA	D	A	NA	NA	D	A	D
9	SD	A	SD	SA	SD	SD	D	SA	SA	A	A	SA	NA	NA	D
10	A	SA	A	SA	SA	NA	A	A	D	SD	A	A	SD	A	D
11	NA	A	D	NA	D	A	A	A	A	NA	A	NA	A	NA	SD
12	NA	D	D	A	SA	SA	D	A	SA	A	A	SA	NA	SA	SD
13	SA	NA	D	A	A	NA	A	SA	A	NA	NA	A	SA	A	NA
14	SD	SA	A	A	D	SD	NA	A	A	D	A	A	A	NA	SD
15	D	SA	A	SA	SA	D	SD	D	SD	SD	SA	SA	SD	SD	SA
16	D	NA	A	SA	A	D	A	NA	A	A	A	A	A	NA	D
17	D	NA	NA	SA	NA	A	SD	SA	SA	SD	SA	A	D	D	SA
18	NA	NA	D	A	D	SA	SA	SA	SA	SA	A	NA	NA	SA	SD
19	D	D	SA	SA	NA	NA	NA	A	D	D	A	A	A	NA	D
20	A	A	A	SA	NA	D	NA	NA	NA	D	NA	D	NA	NA	NA
21	D	D	NA	SA	A	A	NA	SA	A	SA	SA	SA	NA	A	SD
22	D	D	SA	SA	NA	SD	NA	SA	NA	NA	NA	NA	D	D	A
23	NA	D	D	A	A	A	NA	SA	NA	NA	A	NA	SA	NA	SD
24	D	D	NA	SA	SA	A	D	SA	SA	A	SA	SA	NA	A	SD
25	NA	NA	NA	NA	NA	A	A	SA	A	A	NA	NA	SA	A	D
26	D	SA	A	SA	A	A	SD	SA	SA	A	SA	A	NA	A	D
27	D	A	A	SA	A	D	D	A	NA	D	A	NA	A	A	A
28	D	D	SD	SA	SA	SA	D	SA	SA	SA	SA	SA	NA	SA	SA
29	D	D	A	SA	A	A	SD	A	SA	A	SA	A	NA	SA	D
30	D	D	SA	A	A	NA	D	NA	NA	A	NA	SA	A	NA	SD

Note: SA=Strongly Agree, A=Agree, NA=Neutral, D=Disagree, SD=Strongly Disagree

While the survey data have a relative position, the adjacent response levels may not be the same for all the participants. It provides the argument for forced response selection. Therefore, these data were treated as ordinal data rather than interval data in this thesis. Descriptive statistics were used to analyze the overall survey result. The Chi-squared test was used when the results were minimized to nominal levels of agreement and disagreement.

5 Result and Discussion

Two versions of cumulative statistics of the Likert scale data are shown in Tables 3 and 4 below. Table 3 presents the total number of responses for each area of impact on the Likert scale metric. Similarly, Table 4 tabulates the percentage of each Likert scale level and also divides every area of impact between cumulative agreement and disagreement percentage.

Table 3. Cumulative summary count of the Likert scale data

Category	Area of Impact	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Economic	Agricultural water supply	2	4	8	14	2
	Food security	3	6	6	12	3
	Job opportunity	4	10	5	8	3
	Road construction	18	8	3	1	0
	Tourism	7	9	8	4	2
Environmental	Deforestation	6	11	6	4	3
	Soil instability	3	5	9	9	4
	Noise and Air pollution	14	10	5	1	0
	Waste generation	9	11	6	3	1
	Biodiversity	5	11	7	4	3
Social	Public Health	8	12	8	2	0
	Education	8	11	7	4	0
	Loss of land and property	4	7	14	3	2
	Safety and Security	6	8	13	2	1
	Local participation	3	4	4	10	9

Table 4. Cumulative percentage count of the Likert scale data

Area of Impact	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Agricultural water supply	6.7	13.3	26.7	46.7	6.7
	20.0			53.3	
Food security	10.0	20.0	20.0	40.0	10.0
	30.0			50.0	
Job opportunity	13.3	33.3	16.7	26.7	10.0
	46.7			36.7	
Road construction	60.0	26.7	10.0	3.3	0.0
	86.7			3.3	
Tourism	23.3	30.0	26.7	13.3	6.7
	53.3			20.0	
Deforestation	20.0	36.7	20.0	13.3	10.0
	56.7			23.3	
Soil instability	10.0	16.7	30.0	30.0	13.3
	26.7			43.3	
Noise and Air pollution	46.7	33.3	16.7	3.3	0.0
	80.0			3.3	
Waste generation	30.0	36.7	20.0	10.0	3.3
	66.7			13.3	
Biodiversity	16.7	36.7	23.3	13.3	10.0
	53.3			23.3	
Public Health	26.7	40.0	26.7	6.7	0.0
	66.7			6.7	
Education	26.7	36.7	23.3	13.3	0.0
	63.3			13.3	
Loss of land and property	13.3	23.3	46.7	10.0	6.7
	36.7			16.7	
Safety and Security	20.0	26.7	43.3	6.7	3.3
	46.7			10.0	
Local participation	13.3	10.0	13.3	30.0	33.3
	23.3			63.3	

Bar charts or dot charts are commonly used for graphical analysis of the Likert scale scores as the data is ordinal and not continuous. Due to a large number of impact descriptions in the questionnaire, it was more practical to make a single divergent stacked bar chart here. Statgraphics18, a graphical tool, was used to create a divergent stacked bar chart shown in Figure 6 below.

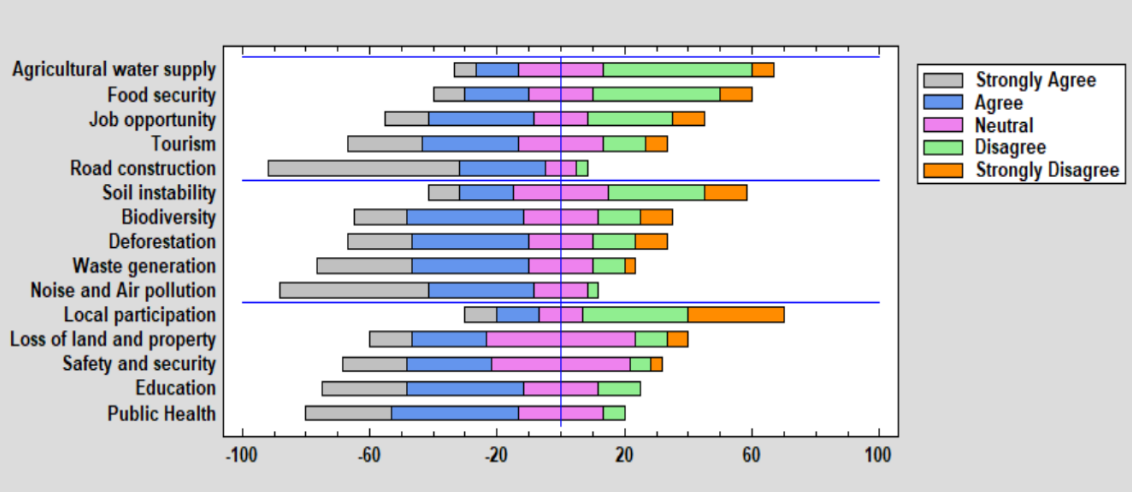

Figure 6. Divergent stacked bar chart for the Likert scale data

The Chi-squared and Fisher's exact tests were used to assess the correlation between the survey scores of two categories in socio-economic class and gender. The socio-economic class was divided into Brahmin/Chrettri and Matwali, while the gender category was divided into male and female. In Nepal, economic and social conditions are linked with ethnicity and regionalism. In the study area, agriculture is predominantly practiced by Matwali communities, whereas the majority of Brahmin/Chettri is involved in government and other business sectors. Although relative, ethnicity largely reflects the economic and social backgrounds, such as poverty, health, and education status. It also creates a ranked structure where participation and representation in public matters are difficult.

Similarly, women in Nepal have traditionally faced gender-based inequalities, including participation in public matters. In the study area, women are still considered responsible to fetch water for domestic use and drinking purposes. Although the gender roles and responsibilities are changing with high out-migration of male for work, equal access to health, education, social security and freedom to women is a long-standing dream.

In the survey, the results were obtained in the Likert-styled scores. In order to process this data statistically, the Likert scale levels were coded into numbers from 1 to 5, with 1 indicating *Strongly Agree* and 5 indicating *Strongly Disagree*. In the middle, 2 was coded for *Agree*, 3 for *Neutral* and *Disagree* with 4. Summary counts of responses in each question were made for both socio-economic class and gender categories. To analyze this data into R, theoretically, t-test could be used to compare the responses between

two groups in each category. Although possible, the t-test is not recommended as these scores are not continuous but rather constraints. It is therefore statistically much safer to use non-parametric tests such as the Chi-squared test.

While running the data in R, a warning message, *Chi-square approximation may be incorrect* and *NA* as the P-value was frequently displayed for many impact statements from the survey. This is due to the fact that a large portion of the counts in the original data have low values. Hence, in addition to the Chi-squared test, Fisher's exact test was run for the same set of data. Table 5 below shows the P-values of Chi-squared and Fisher's exact tests for each impact description from the survey.

Table 5. P-values of the Chi-squared test and Fisher's exact test

Area of Impact	Socio-economic class		Gender	
	chisq.test	fisher.test	chisq.test	fisher.test
Agricultural water supply	0.1072	0.1036	0.1238	0.1114
Food security	NA	0.8403	NA	0.01994
Job opportunity	0.02092	0.0162	0.09897	0.1193
Road construction	NA	0.02475	NA	1
Tourism	0.1372	0.1656	0.5123	0.6593
Deforestation	0.05348	0.0607	0.8113	0.859
Soil instability	0.6781	0.6922	0.8893	0.9761
Noise and Air pollution	NA	0.6802	NA	1
Waste generation	0.8272	0.8684	0.03337	0.01664
Biodiversity	NA	0.5139	NA	0.775
Public Health	NA	0.8382	NA	0.2679
Education	0.4254	0.532	0.66	0.7273
Loss of land and property	0.3742	0.368	0.0482	0.0366
Safety and security	0.07292	0.053	0.01968	0.009091
Local participation	0.4857	0.5421	0.06042	0.06432

P-values of Chi-squared test and Fisher's exact test are not very different in many cases. Furthermore, Fisher's exact test provides P-values even for those questions with low data values. In the correlation assessment, P-value is compared to standard 0.05. The null hypothesis used in each impact description asserts that the category group scores are not significantly different.

Agricultural water supply

Overall, 6.7% of the respondents strongly agreed, followed by 13.3% who agreed that the project had an impact on agricultural water supply during the construction phase. Whereas 46.7% disagreed and 6.7% strongly disagreed with the impact statement. The remaining 26.7% were neutral.

Agriculture is a major sector of income and livelihood in Sundarijal. Bagmati river is the main source of irrigation in the area. As a spring and snow-fed river, water availability in the Bagmati Watershed is naturally restricted. Therefore, it could be said that the effect of the MWSP project on the discharge of this river is minor or none. Correspondingly, a high percentage of survey respondents disagreed (53.3%) with the project impact on agricultural water supply.

The EIA report suggested that a sizable volume of water would be used from the Bagmati river for construction and camp activities. It further anticipated that borrow pits and quarries built along the river could change the river flow rate (Nippon Koei Co. Ltd., 2000). This can possibly explain why 20% of respondents agreed that the project affected irrigation water availability, especially during the dry season for off-season vegetable farming. That being said, the above argument is debatable since the river naturally runs low between January and April (Sharma, 2006). In this regard, to further analyze the impact, statistical analysis of hydrological data is required which is beyond the scope of this study.

The EIA report indicates that approximately 65% of the water supplied in Kathmandu Valley will be added to the Bagmati river at different points during the operation phase. This increase in flow volume is expected to add both pollution load and treated water in the river. The EIA report, however, suggests that additional flow of 1.3 m^3/s to the Bagmati river during the operation phase has several positive effects, including dilution of existing river pollutants (Nippon Koei Co. Ltd., 2000). The report also implies that an increase of treated water in the river will positively contribute to agricultural irrigation, particularly during the dry season when the river naturally runs low at a flow rate of $0.15m^3/s$ (ADB, 2000).

Here, P-values of Chi-squared test(0.11, 0.12) and Fisher's exact test(0.10, 0.11) for both socio-economic class and gender categories respectively are higher than 0.05. This, therefore, shows that in both the categories there is no significant difference in group scores for the impact statement.

Food security

Crop cultivation patterns are directly linked to irrigation facilities and land type. In Sundarijal, typically two to three crops are grown in a year. The cropping pattern here is regionally dominated by paddy, maize, and wheat. The area produces substantial quantities of these crops that are also traded with other crops, mostly potatoes. Food grain production in this region, therefore, appears to be more than satisfactory.

Livestock is an integral part of agriculture in this area. In addition to drawing plows, their dung is used as compost manure to maintain soil nutrients. Livestock such as buffaloes, goats, bullocks, and cows are considered a measure of wealth in this region.

On the whole, 10% of the respondents strongly agreed, followed by 20% who agreed that the project had an impact on food security and sufficiency. While a high 40% disagreed, followed by 10% who strongly disagreed with the impact statement. The remaining 20% were neutral.

A high 50% of the survey respondents disagreed on the project impact on food sufficiency. They believed that the project had no impact on the area's food sufficiency. Some suggested that seed subsidies, farming and animal husbandry programs launched by the project rather increased food production and income in the area. One such program was the milk collection center that enabled farmers to sell milk to the Kathmandu Dairy Development Corporation.

However, 20% of the respondents agreed that the project directly or indirectly affected food sufficiency in the area. They argued that the loss of farmland and forest resulted in lower crop production and less livestock. Few of the respondents who strongly agreed(10%) claimed that waste and dust from construction activities degraded top fertile soil in adjacent farmland. They also assumed that cattle miscarriages resulted from tunnel blasting vibration. Some were also unhappy with rising food prices following the

influx of external workers in the area. It is important to note here that the above arguments are qualitative in nature and require further quantitative analysis for better assessment.

Here, the P-values of the Chi-squared test is *NA* for both socio-economic and gender categories. This shows that a large portion of the counts in the original data have low values. P-value of Fisher's exact test (0.84>0.05) for socio-economic class category shows that there is no strong correlation between the group scores for the impact statement. However, for the gender category, P-value of Fisher's exact test (0.02<0.05) shows that there is a significant difference between the two groups scores for the impact statement. This suggests a strong correlation between male and female responses in regards to the project's impact on food sufficiency.

Employment opportunity

In total, 13.3% of the survey respondents strongly agreed and 33.3% agreed that the project contributed to local employment opportunities. While 26.7% disagreed and 10% strongly disagreed with the contribution statement. The remaining 16.7% of respondents were neutral.

Overall, a high 46.7% of the respondents agreed on the contribution of the project to local employment. Besides direct employment, their arguments surrounded on the revenue from local resources, and growth in local businesses including tourism, transportation, lodging, and remittances. Some also suggested that the project increased the flow and distribution of income in the area as many local farmers and fishermen were able to sell their foods and products to meet the workers' increased demand. They, therefore, agreed that the project had a high positive economic significance in the area.

On the other hand, 36.7% of the respondents disagreed with the project's contribution on local employment. Although the EIA report mentioned that 30% should be local, including 5% female (Nippon Koei Co. Ltd., 2000), many here argued that contractors primarily recruited their own employees, making it hard for local people to get a job. Some also mentioned that the employment process involved political biases preventing disem-

powered and marginalized groups from being employed. Many respondents acknowledged that most hired local workers received predominantly unskilled jobs that required physical labor but paid low wages.

Here, for socio-economic class category, P-values of both Chi-squared and Fisher's exact tests (0.02, 0.02) are below 0.05. Hence, the null hypothesis that there is no significant difference between the scores of two groups in socio-economic class was rejected. This shows a strong correlation between the group scores in socio-economic class category for the impact statement. Conversely, both Chi-squared and Fisher's exact tests (0.10, 0.12) for gender category have P-values greater than 0.05. This, therefore, shows that there is no significant difference between male and female scores for the impact statement.

Road construction

The contribution of the project on road construction was strongly agreed by 60% of the respondents alone. The contribution was further agreed by 26.7%, while only 3.3% of the respondents disagreed. The remaining 10% were neutral.

In total, 86.7% of the respondents agreed that the project contributed directly to the area's road construction. The main reason for this high agreement in response was the Sundarijal-Mahankal access road built by the project. This road originally built for the transport of construction materials was now used for local people's normal mobility. Therefore, a high proportion of respondents acknowledged the fact that they benefited directly from the road built. Besides enhanced accessibility to the capital city, they recognized that the road increased market connectivity to transport their goods and services. They also appreciated the fact that the road built has considerably reduced travel time and cost. Some also believed that the access road contributed positively to their land price and enhanced trade and investment flow in the area.

Here, P-values of the Chi-squared test is *NA* for both socio-economic class and gender categories. This shows that a large portion of the counts in the original data have low values. However, for socio-economic class category, Fisher exact test with low P-value(0.03<0.05) shows that there is a significant difference between the group scores

for the impact statement. This shows a strong correlation between the responses of Brahmin/Chettri and Matwali regarding the project's contribution on road construction.

Tourism

Tourism is a major economic activity and a key source of income in Sundarijal. The region is renowned for its untouched nature. Shivapuri Wildlife Reserve is one of the famous trekking routes close to the capital city. It is full of natural resources, including magnificent flora and fauna.

As per the survey, 23.3% of the respondents strongly agreed, followed by 30% who agreed that the project contributed positively on local tourism development. On the other hand, 13.3% disagreed, followed by 3.3% who strongly disagreed on the contribution statement. The remaining 26.7% were neutral.

Overall, a high 53.3% of the respondents agreed with the contribution of the project on local tourism. Many of these respondents said the building and upgrading of roads, in particular, contributed positively to local tourism. Some indicated that the project facilitated the development of infrastructure, including hotels and lodges in the area. Therefore, it could be said that in addition to enhancing the local tourism, the project also boosted trade and investment flows. Few of these respondents also speculated that the adequate supply of safe and quality water would further improve this sector after completion of the project.

On the contrary, 20% of the respondents disagreed with the project's contribution to local tourism. Some of them criticized that the presence of workers, construction activities, and waste generated during the construction period negatively affected the area's aesthetic appearance. Few also argued that the felling of the trees for the project created visual scars and blocked many trekking routes.

Here, P-values of Chi-squared test(0.14, 0.51) and Fisher's exact test(0.17, 0.66) for both socio-economic class and gender categories respectively are higher than 0.05. This, therefore, shows that in both the categories there is no significant difference in group scores for the impact statement.

Deforestation

The EIA report anticipated the vegetation clearance to be low to moderate in the project area since it mainly consisted of deciduous trees that are abundant in the region (Nippon Koei Co. Ltd., 2000). In Sundarijal, the felling of the trees of any kind can have a considerable impact on vegetation diversity, as it is located in the vicinity of the Langtang National Park and Shivapuri Wildlife and Watershed Reserve.

On the basis of the survey, 20% of the respondents strongly agreed and 36.7% agreed that the project contributed to deforestation in the area. While 13.3 disagreed, followed by 10% who strongly disagreed with the impact statement. The remaining 20% were neutral.

Overall, a high 56.7% of the respondents agreed that project construction caused considerable deforestation in the region. They argued that, contrary to the EIA report suggestion, forest areas with diverse tree species including immature fodder have been destroyed. Some also believed that felling of Uttish trees along the banks of Bagmati river, for instance, has increased the risk of soil erosion. They suggested this was due to the high demand for firewood in camps and timber in construction. Few also criticized the fact that it created an opportunity for local people as well to maximize their economic gain from the clearance of natural vegetation.

Here, P-values of Chi-squared test(0.054, 0.811) and Fisher's exact test(0.060, 0.859) for both socio-economic class and gender categories respectively are higher than 0.05. This, therefore, shows that in both the categories there is no significant difference in group scores for the impact statement.

Soil instability

The survey found that 10% of the respondents strongly agreed, followed by 16.7% who agreed that the project had a negative impact on soil stability. While 30% of the respondents disagreed and 13.3% strongly disagreed with this impact description. The rest of the respondents remained neutral at 30%.

The project area in Sundarijal is located in the vicinity of Bagmati Watershed with dense forest. It can, therefore, be assumed that the area is in a relatively good natural condition. This also helps to explain why a high 43.3% of the respondents disagreed with the impact of the project on soil stability.

However, 26.7% of the respondents agreed that the construction of the project had a negative impact on the area's soil stability. Many here believed that the use of explosives in tunnel construction has increased the risk of slope instability and erosion. They also criticized the disposal of spoil below the cut slope, which contrasts the suggestion in the EIA report. They believed it poses a high risk of slope vegetation degradation, making it vulnerable to erosion in the near future. Few of them also claimed that two active landfalls and several small rockfalls have recently occurred. It is important to point out here that the perceived soil instability above is not entirely due to the project activities. Human factors such as prolonged overgrazing and illegal logging are also leading causes in this regard.

Here, P-values of Chi-squared test(0.68, 0.89) and Fisher's exact test(0.69, 0.98) for both socio-economic class and gender categories respectively are higher than 0.05. This, therefore, shows that in both the categories there is no significant difference in group scores for the impact statement.

Noise and Air pollution

According to the survey, a high 46.7% of the respondents strongly agreed, followed by 33.3% who agreed that the project had a negative impact on air and noise pollution. While only 3.3% disagreed with this impact description. The remaining 16.7% were neutral.

As per the EIA report, construction activities such as excavation and filling, rock/aggregate crushing, drilling and blasting, quarrying and borrowing pose a potential risk of air degradation. The report also suggested that the operation of heavy equipment and vehicular movement generate both high noise and vibration. It further indicated that petrol and diesel used as fuel, in particular, emit hydrocarbons, black soot, SO_2, NO_x, CO, and CO_2 that degrade air quality with high magnitude (Nippon Koei Co. Ltd., 2000). These

predicted impacts were reflected in the survey response when a high 80% of the respondents agreed that project construction increased the noise and air pollution level in the area.

Some even claimed that during tunnel construction, short-lived, high-pitched explosions damaged their homes and also resulted in cattle miscarriages. Many also complained about the noise from vehicular movement during the nights because it hindered their sleeping hours. Few even suggested that wildlife habitat in the area was disturbed and displaced by construction noise and vibration.

In the same regard, many respondents who agreed with the impact statement mentioned about traffic congestion in Sundarijal. They pointed out that Chabahil-Jorpati-Gokarna-Sundarijal road corridor, in particular, was highly congested by heavy-duty vehicles. This was, however, already anticipated in the EIA report since this extremely narrow road was the main entry point to most project sites. In addition to road congestion and noise, some respondents also emphasized on the air quality issue. They pointed out that dust, smoke, and suspended particles were clearly visible in the air.

It should be noted here that the above arguments are based on the subjective responses received during the survey. Therefore, the statistical analysis of the environmental quality index is necessary to quantitatively measure, confirm, and present each problem. It is also important to note that many of the mentioned impacts are short-term that usually last for the construction period.

Here, P-values of the Chi-squared test is *NA* for both socio-economic class and gender categories. This shows that a large portion of the counts in the original data have low values. Furthermore, P-values of Fisher's exact test(0.68,1.00) for both socio-economic class and gender categories are higher than 0.05. This shows that the group scores for both the categories do not differ significantly for the impact statement.

Waste generation

In Sundarijal, the EIA report predicted that the spoil generated during the construction of access roads and tunnel would be the major source of solid waste. It also calculated that waste from construction materials, packaging materials, explosives, and camps would

be significantly high during the construction period. It estimated that construction workers alone would generate 250 kg of waste every day. Therefore, the report proposed appropriate guidelines and measures of spoil disposal prior to the project construction (Nippon Koei Co. Ltd., 2000).

Results from the survey showed that 30% of the respondents strongly agreed, followed by 36.7% who agreed that the project contributed to waste generation in the area. While 10% of the respondents disagreed and only 3.3% strongly disagreed with this impact description. The remaining 20% were neutral.

A high 66.7% of the respondents agreed that the project contributed to waste generation in the area. Many of them said that the litter generated in labor camps was a major issue. They understood that waste littering could have a detrimental effect on public health and sanitary conditions in general. Some also believed that surplus spoil was generated during the project construction in comparison to the proposed disposal sites. They also mentioned that Sundarijal did not have any existing solid waste management system or safe landfill site for this surplus spoil disposal. Therefore, they suspected that much of the camp waste along with construction waste could have ended in open nature or even Bagmati river, causing both land and water pollution.

Correspondingly, many respondents also commented that bad smell related to sewer restoration was a major public concern. They remarked that the lack of immediate waste disposal, especially sludge from manholes posed a potential health hazard and a nuisance to the community.

Here, both Chi-squared test(0.83>0.05) and Fisher's exact test(0.87>0.05) for socio-economic class category show that the group responses between Brahmin/Chettri and Matwali are not significantly different for the impact statement. However, low P-values of Chi-squared(0.03) and Fisher's exact test(0.02) for gender category show a significant difference between the male and female response to the project's impact on waste generation.

Biodiversity

The Sundarijal project site is located close to the Langtang National Park and the Shivapuri Wildlife and Watershed Reserve. Varied species of wildlife are present in these ecologically sensitive areas. For many protected and endangered species, LNP and SWWR are the feeding and breeding grounds. They also include many primary routes for migratory wildlife.

As per the survey, 16.7% of the respondents strongly agreed and 36.7% agreed that the project had an impact on the biodiversity of the area. While, 13.3% disagreed, followed by 10% who strongly disagreed with the impact description. The remaining 23.3% were neutral.

Many of the respondents who agreed with the impact statement (53.3%) supposed that the project had a direct or indirect impact on wildlife habitat loss and biodiversity in general. They reasoned that vegetation clearance along with construction associated noise and vibration could have directly affected breeding and feeding of most wildlife. Also, few respondents suggested incidents of unlawful poaching by camp workers along with the local villagers. They implied that it had a declining effect on the number of wildlife species such as Himalayan Thar, Ghoral, Barking Deer, and Kaliz whose meat is of high market value.

Here, P-values of the Chi-squared test is *NA* for both socio-economic class and gender categories. This shows that a large portion of the counts in the original data have low values. Furthermore, P-values of Fisher's exact test(0.51, 0.78) for both socio-economic class and gender categories are higher than 0.05. This shows that the group scores for both the categories do not differ significantly for the impact statement

Public health

The survey result found that 26.6% of the respondents strongly agreed, followed by 40% who agreed that the project contributed to the public health sector in the area. Whereas, only 6.7% of the respondents disagreed with the contribution description. The remaining 26.7% were neutral.

A high percentage of respondents(66.7%) agreed that the project made a significant contribution to local health sector development. They acknowledged that the project helped to improve and upgrade existing healthcare facilities and supplied local health services with basic medicine and equipment. They also accepted that project conducted community workshops on public health, maternity health, sexually transmitted disease, as well as common sanitation and hygiene practices.

Here, P-values of the Chi-squared test is *NA* for both socio-economic class and gender categories. This shows that a large portion of the counts in the original data have low values. Furthermore, P-values of Fisher's exact test(0.84, 0.27) for both socio-economic class and gender categories are higher than 0.05. This shows that the group scores for both the categories do not differ significantly for the impact statement

Education

On the basis of the survey results, 26.7% of the respondents strongly agreed, followed by 36.7% who agreed on the project's contribution to the local education sector. Here, only 13.3% disagreed with the contribution description. The remaining 23.3% were neutral.

A high percentage of respondents (63.3%) agreed that the project contributed significantly to the development of the local education sector. They mentioned that the existing school facilities were upgraded and maintained under the project's social uplift program. They also acknowledged that the community school was provided with basic education and sports materials. Some also said that grants and scholarships were provided to children mainly from marginally disadvantaged groups. They, therefore, reasoned that such motivating factors significantly decreased school absenteeism and dropout rates. They also believed that the project's prohibition of child labor notably increased school enrolment.

Here, P-values of Chi-squared test(0.43, 0.66) and Fisher's exact test(0.53, 0.73) for both socio-economic class and gender categories respectively are higher than 0.05. This shows that in both the categories there is no significant difference in group scores for the impact statement.

Loss of land and property

According to the EIA report, the project required a total of 134.73 hectares of land, consisting mainly of agricultural land and forest. In the study area alone, for WTP construction, 12 ha of prime agricultural land was permanently acquired. This directly affected 79 families whose main sources of income were agriculture and animal husbandry (Nippon Koei Co. Ltd., 2000).

According to the survey, 13.3% of the respondents strongly agreed and 23.3% agreed that the project had an impact on land and property loss. While 10% of the respondents disagreed, followed by 6.7% who strongly disagreed with the impact description. A high 46.7% remained neutral.

Survey respondents who agreed with the impact statement (36.7%) said land and property losses were significant in terms of income and livelihood for many project-affected families, especially those living in marginal conditions. Although the loss of property and land was compensated in cash, project-affected respondents complained that resettlement and compensation procedures were lengthy and formal. They also claimed that they were paid with compensation under the market value standard at the time. Some also showed dissatisfaction that sentimental issue in compensation process was ignored. They believed the compensation assessment could have been more sympathetic since the loss of land and property is associated with the sentimental issue. Some argued that resettling far off meant leaving behind established social and commercial links in the community which they believed needed addressing during the compensation process.

Many of the respondents who disagreed with the impact statement (16.7%) said the project compensated families fairly for the loss of their land and property. Some of them also considered the loss of land and property insignificant compared to the long term economic and social benefit of the project. They mainly reasoned that the loss of land and property incurred is deemed minimal when compared to the health benefit of the safe water to a large population in the regional context.

Here, P-values of both Chi-squared and Fisher's exact tests (0.37, 0.36) respectively are greater than 0.05 for socio-economic class category. This shows that the scores between Brahmin/Chettri and Matwali respondents do not differ significantly for the impact

statement. However, Fisher's exact test's P-value (0.04<0.05) for gender category shows that there is a significant difference between the scores of male and female to the project's impact on the loss of land and property

Safety and security

Overall, 20% of the respondents strongly agreed, followed by 26.7% who agreed that the project had an impact on safety and security issue in the community. While 6.7% of the respondents disagreed and 3.3% strongly disagreed with this impact statement. A high 43.3% remained neutral.

A total of 46.7% of the respondents agreed that the project had a negative impact on safety and security in the area. Most of these respondents suggested that alcoholism, prostitution, and gambling in the area increased substantially after the influx of outside workers. They believed these factors negatively impacted social practices, norms and community lifestyle in general. A high percentage of respondents (43.3%) remained neutral or did not answer to this impact statement.

Here, Fisher's exact test's P-value(0.01<0.05) for gender category shows that there is a significant difference between the responses of male and female regarding the safety and security question. While, high P-values(0.07, 0.05) for socio-economic class category shows that there is no strong correlation here between the group scores to the impact statement.

Community participation

On the basis of the survey results, 10% of the respondents strongly agreed and 13.3% agreed that the project involved local participation in the decision-making process. Whereas, 33.3% disagreed, followed by 30% who strongly disagreed with this description. The remaining 13.3% were neutral.

A high 63.3% of the respondents disagreed on public participation in the decision-making process. They argued that, as outlined in the EIA report, public participation and consultation did not involve social inclusion, gender equality, and protection of disadvantaged

groups. Few even complained that much of the project's design and implementation phase did not involve the community.

On the other hand, 23.3% of the respondents agreed that the project carried out several group discussions, workshops, and meetings in the community. However, many here acknowledged that political and corporate representatives dominated the decision-making process. They also recognized that many of the project documents were not available for public disclosure during such sessions.

Here, high P-values of Chi-squared test(0.49, 0.06) and Fisher's exact test(0.54, 0.06) for both socio-economic class and gender categories respectively shows that in both the categories there is no significant difference in group scores for the impact statement.

SWOT Analysis

A SWOT analysis presented in Table 6 below explores the project's strength, weakness, opportunity, and threat during its construction phase. It mainly utilizes the results of the survey and categorically represents them in the tabular form. Here, the analysis is presented in a holistic approach, as many of the parameters are inherently linked. It is, therefore, recommended to use it as a performance indicator framework for further planning in the development of the project. Opportunities and threats, in particular, could be further examined for better management of the project in the future.

Table 6. SWOT analysis

Strength	Weakness
Evidently the only viable alternative from technical and socio-economical perspective to water shortage in Kathmandu Valley	Insufficient compensation process with an ambiguous and formal framework for land and property loss
The government of Nepal and several renowned investment organizations as project stakeholders	Impact on livelihoods of farmers due to loss of agricultural and grazing land, miscarriages of cattle from blasting vibration and decline in the fish population
Increment in the local economy through job creation, skill development and revenue from local resources	Air and noise pollution from explosives, heavy machinery, and heavy vehicle movement
Increased mobility with reduced travel time and costs through upgrading and building of access roads	Inadequate disposal of waste generated from construction spoil, material waste, packaging waste, explosive waste, and camp waste
Economic benefits from trade and investment flows, community infrastructure development, and market connectivity for goods and service transfer	Vegetation clearance and loss of biodiversity and habitat in ecologically sensitive areas with many protected and endangered species
Investment in education and training programs by upgrading physical facilities and providing educational materials, grants and scholarship for basic education	Unsatisfactory local participation and public consultation in the decision-making process
Development of general health sector by upgrading healthcare facilities, providing basic medicine and equipment to local health centers and implementing community sanitation programs	Insufficient solution strategies for social issues concerning prostitution, alcoholism, gambling, crime, and illegal poaching
Opportunity	**Threat**
Improve public health by providing safe drinking water and also reduce health costs related to waterborne disease	Absurdly high additional funding due to poor governance and contractual delays
Further emphasis on alternative water sources to meet increased demand	Insufficient emphasis on increased water demand as a result of population growth
Improved and comprehensive project progress monitoring to minimize additional budget costs and	Possibility of conflicts for compensation as many demands from affected people has either increased or changed
Significant potential for tourism and local business development with increased investment and trade flows	Potential soil and river erosion from vegetation clearance and improper spoil disposal
Capacity building and skill development for job opportunities in the operation phase	Possibility of irrigation water disruption due to reduced river discharge and increased residual flow downstream during project operation
Government commitment to build and maintain trust with stakeholders including contractors and donors	Risk of disease spread from stagnant water and tunnel effluent during the operation phase
Enhanced local participation to ensure comprehensive decision-making and problem-solving process	Likelihood of increase in social issue resulting from congestion, changes in land price and tax on local resources

6 Summary

MWSP is considered the most economically viable, socially acceptable and environmentally less damaging alternative for sustainable water supply to Kathmandu Valley. It aims to solve the issue of prolonged shortages of drinking water in the capital. Besides the reduced risk of waterborne diseases, the project intends to significantly reduce time and cost spent by Kathmandu residents on drinking water.

During the construction phase, the project's socio-economic and environmental dimensions were diverse in nature. The study area and its residents were recipients of both adverse and beneficial effects of the project. Land acquisition, compensation, and resettlement process was the most complex and sensitive issue in the study area.

According to the survey, agriculture is the primary source of survival for many families in the study area; therefore, the loss of farmland and grazing land was significant in terms of livelihood as well as sentiment attached to it. While the project compensated for the acquisition of land and property, the survey found that the land loss for those families in marginal condition was considerable. As per the survey result, the project's impact on agricultural water supply and food production was minor to none. Some responses, however, implied the project's impact on reduced Bagmati river flow, particularly in dry season affecting off-season vegetable farming. In this regard, the reasoning of these respondents is debatable as the river naturally runs low from January to April (Sharma, 2006). Environmental issues related to project construction mainly included trees felling, forest fragmentation, waste production, biodiversity habitat loss. The survey results showed that vegetation clearance and spoil disposal were not properly contained within the EIA suggestion and guidelines, increasing the risk of soil and water erosion in the area. The survey responses indicated an increase in air and noise pollution in the area during the construction period. It is important to note here that the survey responses were qualitative and the perceived impacts were short-term. Therefore, the statistical analysis of the environmental quality index is recommended for further evaluation. Based on the survey response, alcoholism, prostitution, and gambling in the area increased largely after the influx of outside workers. The survey result also suggested that these factors negatively impacted social practices, norms and community lifestyle in general.

Conversely, local employment, access road construction, market accessibility, and physical infrastructure development were found to be the main merits of the project. The survey found that the project positively enhanced the local economy through job creation, manpower and skill development, and revenue from local resources. Upgrading and building of access roads increased mobility and market accessibility for local people with reduced travel time and cost. The survey also found that the tourism, health, education, and local business sectors were substantially enhanced under the project's social uplift program.

Based on the survey, many of the project impacts were not contained within the acceptable limits due to poor implementation of mitigation measures and lack of rigorous monitoring during construction. The adverse impacts of the project on biophysical environment, land and vegetation degradation, in particular, could have been minimized further through effective implementation of mitigation measure, such as safe disposal of spoil. Local participation and public consultation could have been enhanced with more social inclusion, gender equality and protection of disadvantaged groups. To make the project activities more transparent, there could have been more visible and effective access to information for public disclosure. It is also recommended that mitigation measures could have been more robust and action-specific, rather than general prescriptions. It would tremendously decrease the concerns and complaints of local people and facilitate project execution in a smooth manner.

Currently, the project is still in the construction phase due to poor governance and contractual delays. Besides additional budget cost, the project should also reassess the increased demand for drinking water in regards to population growth.

It is worth noting here that the project's impacts will change in dimensions and magnitudes during the operation phase. The reduction in Melamchi flow, for instance, is expected to be significantly high with the diversion of 2 m^3/s during the operation phase (Nippon Koei Co. Ltd., 2000). This reduction in river water level at the tunnel intake zones has the potential to drip out springs and lower the overall groundwater level, affecting many local communities. The EIA report also anticipates that reduced river discharge during the operation phase has a potential negative impact on fish population downstream, affecting the livelihoods of many fishermen. The report also suggests that in the Sundarijal tunnel outlet zone, the risk of disease spread from stagnant water and tunnel

effluent is high during project operation. Project induced congestion, changes in land price and taxes on local resources may lead to social conflicts in the future. These are just a few descriptions of the operational impacts that go beyond the scope of this study.

While this study analyzed both merits and negative impacts on the project during its construction, it is important to note that the research was primarily qualitative. Therefore, it can be argued that it does not provide a representative overview of the situation due to the subjective nature of responses, sampling bias, and limited sampling size. It is highly recommended to quantitatively assess the impacts of the project in order to find more detailed and statistically representative results.

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Appendices

Appendix 1. Survey questionnaire used in the field study

घरधुरी सर्वेक्षण

सुंदरिजल ७,८ काठमाडौं

मिति :

नाम :
थर :
उमेर :
लिंग :
परिवार सदस्य संख्या :

	धेरै छ	छ	भन्न चाहन्न	थोरै छ	छैन
१. मलाई यो मेलमची परियोजनाको बारे थाहा छ।	○	○	○	○	○
२. यस परियोजनाका गतिविधिहरूले विभिन्न समस्याहरू सिर्जना गरेको छ।	○	○	○	○	○
३. यस परियोजनाबाट धेरै सकारात्मक फाइदाहरू पनी भएका छन।	○	○	○	○	○
४. यो परियोजनाले गाउँमा रोजगार अवसरको वृद्धि भएको छ।	○	○	○	○	○
५. यस परियोजनाबाट घर परिवारको आयआर्जनमा वृद्धि भएको छ।	○	○	○	○	○
६. यो परियोजनाबाट कृषि को लागि जल आपूर्तिका साथै खाद्य उत्पादनमा प्रभाव परेको छ ।	○	○	○	○	○
७. यस परियोजनाले गाऊँको स्वास्थ्य सेवा सुविधा र शिक्षा विकासमा योगदान पारेको छ ।	○	○	○	○	○
८. यो परियोजनाले सडक निर्माणका साथै बज़ार सम्मको पहुच बड़ाएको छ ।	○	○	○	○	○

९. यस परियोजनाका कारण गाँउ क्षेत्रको पर्यटन विकासमा टेवा पुगेको छ।

○ ○ ○ ○ ○

१०. यस परियोजनाका कारण सामाजिक विकृतिहारू पनी फैलिएका छन ।

○ ○ ○ ○ ○

११. यो परियोजना निर्माणका लागी कृषि भूमिको अधिग्रहणका साथै धेरै स्थानीयहरू विस्थापित हुनु परेको छ।

○ ○ ○ ○ ○

१२. यो परियोजना निर्माणले भूमि कटानका साथै पहिरोको समस्या बढेको छ ।

○ ○ ○ ○ ○

१३. यो परियोजना निर्माणले सामुदायिक वन विनासका साथै जंगली वन्यजंतुमा पनी असर परेको छ ।

○ ○ ○ ○ ○

१४. यस परियोजना निर्माणले गाऊँमा फोहोर र दुर्गन्ध बढेको छ।

○ ○ ○ ○ ○

१५. यो परियोजना निर्माणले गर्दा गाऊँक्षेत्रमा ध्वनि प्रदुषण र वायु प्रदूषण बढेको छ।

○ ○ ○ ○ ○

१६. यस परियोजना निर्माणका कारण सामाजिक समस्या साथै सामुदायिक जीवनशैलीमा असर परेको छ । ।

○ ○ ○ ○ ○

१७. यस परियोजनाका नकारात्मक प्रभावहरू घटाउन स्थानीय सदस्य हरूको छलफलमा सहभागिता हुन्छ।

○ ○ ○ ○ ○

यदि कुनै टिप्पणी भए .....
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Appendix 2. Photographs taken at the tunnel outlet zone, Sundarijal Kathmandu

1

2

1,2: Photos showing the hoarding boards with the project information on MWSP and WTP respectively

3,4: Photos showing the exterior and interior view respectively of the water diversion tunnel(WDT)

5,6: Photos of the construction workers examining the excavated tunnel for the progress status reporting

7: Photo of MWSPB site office in Sundarijal

8: Photo showing the contruction material collection center

9,10: Photos showing the WTP under construction phase

11: Photo showing the disposal of construction spoil on the cut slope

12: Photo showing the close proximity of the study area from the project site