2016

Malaria Micro-stratification

Government of Nepal
Ministry of Health
Department of Health Services
Epidemiology and Disease Control Division
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Acknowledgement

It gives me great pleasure to bring to you the final “Malaria Micro-stratification 2016” report which is an important document for monitoring and planning specific intervention activities to help the country reach elimination of malaria by the year 2025 as specified in the Nepal Malaria Strategic Plan (NMSP) 2014-2025 AD.

In 2012, Village Development Committee (VDC) wise micro- stratification was done which collected basic information from VDCS of malaria reported districts and intervention activities were conducted accordingly. Based on the NMSP 2014-2025 and the recommendation of the external mid-term review (MTR) done in 2013, a ward level micro-stratification was conducted in 2016. To understand the current status of malaria in the communities, ward level malaria related information were collected from 2014 till 2016 and the data was analyzed to stratify malaria risk into high, moderate, low and no risk wards to aid the program in devising targeted interventions. The program is ambitiously aiming for zero transmission by 2020 and this is a monumental task with the ever present burden of imported cases in the country along with the vectors now being seen higher up in the hills where malaria was not prevalent before. This report will certainly guide program managers and implementer across regions and districts to be specific and astute in their planning ahead thereby being both effective and efficient.

I would like to express my gratitude to Dr. Bishwo Raj Khanal, former Executive Director of Vector Borne and Disease Control Research and Training Centre (VBDRTC) for preparing this final report. I also would like to thank Dr. Bibek Kumar Lal, Chief of Disease Control Section, Epidemiology and Disease Control Division (EDCD) and his team along with the Program Management Unit (PMU) staff who worked tirelessly helping with the data collection and analysis. A big gratitude goes to Dr. Suman Thapa, who provided the overall technical support in conducting the study as well as his support to finalize this report. I would also like to thank various External Development Partners (EDPs) including World Health Organization (WHO), USAID/PMI for their technical contribution and support during various steps of the study. I would also take this opportunity to thank the district and regional teams including the Regional Health Directorates (RHDs), District Public Health Offices (DPHOs), Vector Control Inspectors (VCI)/ Vector Control Supervisors (VCS)/ Malaria Inspectors (MIs) and other staff who have contributed in this study especially obtaining ward level information.

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Abbreviations

AL	Artemether-Lumefantrine combination
API	Annual Parasite Incidence
BCC	Behavior Change Communication
CDC	Center for Diseases Control
DHO	District Health Office
DPHO	District Public Health Office
EDCD	Epidemiology and Disease Control Division
EDPT	Early Diagnosis and Prompt Treatment
EPHS	Essential Public Health Services
GIS	Geographic Information System
GPS	Global Positioning System
HMIS	Health Management Information System
ICIMOD	International Center for Integrated Mountain Development
IMCI	Integrated Management of Childhood Illness
IRS	Indoor Residual Spraying
LLIN	Long Lasting Insecticide Treated Net
MDGs	Millennium Development Goals
MI	Malaria Inspectors
MOHP	Ministry of Health and Population
MS	Micro stratification
NMP	National Malaria Program
Pf	Plasmodium falciparum
PMU	Programme Management Unit
Pv	Plasmodium vivax
RBM	Roll Back Malaria
RDT	Rapid Diagnostic Test
SOP	Standard Operating Procedure
SP	Sulfadoxine–Pyrimethamine
TWG	Technical Working Group
TOR	Terms of Reference
USAID/PMI	United States Aid for International Development/President Malaria Initiatives
VBDRTC	Vector Borne Disease Research and Training Center
VCI	Vector Control Inspector
VCO	Vector Control Officer
VDC	Village Development Committee
WHO	World Health Organization

Executive Summary

Malaria risk stratification identifies geographical areas based on the potential risk of malaria transmission. Besides, it is a prerequisite for the rational targeted interventions and an essential step for an effective and efficient resource mobilization.

In the past, malaria risk stratification in Nepal was conducted at the district level and the population of the district was defined as the population at risk of malaria. But, with the substantial decline in the burden of malaria during the past decades, and the evidence that only few Village Development committees (VDCs) within the district reported malaria cases while other VDCs remained free of malaria; there was a need to conduct the study at a more basic level such as wards.

Malaria stratification was conducted in 2012 and the study provided the strategic evidence of malaria transmission at the VDC level and the population of the VDC was defined as the population at risk of malaria. The study provided the evidence of a declining trend of transmission of malaria and confirmed the shrinking malaria map in the country. The recommendations of an external and -internal review by the National Malaria Programme (NMP) in 2010 and an External Programme Review in 2013, confirm the changing malaria landscape in Nepal. Based on the recommendations of Malaria Programme Review, National Malaria Programme embarked on the road to "Malaria Free Nepal by 2026."

But, malaria stratification has to be tailored to suit the changing epidemiology of malaria in the country. Malaria-metric data from last five years reveal that even within a VDC, malaria is concentrated within some wards while other wards remain free. In these settings, transmission is typically sufficiently low and spatially heterogeneous to warrant a need for estimates of malaria risk at a community level, the wards. In order, to refine the risk stratification at the community level and thereby define the total population at risk of malaria; NMP recommended malaria risk micro- stratification at the wards level of the VDCs. Malaria Micro-stratification was conducted in all high and moderate risk VDCs of 25 districts and 10 % of low and no risk VDCs of other districts. The methodology used recent malaria burden data supplemented by information on the spatial distribution of key determinants of transmission risk including climate, ecology, and the presence or abundance of key vector species and vulnerability in terms of human population movement. The method was based on 2012 micro-stratification and it was recommended by Epidemiology and Disease Control Division (EDCD) and Malaria Technical Working Group (TWG). EDCD provided the overall oversight of the study.

Disease burden, geo-ecology & entomological risk, and vulnerability were given a defined weight and each ward received a response on the three determinants. The weightage response of each determinant for a ward was calculated and the summation of the three determinants was converted into percentage. A cut off percentage of 75 or more was agreed as the criteria to define a high risk ward.

High risk wards were identified in 54 wards scattered across 12 districts. Out of these high risk wards, 35 wards were in far-western development region, 11 in the mid-western development region, three (3) in the western development region, and five (5) in the central development region while no high risk ward was detected in eastern development region. Furthermore, moderate risk wards were identified in 370 wards in 27 districts (15 additional districts to the 12 districts that contained high risk wards) of these moderate risk wards, 149 wards were in the far western development region, 89 wards in the mid-west development region, 43 wards in the western development region and 63 wards in the central development region and 26 wards in the eastern development region. Malaria transmission is concentrated in the far western and mid-western development regions with these two regions accounting for more than 80 % high risk burden and around 65% moderate risk burden. Malaria is shrinking in Nepal and has currently reached low level of endemicity. Additionally, heterogeneity in infectious disease is likely to limit the infection further among certain vulnerable population and their community. Therefore as the country embarks on the path to elimination, it is recommended that micro-stratification be updated every year with the updated risk stratification being a requisite for an effective and efficient intervention.

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Background

Malaria is a priority public health problem of Nepal where approximately 50 % of the population is at risk of malaria (1). The population and the area at risk of malaria have been shrinking over the years primarily as a result of effective and successful malaria programme. Earlier the population living in a district was taken as the denominator but the most recent micro stratification, 2012 identified the population living in a VDC as the denominator. There are pockets of areas within the village with ongoing transmission of malaria while other areas within the village are not conducive for malaria transmission. The high and moderate malaria risk areas consist of foothills, forests fringe, forests in Terai and inner Terai valleys, whereas the low risk area consist of southern planes and northern hills/ hill river valleys.

The trend of confirmed malaria cases during the last three decades show fluctuations, with a peak in 1985 when the number exceeded 42,321, representing the highest malaria case-load ever recorded in Nepal (1). This was followed by a steep decline each year till date with a few major outbreaks in between. The last outbreak occurred in 2006 in the villages of Banke accounting for 36 deaths. Although clinical malaria cases increased during the early years of the control phase, mostly due to scale up and expansion of community based integrated management of childhood illness (CBIMCI) programme throughout the nation, yet implementation of appropriate modification in the guidelines and ensuring increased access to diagnosis and treatment of malaria has contributed to a gradual decreasing trend in clinical malaria during the last few years (108,179 in 2010 versus 20,861 in 2014/15). Total confirmed malaria cases declined by approximately 90 % over a decade (12,750 cases in 2002 versus 1352cases in 2014/15), while deaths have been reported a few in between 2011 till 2016 mostly imported cases. All 3 deaths reported due to malaria reported in 2016 were imported from Africa and India. The proportion of Plasmodium falciparum (Pf) infection accounts for around 20% while 80% of the total cases are Plasmodium vivax (Pv) infections. The proportion of imported cases shows increasing trend throughout the last five years, which is a major challenge for the current elimination program (1).

Nepal has achieved and exceeded the malaria target of the Millennium Development Goals (MDGs) and universal coverage of malaria control interventions, and the Roll Back Malaria (RBM) targets of 2010 (4). The country has made significant progress in controlling malaria transmission over the past decade. The gains are attributed mainly to a change in drug therapy from the custom sulphadoxime- pyremethamine (SP) therapy to Artemether and lumefrantine (AL), IRS in high-endemic foci, the distribution of LLINs in high-endemic areas, and other enabling factors such as strategic partnerships, socio-economic development and free health service delivery through government health institutions (2).

1. Introduction

In Nepal, the first malaria micro-stratification was limited to district level where a district was identified as the basic administrative unit. The population at risk of malaria was defined as the total population of the district. But, analyses of malaria information throughout the years from the districts do not support the view that the total population of the district are at risk since malaria is a focal disease and is usually seen in hard to reach population and marginalized community. Therefore, the most recent malaria micro-stratification, 2012 provided the insight of malaria risk at VDC level and this strategic information was very useful to the National Malaria Program to target effective interventions at VDCs level. The 2012 study concluded that 65 districts out of the 75 districts and about 80% of the total population were residing in areas at risk of malaria. It further streamlined that 1,254 VDC's in 40 districts were at high or moderate risk of malaria. Approximately 13.02 m populations (48% of total population) are living in malaria endemic areas. Among them, 0.98 million live in high risk areas (54 VDCs), 2.66 million in moderate risk areas (201 VDCs) and 9.37 million in low risk areas (999 VDCs). The high and moderate risk areas include foothills, forests fringe areas, forests in Terai and inner Terai valleys, whereas the low risk area consist of southern planes and northern hills/ hill river valleys (3).

A VDC may be geographically diverse and distinct in ecology and land use; people living in hill top settlement but working down in their fields in foothills and at times sleeping there to guard their crops, or some parts of the VDCs lying close to the forest while other parts of the VDC may be a day or two days walk from the forested area. Furthermore, the ecological and entomological context may be different in such a diverse geographical spread and generalization may not be appropriate since the hill tops sloping environment may not sustain mosquitoes because of low temperatures and fast moving streams despite adequate rainfall and humidity. However, the plain area in the foothills may be ideal for vector breeding with appropriate temperature and rainfall and slow moving streams. A review of malaria information since the last five years reveal that even within a VDC, malaria is concentrated within some wards while other wards are not affected at all. In order to refine the risk stratification at the community level and thereby define the total population at risk of malaria; NMP along with MTR 2013 recommended malaria risk micro- stratification to be done at the ward level of the VDCs. In addition, certain inherent limitations identified in the previous micro-stratification study and the recommendation to update the risk stratification every 2 to 3 years were to be addressed in the current proposed micro-stratification. The current micro-stratification would adopt and align the recommendations generated in earlier micro-stratification to further refine the risk at an even smaller administrative unit (3).

Determinants of Malaria Transmission: Transmission of malaria is dependent on the receptivity and vulnerability characteristics of an area. Receptivity is dependent on the presence and behavior bionomics of vectors, and ecological/climatic conditions favorable

for transmission of malaria. Vulnerability depends on the population movement to malaria risk/endemic areas, possibility of influx of malaria patients or vectors or the possibility of malaria parasite introduction. The pool of reservoir of infection in an area is determined by the level of disease burden – proportion of people infected in a year in a defined population.

Micro stratification is the study of the three critical factors that determine malaria transmission: disease burden (API)- confirmed malaria cases per 1000 risk population) in the last three years, receptivity (ecology)in an environment which support the vectors, vector behaviors and bionomics that define relative efficiency of the vector, and the duration of transmission; and lastly vulnerability in terms of population movement (3). The three key determinants are given weights to stratify the malaria risk. In this study receptivity (based on eco-environmental & entomological characteristics) was allotted 0.5, disease burden (based on average API) was allotted 0.3, and vulnerability (based on population movement) was allotted 0.2; a total of 1.0 was the maximum weight allotted for micro stratification.

Disease Burden: The disease burden was defined as the average annual parasite incidence (API) over a three year period (2014 to 2016). API was calculated as the number of confirmed malaria cases per year reported in the local health facility from the ward divided by the population of the same ward. If the reported average API of the ward during the period was more than 1 then the ward was classified as high burden. If reported average API during the period was more than 0.01 up to 0.99 then the ward was grouped as moderate burden, while wards with average API is 0 during the period were grouped as low burden. Malaria disease burden was defined as the average API of the ward (2014, 2015 & 2016) based on the number of confirmed malaria cases derived from line listing of the cases at the health facility (3). Disease burden received a total weightage of 0.3 (30%) out of the total micro stratification weight of 1.0. Within this allotted weight each wards received the following response score based on the API average of 2014-2016:

- High disease burden wards with average API more than 1.0 were allotted a response value of 1.
- Moderate disease burden wards with average API more than 0.01 up to 0.99 were allotted a response value of 0.6.
- Low disease burden wards with average API 0 were allotted a response value of 0.

Although the response value for disease burden ranged from 0 to 1, the overall allotted weight was 0.3, hence the weightage response value ranged from 0 to 0.3. If the weightage response of the ward was 0.3 (weight x response- 0.3x1 = 0.3), it was classified as a high disease burden ward. If the weightage response of the ward was 0.18 (weight x response- 0.3 x 0.6 = 0.18), it was classified as a moderate disease burden ward while if the weightage response of the ward was 0 (0.3 x 0 =0), it was classified as a low disease burden ward.

Receptivity: This determinant accounted for the climate, geo-ecology and vectors species prevalent in the ward. Climatic, topographical, and land use data were extracted from various sources including Department of Meteorology, Department of Survey and ICIMOD. An entomological cross sectional study was conducted in 2016 with representative sampling of sites from 5 different ecological zones. The data related to vector species and their behaviors were thus extrapolated mainly from this afore mentioned study (Table 1) and to some extent complemented by previous historical evidences (*see Annex 1)*. The receptivity was given an overall weightage of 0.5. Out of the total of 0.5 weight, 0.3 (60%) importance was given for geo- ecology & environment, while the entomological risk based on vector presence, breeding and behavior bionomics was allotted 0.2 (remaining 40%). Under ecology and environment, altitude, temperature, rainfall, presence of water bodies, forest coverage, development projects in the ward, and ecological zone classification were given consideration and value. Geo-environment component was allotted 0.25 except for ecological zone which was allotted 0.2 and entomological risk (based on vectors characteristics, behavior and bionomics and transmission potential) was allotted 0.2. Entomological risk of a ward was defined based on the ecological profile of the ward, if the major ecological setting of the ward lay in inner terai then it was grouped under inner terai and the response value for the vector species and their behaviors and entomological risk prevalent in inner terai given to that particular ward.

There are five ecological zones that were considered were: plain outer Terai, inner Terai (valley in between Shiwalik and Mahabharata ranges), hill, Middle Mountain and High Mountain. Due to various climatic factors and altitude, transmission potential of same species of vector varies accordingly in different ecological setting of Nepal. Combination of ecological zone, land use characteristics and presence of malaria cases were analyzed in GIS environment, to derive entomological risk of malaria transmission. The plain outer Terai VDCs was further subdivided into two categories, forest ecosystem (high transmission potential) and cultivated areas (low transmission potential) based on land use. Inner Terai was grouped as high or moderate transmission potential while the remaining three ecological zones were categorized under low transmission potential. Response weight was allotted to the ward based on the findings of the representative entomological study and historical evidences, wards with high transmission potential received a response value of 1, moderate burden wards received a response value 0.6 and low burden wards received a response value of 0.1. The total weightage a ward received in geo-environment & entomological risk was 0.5. The weightage response would therefore be in the range of 0 to 0.05.

Vulnerability: This determinant was measured in terms of population movement. Wards reporting regular movement of population to forest with overnight stay or wards that have ongoing development projects or resettlement activities were assigned a higher score in the vulnerability category. Wards reporting movement of people to high risk states of India and high risk VDCs of the country were assigned to moderate vulnerability category while wards

reporting population movement to endemic areas of the country as well as other countries but limited movement to forest were assigned to low vulnerability. Any wards with no population movement to non-endemic areas were classified as no risk. The overall weight allotted for vulnerability was 0.2. The response weight ranged from 0.1 to 1.0, and the response weightage's response would be in the range of 0.02 to 0.2.

2. Objectives

The primary objective of the micro-stratification study was to define the risk of malaria at the ward level of a VDC/Municipality, which is the basic unit of the community. This will also provide strategic malaria information on the total area and the population at risk of malaria. In addition to this, the study will provide ward level malaria information which will be instrumental in planning, monitoring and evaluating effective interventions especially in a scenario where Nepal has envisioned malaria elimination within the eight years. Effective targeted interventions at the ward level are efficacious and efficient mode of resource management because it will ensure maximum resource where it is required. The study ensured community participation with interaction with local people during on site field activities at the ward level for documenting eco - environmental situation of the wards. The study inadvertently helped build the capacity of national programme to conduct similar studies at regular intervals in future.

3. Methods

3.1 Questionnaire design:

The study team used the existing forms and formats developed in micro stratification 2012. However a minor modification was made in view of collecting wards level basic information required for the study. Basically, the ward level information in the Village Development Committee (VDC) questionnaire template was designed into two parts; the first part contained demographic, geo-ecological, meteorological, socio-economic and entomological information, whereas the second part contained malaria disease, diagnosis and treatment, classification, severity/death, and containment information including vector control. The team organized technical consultation meetings with EDCD and WHO Country Office for sharing of these documents. The questionnaires were reviewed by the technical working group (TWG) and endorsed by EDCD with appropriate suggested modifications.

3.2 Study Districts:

All 75 districts have been stratified previously into high, moderate, low and no malaria risk districts. The study districts are the high risk 15 districts and 10 moderate risk districts with expansion to any other district with ongoing malaria transmission (based on the data of last 3 years). In addition, 10% of low risk (40 districts) and no risk malaria (10 districts) districts were included in the study. Based on this method, a total of 32 districts were included in

the study, which comprised of 15 high risks, 10 moderate risks, 5 low risks and 1 no risk district. Baitadi district, an endemic malaria district was added in the study based on malaria data of last 3 years. Low and no risk districts were selected randomly. All low risk districts were listed in each region and a number was awarded to each district and a random number was generated from each region to select the district. One no risk district was selected in a similar fashion. A total of 31 districts were selected for the micro stratification study. EDCD led the process of selection of the districts.

3.3 Study Wards:

Each VDC/ municipality in the districts was further stratified as high, moderate, low and no malaria risk. Each VDC/municipality is divided into a number of wards and there are usually 9 wards in a VDC but in a municipality may contain upto 35 wards based on the population. This study defines the wards as the unit for micro stratification because this is the basic unit of community living in Nepal. A public health facility provides primary health care to the people of the VDC. The study VDCs/Municipalities in the districts were identified after reviewing the previous 3 year malaria information available at the DPHOs/DHOs. Malaria information at the DPHOs/DHOs was cross checked and verified with HMIS data. All the public health facilities providing health care service to the population of the VDCs/Municipalities of the district was mapped. Malaria information in each of the HFs for the last 3 years was collected and reviewed. The study wards are derived from the review of malaria information based on the average API of the last 3 years, the wards were categorized as: high risk, moderate risk, low risk wards. An on- site visit to record eco-environmental and entomological variables of all the high risk and moderate risk wards and 10 % of all the low and no risk wards of the district was conducted.

3.4 Study Protocol:

Each district was covered in 7 days and the central and regional teams provided orientation and support to the district team to prepare the district MS plan.

3.5 District Orientation:

Each team visited the district to orient the staffs of DPHOs/DHOs and discussed with VCO/VCI/MI and laboratory technician of the district and shared the experience of previous micro-stratification survey (2012). The formats were introduced to the district team and mock data practice was conducted by the Regional and Central team in DPHO/DHO. The formats for the study were disaggregated into 3 sections: basic information, malaria information, lab & entomology and others sections. Regional public health officer, laboratory technician and entomological officer covered basic information with malaria disease information, laboratory, and entomology (LLIN, IRS etc.) section respectively.

3.6 District Malaria Information Review

Regional statistical officer and the district team reviewed the last 3 years malaria data of the district (2014, 2015, and 2016). Each VDC/Municipality of the district was categorized based on review of malaria burden of the health facility providing health care delivery service to the area. This data was disaggregated to define the ward level malaria information. The lists of wards within the VDCs were finalized and maps of each ward secured from the District Development Office. Malaria morbidity and mortality data from local health facilities and district public health office and prior micro stratification results were discussed. Potential or ongoing new areas of malaria transmission were identified based on district reports and case and foci investigative reports. .

3.7 Malaria Information from Public Health Facility

District teams conducted on-site visit of the local health facility to verify the malaria information submitted by the facility and reviewed the line listings. Line listing of malaria cases during 2014, 2015 & 2016 were reviewed in detail and the wards were selected based on the address listed in the line listing. Regional teams facilitated the process and verified the malaria data and conducted random supervision and monitoring checks in selected wards.

The district team reviewed the malaria information available in the health facility of the last 3 years. The team verified the malaria laboratory register, malaria treatment register and HMIS 9.3 at the health facility. The team also observed the diagnostic methods, treatment practices and the method of case classification as indigenous or imported case.

3.8 Geo-ecology & Environmental Information of the wards

District teams with support from the staffs of local health facility conducted on site visit to the malaria risk wards of VDCs to collect eco-environmental and entomological variables, Facilities in the ward as, water resources, open tanks, ponds or other water bodies; forested area & percentage of forest coverage, and general lay out of the ward was observed and recorded. A brief interaction was made with local community and a general view of the ward and adjacent surrounding wards was obtained. This was important collect information on disease burden, development projects, migration patterns, and interventions practices (LLINs distribution, use/ washing and state of wear and tear, IRS practices). Every third day of the field trip, district statistical officer shared the district template with the central team and the regional team. This activity ensured monitoring the progress and identified the problems in the study.

3.9 Geo-ecology & Environmental Information

Information on climate and environmental situation of the wards were collected by the regional and central teams from the Department of Survey and Department of

Meteorology. Additional information was also collected by the central teams from ICIMOD and other relevant agencies.

4. Entomology Study

4.1 Entomological survey:

Entomology Survey was conducted in each developmental regions of the country representing ecological substrata i) outer plain terai, ii) Forest, forest fringe and hill, iii) inner Terai and iv) hill and hill upper river valley. At least one ward was randomly selected from each malaria risk area (high, moderate and low) but with representation of various ecological substrata (i.e. plain cultivated terai, forest and forest fringe, foot hill, inner terai and mountain and upper river valley) of five development regions. Altogether twenty five wards were selected for the study and at least five wards were selected from each development region. The wards were selected on the basis of micro stratification 2012 as well as the burden of malaria cases reported between 2012 and 2014.

4.2 Entomological Field techniques:

The following field methods were conducted during the study.

1. Indoor Hand Collection

2. Outdoor Hand Collection

3. Human landing/bait catches

4. Animal biting catches

5. Larval surveys

6. Entomological Laboratory techniques

The following laboratory techniques were used during the survey period

1. Identification of adult and larva of mosquito
2. Examination of abdominal condition
3. Salivary gland dissection for sporozoites and or preservation of specimen for ELISA
4. Ovary dissection for parity determination
5. Preservation of specimen for further investigation (cytogenetic study)
6. Blood meal identification (preservation of specimen for ELISA or precipitation test)

The study findings characterized the species and behavior bionomics of the vectors in five distinct ecological zones. This finding along with the findings of a national workshop conducted in 2013, “Entomological stratification of malaria transmission risk in different

ecological settings" was used to allot the entomological weight of a ward (see annex1). If the ward was grouped under the categorized ecological zone then it was presumed that the species akin to the ecological zone would be prevalent in the ward.

The study was conducted in each development region representing ecological substrata focusing on the basis of malaria cases reported during 2012 to 2014.

5. Data System

District level teams with the help and support of local VDCs/wards officials and health workers from the HFs collected the data in a paper format (MS Forms). Data were compiled in electronic version after verification of the data in the districts.

Separate Micro stratification formats were used for health facility and the study ward. The district teams with the support of regional teams conducted a detail review of malaria information of the health facility of the last 3 years. Line listings of the cases were reviewed and it was cross checked in the malaria case register. Only, cross checked data after data verification with line listings were utilized in the study. Central data bank was established in EDCD and electronic version of the data collected in each district was transferred to the center. Data form health facilities and the findings of the on-site ward visit was collected in a paper format. The district collated and compiled the malaria information received from the study team of the district in an Excel format at the district. Regional study team conducted cross checks and verified and validated the malaria information collected by the district study team in some random sites. District study teams then transferred MS data of the district to the central data bank. The central team consolidated the district data and reviewed the field reports from the regional teams. The central team then entered the data information in a standard template for compilation and validation of the collected data. This template was used for data cleaning and for validation. Feedback was then sent to the regional teams on regular basis to review and correct any incorrect data. The central data bank compiled the data for analyses. The flow of malaria information is outlined below.

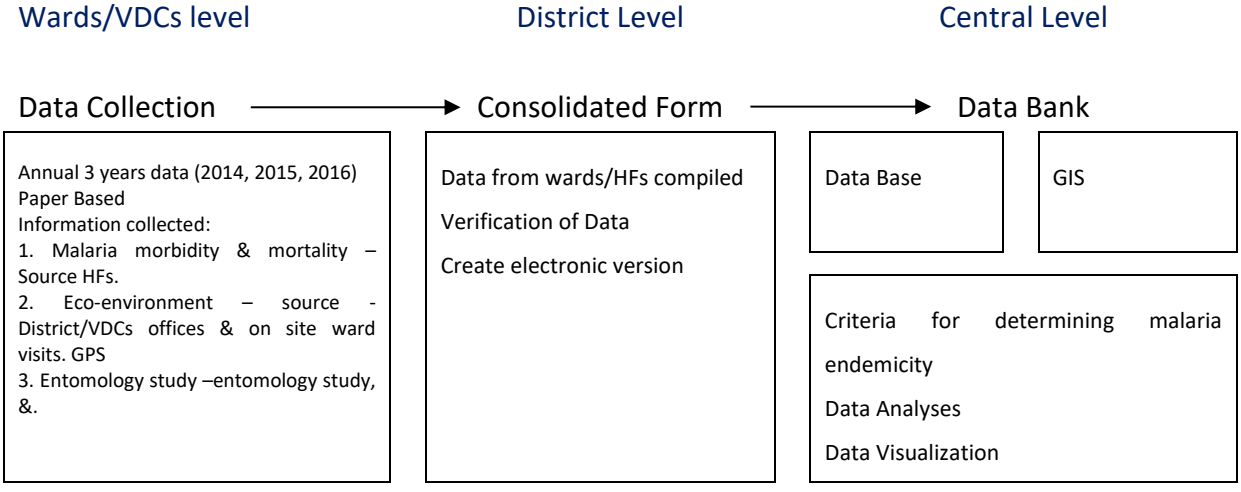

Figure 1: Malaria Information Flow

6. Study Teams

There were 3 teams formed for the study - central, regional, and district teams. The composition of the teams and activities were as follows**.**

6.1 Central Team:

The central team was chaired by the Director/EDCD, and the members of the team were chiefs of Disease Control and Epidemiology Unit/ EDCD and the Program Manager/ SCI Program Management Unit/EDCD. This was the apex body for the MS study. The staff of Disease Control and Epidemiology Units/EDCD, especially public health officers, VCOs/VCIs/MIs/and Entomological officer, Staffs from SCI/PMU team from SCI will provide the technical support

6.2 Regional Team:

There were 5 regional teams that went to Central, Eastern, Western, and Mid and Far Western regions. Each team included a Regional Surveillance Coordinator, Entomologist, Public health /Data assistant, and laboratory /entomology technician. They were responsible for collation of data collected by the district teams, verification and validation of data in randomly selected health facilities (data validation based on random selection) but covering high & moderate risk areas, and for recent ongoing transmission risk areas. Micro stratification was conducted in phases, keeping in view the current national context - phase 1: covered 16 districts and phase 2 covered the rest of the districts. Ideally, MS should have been conducted throughout the country but due to resource and time constraints, the study focused more on the 25 endemic districts (high & moderate risk) with a provision for expansion to VDCs where recent data (last 3 years) suggest ongoing transmission of malaria.

The teams reported to EDCD/SC Micro stratification team in the center at least once in 3 days and with the final report on the 10th day of their visit to the district. Entomologist with the help of technicians and other support staffs collected mosquitoes from at least five wards (from 2 high risks, 2 moderate risks and 1 low risk VDCs) from each Developmental Region and from recently identified ongoing transmission areas. The VDCs and wards were selected randomly and a total of twenty five to thirty wards was covered by the study. Entomologist identified the species by hand lens on site and later on confirmed by portable stereomicroscope.

6.3 District Team

The district of team members comprised of DPHO/DHO, Statistical Officer/Assistant, VCI/ /MI, and Lab Officer/ Assistants. The district had the latest version of the district profile. The forms were provided to the districts from the center and the districts provided the forms to the ward level study teams. They collected and reviewed three years (2014, 2015, 2016

VDCs wise, health facility based basic malaria information. Malaria data from health facilities was disaggregated and analyzed to identify the wards within a VDC, where cases of malaria were documented within the last 3 years. The potential wards for micro stratification (all wards within high & moderate risk and recent ongoing transmission in the VDCs of their district) were identified by the respective DPHO/DHO. The district team formed ward level teams; the number of teams depended on the number of study wards within the districts. Each team had to complete 2 study wards in a day, while in some hilly areas and difficult terrains further compounded by the monsoon could cover only one ward in a whole day. The staff from the nearest local public health facility and FCHVs from the concerned ward were involved in the process. The study team reviewed and verified malaria information for the last 3 years at the HFs based on the malaria lab register, malaria treatment register and consolidated reporting form (HMIS 9.3). The details were entered into the micro stratification forms. Local VDCs official and ward members were consulted for collecting basic information of the wards. The ward level information from each VDC was verified and consolidated into an electronic version in the district.

7. Monitoring

There were two tiers of robust monitoring activities that would ensure adequate checks in the study.

Monitoring Checklist:

a) HMIS data (2014, 2015, 2016)) and maps of districts/VDC (with wards clearly visible.

b) Electronic data collection gadgets - GPS. An onsite GPS coordinate including altitude was taken for all the wards visited during the study. This would aid the program develop maps using GIS in the future to help plan interventions and also study the pattern of transmission of malaria in the country. Furthermore it would help create heat maps of risk areas in the future based on disease transmission.

8. Data Analysis

The malaria risk stratification takes into account several key determinants of malaria transmission, disease burden (API- malaria cases per 1000 risk population) in the last three years; ecology that determines the presence of the vectors, relative efficiency of the vectors in malaria transmission, duration of transmission in ecological zones; and vulnerability in terms of population movement. The key determinants (termed as major variables) are given weights to stratify the malaria risk. Data analyses have been done by using Center for Diseases Control (CDC) tool to assess performance of ten Essential Public Health Services (EPHS). The methodology of assessment tool was adopted after discussion with EDCD to identify areas of malaria risk. GIS analyses were also done in ward basis. A ward was considered in a defined ecological zone, if major part of the ward fell in that zone. The same principal was applied in determining the land use of the ward as well. A special consideration was given to the ward which reported indigenous cases in 2016 but not in

2015 and 2014 keeping in mind the ongoing transmission of malaria in the ward. The ward with one indigenous case in each year or in any two years out of the total 3 years study period was re-evaluated based on receptivity and vulnerability factors.

8.1. Scoring Methodology for Micro-stratification of Malaria Risk

Each determinant was allotted a weight and a response value to the determinant, weightage response value of the determinant was calculated by multiplication of the weight and response value. These weighted values were combined to construct the overall risk score. This methodology was implemented through three steps. Both qualitative and quantitative variables were converted to qualitative variables. A four-point, Likert-type response, was assigned to each variable. The variables and weight considered for the micro stratification was finalized after discussion with EDCD and TWG/Malaria. The variables and the weight were identified as follows: (i) average API with "0.3" wt.; (ii) transmission risk (receptivity) with "0.5" wt. (iii) and population movement (vulnerability) with "0.2" wt (Table 1).

Table 1: Overall Scoring of Malaria Risk

Level	Overall risk	(Sum of Wt. of variable and Response of variable)* 100	
Indicators : Weight (wt.)	Disease Burden (0.3)	Ecology (0.5)	Vulnerability((0.2)
Variable : Response weight High (1.0) - **H** Mod (0.6) - **M** Low (0.1) – **L** No (0.0) - **N**	**Annual Parasite Incidence in three years** Average API > = 1.0 – **H** Average API is 0.01 to 0.99 – **M** Average API is 0 – **L**	**Transmission risk Combination of geo-ecosystem & vector species** (Refer Annex 4)	**Population movement :** Movement to: 1. forest with overnight stay, and development projects: roads/damn construction/ re-settlement **– H,** 2. high risk districts of the country and to 11 states from India **– M,** 3. endemic districts, endemic countries, and limited movement to forest **– L ,** 4. Non-endemic areas of the country and abroad**– N.**

8.2 Operational definition of risk

Risk definition was formulated by EDCD team for identification of malaria risk (3). Overall score range from 0 to 100%, which was classified into four categories based on operational definition of malaria risk.

No Risk: No evidence of malaria transmission including in the last three years; ecology is not favorable for transmission (e.g., urban areas; high altitude areas); there may be cases but imported from other areas. A ward is considered no risk if overall score is (0.2*1)*100 = 20% or less.

Low risk: Evidence of transmission, but no indigenous case in the last three years; average three-years API = 0; malaria risk is present due to favorable ecology or evidence of presence of vectors, and there is movement of population to/from malaria endemic areas. A ward is considered low risk if overall score is (0.2*1+0.4*1)*100 = 60% or less.

Moderate risk: Evidence of transmission and presence of indigenous cases in the last three years; average three-year API is less than 1/1,000 population; malaria risk is present due to favorable ecology or presence of vectors, and there is movement of population. A ward is considered moderate risk if overall score is (0.2*1+0.3*1 +0.25*1)*100 = less than 75 % or less.

High risk: Evidence of ongoing transmission and there are indigenous cases in the last three years; average three-year API = equal to or greater than 1/1,000 population; malaria risk is present due favorable ecology and /or presence of vectors and there is population movement. A ward is considered high risk if overall score is (0.2*1+0.3*1 +0.5*1)*100 = 100% or less.

A cut off percentage of overall score of 75 % or more was defined as high risk wards, wards with 60 % or more but less than 75 % were defined as moderate risk, and wards with 20 % or more but less than 60 % were defined as low risk and wards with less than 20 % were defined as no risk wards.

9. Results and Discussion

Malaria micro-stratification was conducted in 2012 to identify risk of malaria at the VDC level to ensure effective targeted interventions to achieve the vision of "Malaria Free Nepal by 2026". The study had recommended ward wise micro-stratification to generate strategic information for informed decision making and to validate the risk factors. The malaria risk stratification was based on three key variables: disease burden (API –malaria cases per 1000 risk population) in the last 3 years, receptivity (ecology) that determine the presence of the vectors, relative efficiency of vectors in malaria transmission, duration of transmission in ecological zones and vulnerability means population movement in risk areas. This ward level stratification study can be used to verify the previous VDC level study, define the risk areas and provide the strategic information for informed decision making for planning and implementation of interventions at ward level.

9.1 Disease burden:

The burden of malaria in a ward was derived from review of 2014 -2016 malaria data from the local health facility. Based on the average API of recent three years(2014 -2016), wards with average API one or more were defined as high disease burden, wards with average API more than 0.01 up to 0.99 were defined as moderate disease burden, and wards with

average API of 0 were defined as low disease burden. Based on the disease burden of the ward (average API of recent three years, 2014 -2016. wards with response weightage of 0.3 were defined as high disease burden, wards with response weightage of 0.18 were defined as moderate disease burden, a wards with response weightage of 0.0 were defined as low to no disease burden.

9.2 Receptivity:

The vectors bionomics and their behaviors and transmission potential are determined by the geo - ecological setting, which has profound influence on their reproduction and sustainability. The country is divided into 5 distinct ecological zones such as Plain outer terai, inner terai, hills and river valleys, Middle Mountain and High Mountain. The plain outer terai is subdivided into two categories, forest ecosystem with high transmission potential and cultivated areas with low transmission potential. Inner terai has a high and moderate transmission potential of same species of vectors and is dependent on different ecological settings. While high and middle mountains do not support vectors, some hills and river valleys areas sustain malaria transmission.

Based on the geo-ecology, vectors and land use, wards with response weightage of 0.5 were defined as high transmission potential, wards with response weightage of 0.3 were defined as moderate potential, and wards with response weightage of 0.05 were defined as low transmission potential.

9.3 Vulnerability:

The third determinant factor for risk transmission is vulnerability measured in terms of population movement. If there is a regular movement to forest (with overnight stay) or has ongoing development project or resettlement activities, those are assigned high vulnerability category. Movement to high risk states of India or other countries like Africa and high risk VDCs within the country is assigned to moderate vulnerability category, movement to endemic areas of the countries or other countries and limited movement to forest are assigned low vulnerability and movement to non-endemic areas are categorized no risk.

Based on the criteria defined above, wards with response weightage of 0.2 were assigned as high vulnerable, wards with response weightage of 0.12 were assigned moderate vulnerable and wards with response weightage of 0.02 were assigned as low vulnerable.

9.4. Result (Overall risk):

The results of this study were based on summation of scores of each determinant that the ward received. The three determinants and their weight were - disease burden with weight of 0.3, receptivity (geo-ecology) with weight of 0.5 and vulnerability with weight of 0.2. Based on this analysis, a ward with a score of 75% or more was categorized as high risk, a

ward with a score of 60 % or more was categorized as a moderate risk ward, a ward with a score of more than 20 % but less than 60% was categorized as low risk, and a ward with a score of 20 % or less was categorized as no risk.

The study revealed that a total of 29,433 out of a total 31,550 wards were found to be at some level of risk of transmission. Out of these, 54 wards in 28 VDCs of 12 districts were at found to be at high risk (0.17% of total risk wards), 370 wards (1.17% of total risk wards) across 127 VDCs of 27 districts (including the 12 high risk districts) were categorized as moderate risk and 29,009 wards (91.94% of total risk wards) were categorized as low risk wards whereas the remaining 2117 wards (6.70% of total risk wards) came under no risk categories. Based on the latest population census, a total of 169,747 people (0.60%) live in high risk wards, similarly 1,357,723 people (4.83%) live in moderate risk wards and 2,39,60,215 people (85.30%) live in low risk wards and 25,99,694 (9.25%) live under no risk wards.

At a Regional level approximately 85% of the High Risk Wards were found in Far Western Development Region and Mid-Western Development Region. Among the 54 high risk wards, 35 wards (64.81%) were in Far Western Development Region alone with the remaining 11 wards (20.37%) in Mid-Western Development Region, 5 wards (9.26%) in Central Development Region and 3 wards (5.56%) in Western Development Region (WDR). The Eastern Development Region did not have any high risk wards.

Due to reliability issues in the data reported through the HMIs as well as the non-availability of line listing of all the confirmed cases several criteria was put in place. A ward where malaria information of 2015 and 2014 was not available for review (eg. Baitadi district, Maharudra wards no.8), however, there was an ongoing most recent transmission (i.e in 2016) or where a focal outbreak had occurred was straight away classified as high risk because there was an ongoing transmission with API of most recent year suggesting a focal outbreak in the ward. Wards with indigenous cases in all 3 years, wards with indigenous case in 2 out of 3 years, and wards with imported cases with evidence of probable introduced cases were categorized as moderate risk. A ward with a single indigenous case in each of the three years was classified as moderate risk although it may have been a misclassified case; yet since only 75 % – 80 % line listings were available and people seek care outside the public health facility; it was more prudent to be over-cautious since the goal was getting to zero indigenous case by 2020 (recently revised goal that the earlier 2022).

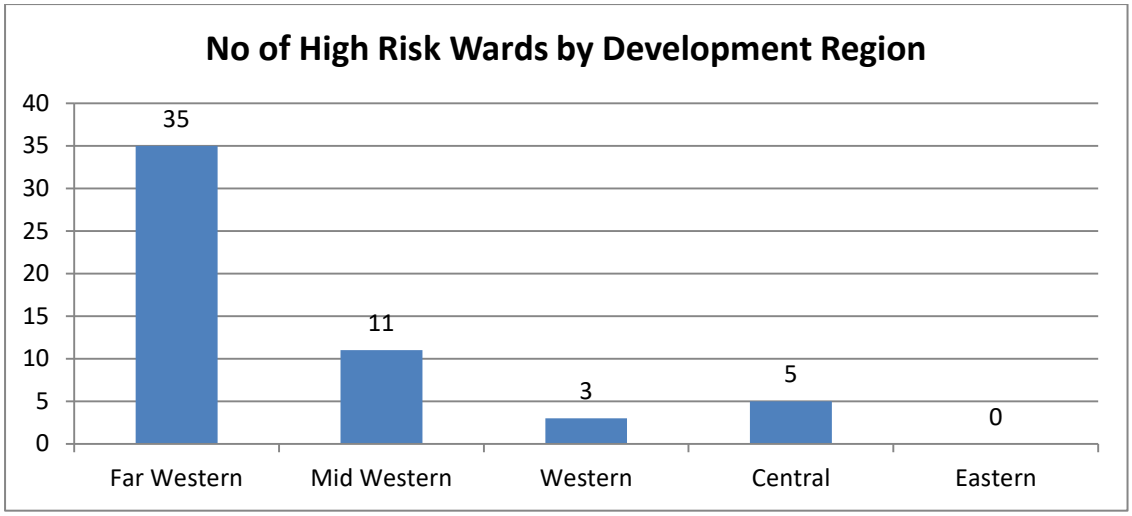

Figure 2: Number of high risk wards by development regions

Among the total 370 moderate risk wards, Far Western Development Region had 149 moderate risk wards (40.27 %), Mid-Western Development Region had 89 moderate risk wards (24.05%), Western Development Region had 43 moderate Risk wards (11.62%), whereas Central Development Region had 63 moderate risk wards (17.03%), and Eastern Development Region had 26 Moderate Risk Wards (7.03%). The highest numbers of moderate risk ward were found to be concentrated in the Mid and Far Western region of Nepal (64.32%) suggesting the major risk in these areas as well as additional targeted interventions. The Eastern region had the least number of moderate risk wards, however in the past there were some high risk districts in this region with periodic focal outbreaks. (Figure no 3).

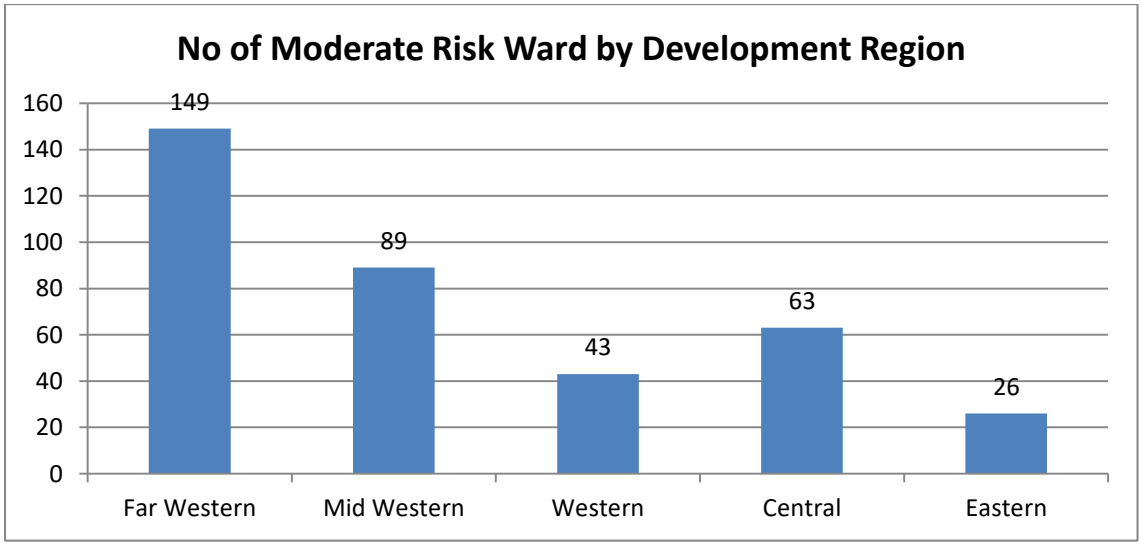

Figure 3: Number of moderate risk wards by Development regions

The total population at high and moderate risk of malaria is 1,527,468 (see table), living in 424 wards in 27 districts.

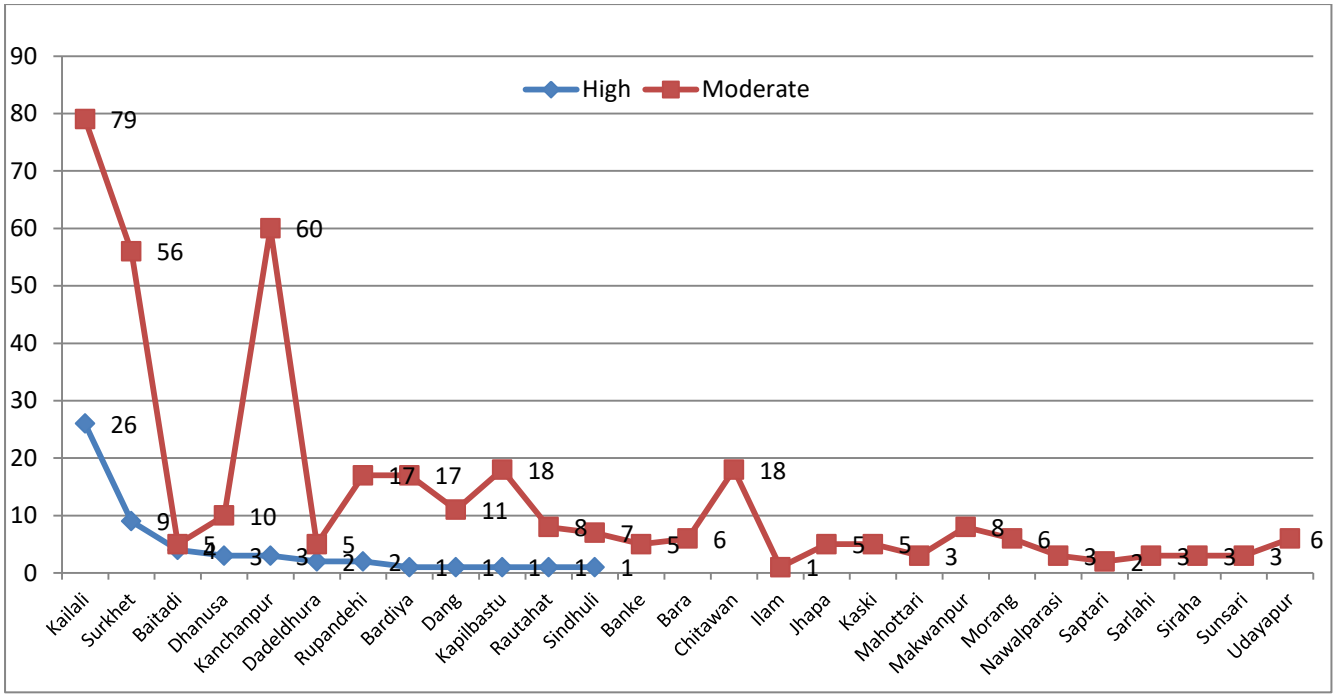

Figure 4: Number of high and moderate risk wards in the districts

Among the total 29,009 low risk wards in the country, EDR has 6,449 wards (22.23%), CDR has 8,728 wards (30.09 %), WDR has 6,749 wards (23.27%), MWDR has 4,011 wards (13.83%), and FWDR has 3,072 wards (10.59%). Total malaria risk wards categorized as high, moderate, low and no risk wards with VDCS by Development Regions is shown in table 3 and 4 with the population at risk .

Table 2: Risk Population wards wise by 5 Development Region

Region	N0. of districts	High Risk		Moderate Risk		Low Risk		No Risk		Total	
		wards	Population.	wards	Population	Wards	Population.	wards	population	wards	population
Eastern	16	0	0	26	104337	6449	5824444	720	247737	7195	6176518
Central	19	5	16186	63	268995	8728	7751164	467	2182589	9349	10218934
Western	16	3	14774	43	156421	6749	5035896	264	18636	7079	5225727
Midwestern	15	11	34933	89	184175	4011	3388633	666	150732	4777	3758473
Far western	9	35	103854	149	643795	3072	1960078	0	0	3150	2707727
Grand total	75	54	169747	370	1357723	29009	23960215	2117	2599694	31550	28087379

Projected population data taken from census 2011 CBS

Among the total 54 high risk wards within 28 VDCs in 12 districts, 35 wards (64.81%) are in 12 VDCs of FWDR, 11 wards (20.37%) are in 9 VDCs of MWDR. While FWDR and MWDR have 84% of high risk wards, only 8 high risk wards (14.8 %) are in WDR and CDR. EDR does not have a high risk ward. Among the total 370 moderate risk wards scattered in 127 VDCs of 27 districts, 149 wards (40.27%) are in 30 VDCs of 4 districts in FWDR, 89 wards (24%) are in 36 VDCs of 6 districts in MWDR, 43 wards (11.6 %) are in 24 VDCs of 4 districts in WDR, 63

wards (17%) are in 21 VDCs of 6 districts in CDR, and 26 wards (7%) are in 16 VDCs of 7 districts in EDR. The total high and moderate risk malaria wards in this study are scattered in 127 VDCs in 27 districts (see Table 2 and Annex 2).

9.5 Discussion

Earlier stratification of malaria was conducted in the district as the district was taken as the basic unit and the population at risk of malaria was defined as the total population of the district. But consistent review of malaria information from the districts reveal that only some areas within the districts reported malaria case while other areas within the districts remain relatively free of malaria. The recommendations of an internal review by the National Malaria Programme (NMP) in 2010 and an External Programme Review in 2013, confirmed the changing malaria landscape in Nepal. This was further confirmed by the results of a micro-stratification study to define the areas and populations at risk in 2012. The 2012 micro stratification study provided the evidence of transmission of malaria at VDCs level, and provided insights on malaria risk at VDC level, and confirmed the shrinking malaria map thereby enabling NMP to target effective interventions in VDCs. The stratification of 2012 had categorized the endemic areas into 54 high risk VDCs, 201 moderate risk VDCs and 999 low risk VDCs across 65 districts. The remaining 10 districts had been categorized as no malaria risk districts (3).

But, review and analysis of malaria data from the last five years reveal differential malaria risk even within VDCs and provide support to the changing epidemiology of malaria in the country. The burden of malaria is on the decline in Nepal and has now approached a stage of low endemicity. NMSP (2014-2025) and the MTR (2013) recommended malaria risk micro-stratification to be done up to the wards (smallest administrative unit) with the key population at risk of malaria identified as the total population living in the ward where transmission of malaria is ongoing or possible.

As the number of malaria infections decline further during the years, heterogeneity of malaria infection is more likely with infection localized in certain demographic areas and among vulnerable population such as marginalized people, migrants and mobile groups. Ward wise micro-stratification 2016 confirmed the potential of transmission of malaria in localized, focal areas of the malaria risk VDCs, the wards. The malaria risk areas identified at the wards level show that 54 wards of 12 districts are in high risk, 370 wards of 15 districts, in addition to the 12 districts are in moderate risk districts. Rest of the wards of the 27 districts and the wards of other districts are either classified as low or no malaria risk.

About 67% of high and moderate risk wards are located in FWDR and MWR which is in conformity to the disease burden seen in the country. Although it is difficult to compare previous VDCs wise micro-stratification 2012 data with the current wards based micro-stratification 2016 data because the basic unit and the population has shrunk, yet it confirms a decline of malaria burden in the country. But, the wards based micro-stratification 2016 data localizes focal areas within a VDC where transmission of malaria is

ongoing. This is particularly of importance not only to confirm the decline of malaria burden in the country but also to implement effective and efficient targeted interventions in the area. The population at risk of malaria decreased by 63.79% from the 2012 study, primarily due to the shrinking of malaria map in the country and less number of people resides in a ward as compared to the population that live in a VDC/municipality**.**

Despite the 27 districts fostering the majority of the high and moderate risk wards, the current climate change, constant migration of population and the possible adapting capacity of the primary vectors the remaining 38 districts where low risk areas are present also pose an intermittent threat for future outbreaks. With the country heading into elimination by 2026 as per the revised timeline, it is imperative that the program focuses interventions primarily on the endemic districts, however, on the other side be vigilant and cautious of the remaining 38 receptive districts through strengthened case based surveillance. Even the limitations of quality and complete data needs to be addressed very soon to ensure that all risk areas are identified and all active foci being cleared.

It is recommended that with a substantial decline and shrinkage of malaria transmission in the country, universal coverage should be scaled up to cover the high and moderate risk malaria wards. This would ensure effective coverage of areas where transmission of malaria is ongoing and pave the way towards elimination by potentially reducing and ultimately interrupting transmission of malaria in the country. Further studies will need to be done to refine the risk areas on a periodic basis.

10. Limitations

- Routine recording and reporting of malaria cases through HMIS (DHIS 2), EWARS and MDIS systems do not cover most of the private health facilities such as private clinics and hospitals, medical colleges, and other private sectors, so underestimate of malaria disease burden is likely.
- Line listings of malaria cases during the 3 years were available for only 75 – 80% of total reported cases. This may have impact on weights allotted to disease burden of some wards. While recent year (2016) data reveal indigenous cases but lack of earlier data (2014, 2015) may have impacted award to be classified as low because the weight of disease burden was defined as the average API score of three years. Since NMP is moving towards the vision of Malaria Free Nepal by 2026, indigenous case was allotted higher weight than imported case. This may have impacted some wards with single indigenous case every year to be classified as moderate while other wards as low risk despite more malaria cases but mostly imported cases.
- Entomological information is limited to a few representative ecological strata and the study relied on historical evidence from earlier study to complement the limitations. The adverse effects of large scale use of insecticides in agriculture and the impacts of global warming and climate change on vector bionomics and behaviors is lacking.

- Wide availability and proper use of various SOPs in the health facility level is lacking and case classification is not standardized in the health facilities. Some misclassification of cases may have impacted the outcome of the study.
- Clinical malaria cases from the public and private hospitals, medical collages, clinics and pharmacies are not reported and may contribute to underestimate of malaria burden in the country.
- It is possible that some wards may have been a misclassified in a lower category if people sought medical care in areas outside their local health facility;

11. Conclusion and Recommendation

Previous strategic information (2012 micro-stratification) had been used for guiding an efficient, cost effective and comprehensive program in the community at the level of VDCs that may have contributed to the decline of malaria burden and risk population in the country. This current study is more informative and specific with analysis of transmission of malaria at the basic administrative level, i.e. the wards. The information derived from the study may be useful for informed decision making to plan and implement an effective and efficient program targeted towards elimination. As the dynamics of malaria epidemiology is changing in the country, the area at risk of malaria may change continuously so it is recommended that regular micro-stratification should be conducted every year based on the disease burden in the most recent year. Following recommendations are given below.

1. Every year NMP should review and update micro-stratification at ward level or below to make it more specific.
2. Community level case diagnosis, treatment, surveillance and program intervention should be more focused through local government especially in mid-western and far western region.
3. Entomological survey should be conducted to cover all geographical areas of Nepal
4. Increased access to early diagnosis and treatment in all public and private hospital and clinics should be ensured, and the data from all settings should be made accessible for monitoring purposes
5. Case Surveillance and classification of cases should be strengthened and foci investigation and outbreak should be linked with entomological information
6. All positive cases should be notified in both public and private sectors, all confirmed cases should be investigated and classified, geo reference of the case should be recorded using GPS.
7. Computerized data base system should be strengthened with link to GIS map and immediate locally response mechanism should be developed.
8. Suggestions for key surveys and research studies
    - Mapping of all cases by indicating ward or Village or Tole
    - KAP Survey to increase public awareness and support for the programme.

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13. Annex

Annex 1: Entomological stratification of malaria transmission risk in different ecological settings

Entomological stratification of malaria transmission risk in different eco-zones											
Eco-Zones	**Vector/s**	**Seasonal prevalence/months**			**Host performance**	**Biting rhythm hrs**			**Resting and feeding behavior**	**Breeding habitat**	**Susceptibility to insecticides**	**Transmission risk ***
		Start	**Peak**	**End**	**Anthrophilic or Zoophilic**	**Start**	**End**	**Peak**				
Outer Terai Plain cultivated land(Rice ecosystem)	An. anularis	March	Aug	Nov	Zoophilic	7:00 PM	5:00 AM	11:00PM	Endophagic Exophilic	Pond, paddy field	Resistant to DDT,BHC& Susceptible to OP & Synthetic pyrethroids	Low Risk
Outer Terai Forest fringe ,Forested & foothills (Fluvieco-System)	An. Fluvitialis	Feb	May	Dec	Indiscriminate (Anthrophilic or Zoophilic both)	7:00 PM	5:00 AM	10:00PM	Endophagic-exophilic, or exophagic-exophilic	Slow running,clear water with marginal and emergent vegetation	Susceptible to all insecticides	High (Perenneal transmission and High to moderate transmission)
	An. maculatus	Feb	May	Dec	Zoophilic	6.00 PM	2:00 AM	9:00 PM	Endophagic Exophallic	Slow running, clear water with marginal, emergent vegetation & shallow rice field	Susceptible to all insecticides	Low Transmission
Inner Terai (Forest ecosystem)	An.fluviti	Feb	Mar-April, Oct-Dec	Dec	Indiscriminate (Anthrophilic or Zoophilic both)	7:00 PM	5:00 AM	10:00PM	Endophagic-Exophilic, or Exophagic-Exophillic	Slow running, Clear water with marginal and emergent vegetation	Susceptible to all insecticides	High (Perenneal transmission)&High to moderate transmission An
	An. maculatus	Feb	May	Dec	Zoophilic	6.00 PM	2:00 AM	9:00 PM	Endophagic-Exophallic	Slow running, Clearwater with marginal, emergent vegetation shallow rice	Susceptible to all insecticides	Moderate to Low

										field		
Hills &hills river valleys (Hill river-ecosystem	An. fluvitialis	Mar	Aug	Oct	Indiscriminate	7:00 PM	5:00 AM	10:00PM	Endophagic-Exophilic,or Exophagic-Exophilic	Slow running ,clearwater with marginal and emergent Vegetation	Susceptible to all insecticides	Low (Transmission period short)
	An. maculatus	Mar	Aug	Oct	Zoophilic	6:00 PM	2:00 AM	9:00 PM	Endophagic-Exophillic	Slow running, Clearwater with marginal, emergent vegetation	Susceptible to all insecticides	Low (Transmission period short) – July -oct.
Mountain and upper rivervalleys Hills-River – ecosystem	An. maculatus	Jun	Aug	Sept	Zoophilic	6:00 PM	2:00 AM	9:00 PM	Endophagic-Exophillic	Slow running, Clearwater withmarginal, emergent vegetation & (terrace type of farming)	Susceptible to all insecticides	(Transmission period very short (July-sept) Low

Annex 2: VDCs and ward wise risk status

Region	High Risk			Moderate Risk			Low Risk			No Risk		
	Districts	VDCs muni	Wards	Districts	VDCs muni	Wards	Districts	VDCs muni	Wards	Districts	VDCs muni	Wards
Eastern	-	-	-	7	16	26	7	674	6449	2	80	720
Central	3	5	5	5	22	63	8	900	8728	3	35	467
Western	2	2	3	2	26	43	10	683	6749	2	29	264
Midwestern	3	9	11	1	33	89	8	391	4011	3	75	666
Far western	4	12	35		30	149	5	293	3072	0	0	0
Total	12	28	54	12+15	127	370	38	2941	29009	10	219	2117

Projected population data taken from census 2011 CBS

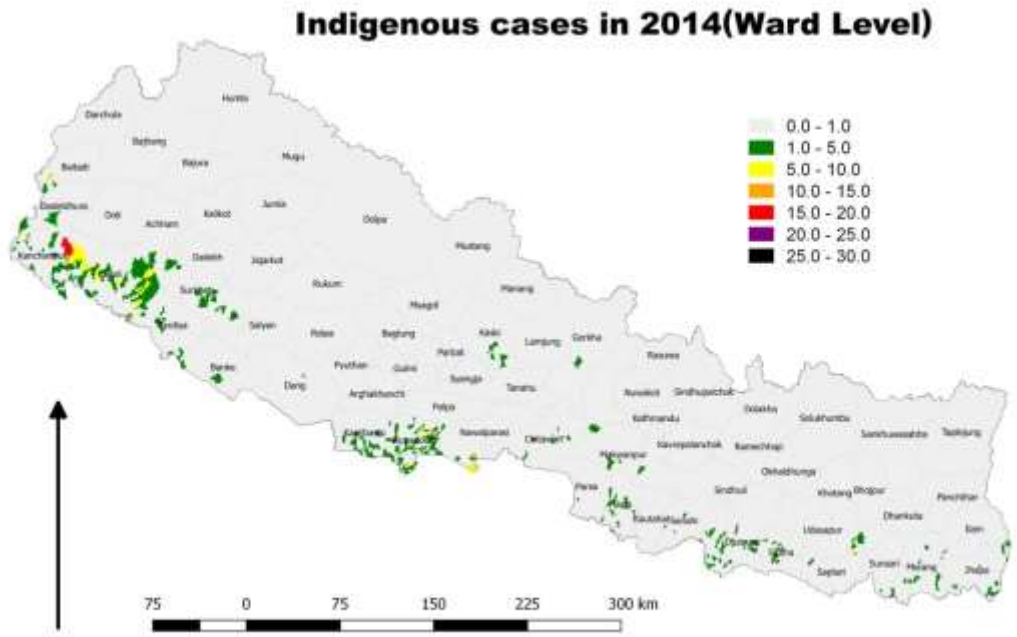
Annex 3: Vector Species Identified (Entomological) Survey (May 2016-May 2017) Region Wise

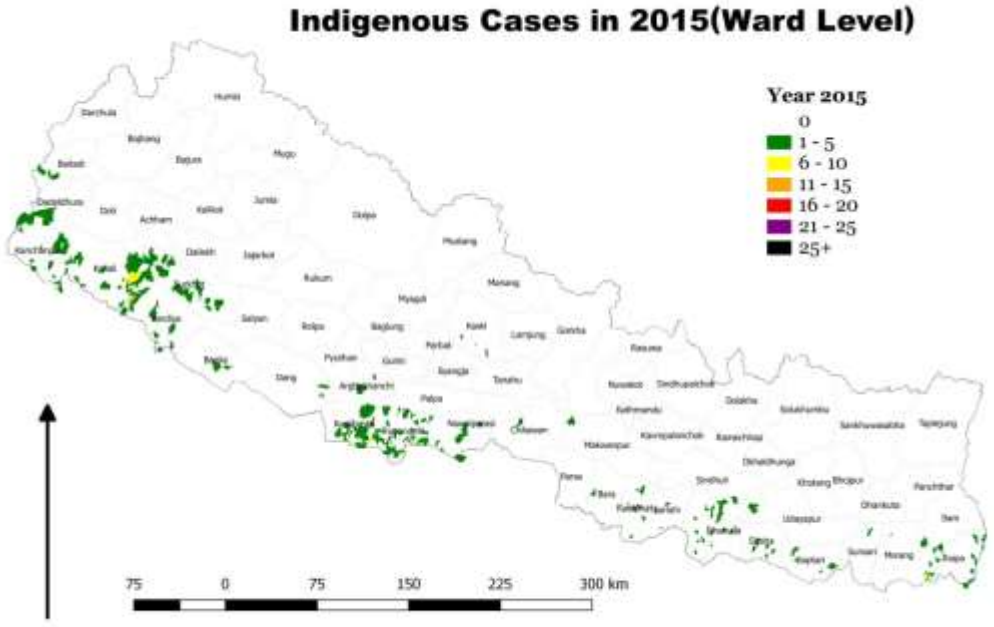
S.N.	Region	Topography	Study site & period of Survey	Anopheles mosquitoes collected	Pre-dominant Species	Established malaria vectors of Nepal recorded during the survey	Major Breeding Places
1	**Central**	**Inner Terai**	*Meghauli VDC W.N. -3, Chitwan May 28, 2016 to June 5, 2016*	▪ *An. Culicifacies* ▪ *An. vagus* ▪ *An. annularis* ▪ *An. fluviatilis* ▪ *An. splendidus,* ▪ *An.peditaeniatus*	*An. Culicifacies*	*An. annularis* *An. fluviatilis*	*River margin and Ground pool*
2	**Eastern**	**Forest, forest fringe and Hill**	*Kerabari VDC W.N. 1-8, Morang* *June 13 - 19, 2016*	▪ *An. Culicifacies* ▪ *An. vagus* ▪ *An. annularis* ▪ *An. pseudowillmori*	*An. vagus*	*An. annularis*	*Stream; irrigation canal, ground pool*
3	**Mid – western**	**Forest, forest fringe and Hill**	*Baniyabhar VDC W.N. 2, Bardiya* *22 June - 28 Jun , 2016*	▪ *An. Culicifacies* ▪ *An. vagus* ▪ *An. annularis* ▪ *An. fluviatilis* ▪ *An. splendidus,* ▪ *An. subpictus*	*An. culicifacies*	*An. fluviatilis* *An. annularis*	*River margin, irrigation canal and Ground pool*
4	**Western**	**Inner terai**	*Tamasariya VDC ward # 4, Amrasa (Madhya Bindu Municipality W.N. 7), Nawalparasi July 5, 2016 to July 11, 2016*	▪ *An. Culicifacies* ▪ *An. vagus* ▪ *An. annularis* ▪ *An. fluviatilis* ▪ *An. splendidus,* ▪ *An. subpictus* ▪ *An. pseudowillmori*	*An. vagus*	*An. fluviatilis* *An. annularis*	*stream, irrigation canal, paddy field and Ground pool*
5	**Western**	**Forest, forest fringe and Hill**	*Shivpur VDC, Baluhawa village W. N. 9, presently W.N. 2 of Shivraj municipality , Kapilbastu* *September 27, 2016 to October 3, 2016*	➢ *An. nigerrimus* ➢ *An. Culicifacies* ➢ *An. vagus* ➢ *An. fluviatilis* ➢ *An. annularis* ➢ *An. pseudowillimori* ➢ *An. aconitus* ➢ *An. barbirostris* ➢ *An. tesselatus*	*An. nigerrimus*	*An. fluviatilis* *An. annularis*	*River, irrigation canal, paddy field*
6	**Far-western**	**Hill and Hill**	*Sugarkhal VDC*	➢ *An. fluviatilis* ➢ *An.*	*Anopheles*	*An. fluviatilis*	*Seepages, streams*

S.N.	Region	Topography	Study site & period of Survey	Anopheles mosquitoes collected	Pre-dominant Species	Established malaria vectors of Nepal recorded during the survey	Major Breeding Places
		river valley	*W.N. 7 and 8, Kailali* *October 23 – 29 , 2016*	*pseudowillimori* ➢ *An. willmori* ➢ *An. subpictus* ➢ *An. fluviatilis* ➢ *An. tesselatus* ➢ *An. jemsai*	*fluviatilis*	*An. annularis* *An. willmori*	*and river*
7	**Central**	**Plain cultivated Terai**	*Manahari VDC W.N. -2, Makawanpur* *02/01/2017 to 08/01/2017*	▪ *Anopheles fluviatilis* ▪ *An. annularis* ▪ *An. pseudowillimori* ▪ *An. peditaeniatus* ▪ *An. vagus* ▪ *An. culicifacies* ▪ *An. umbrosus* *An. Culiciformis*	*An. annularis*	*An. fluviatilis* *An. annularis*	*Ground pool and irrigation/field canal*
8	**Central**	**Plain cultivated Terai**	*Bhawanipur (Gadhimai Municipality-Bara)* *02/01/2017 to 08/01/2017*	▪ *Anopheles fluviatilis* ▪ *An. annularis* ▪ *An. pseudowillimori* ▪ *An. peditaeniatus* ▪ *An. vagus* ▪ *An. culicifacies* ▪ *An. umbrosus* ▪ *An. culiciformis*	*An. Annularis*	*An. Fluviatilis* *An. annularis*	*Irrigation canal, ground pool,* *river margin*
9	**Central**	**Forest, forest fringe and Hill**	*Tulsichaura, Dharkhola, W.N. 1, Mithila NP* *10 – 15 April, 2017*	▪ *Anopheles fluviatilis* ▪ *An. annularis* ▪ *An. pseudowillimori* ▪ *An. barbirostris* ▪ *An. vagus* ▪ *An. culicifacies* ▪ *An. tessellatus* ▪ *An. jemsai*	*An.culicifacies*	*An. fluviatilis* *An. annularis*	*Seepages, pond, field canal and river*
10	**Central**	**Forest, forest frnge and Hill**	*Kalapani, Bardibas NP, Mahottari* *10-15 April, 2017*	▪ *Anopheles fluviatilis* ▪ *An. annularis* ▪ *An. pseudowillimori* ▪ *An. barbirostris* ▪ *An. vagus* ▪ *An. culicifacies* ▪ *An. tessellatus* ▪ *An. willmori*	*Anopheles fluviatilis*	*An. fluviatilis* *An. annularis* *An.willori*	*Irrigation canal, ground pool, rice field, streams and river*
11	**Eastern**	**Forest, forest fringe and Hill**	*Indreni, Bahundangi VDC W..N. 1; Jhapa* *14 – 20 March, 2017*	▪ *Anopheles fluviatilis* ▪ *An. annularis* ▪ *An. pseudowillimori* ▪ *An. jeyporensis* ▪ *An. vagus* ▪ *An. culicifacies* ▪ *An. tessellatus* ▪ *An. jemesii* ▪ *An. pallidus*	*An. psudowillmori*	*An. fluviailis* *An.anaris*	*Seepage, Irrigation canal, ,streams and river bed*
12	**Eastern**	**Forest,**	Panmara, Dharan	▪ *An. Culicifacies* ▪ *An. vagus*	*An. vagus*	*An. pseudowillmori*	*Irrigation canal*

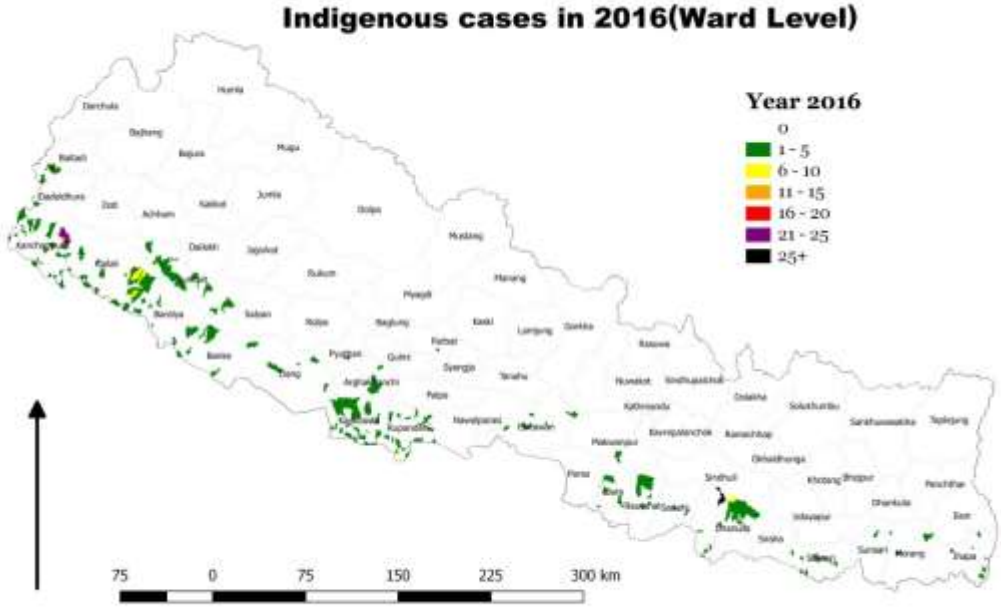
S.N.	Region	Topography	Study site & period of Survey	Anopheles mosquitoes collected	Pre-dominant Species	Established malaria vectors of Nepal recorded during the survey	Major Breeding Places
		forest fringe and Hill	Municipality ;W.N. 29, Sunsari 20 – 26 May, 2017	▪ *An. subpictus* ▪ *An. seudowillmori*			

Annex 4. Year-wise Map of Indigenous Case

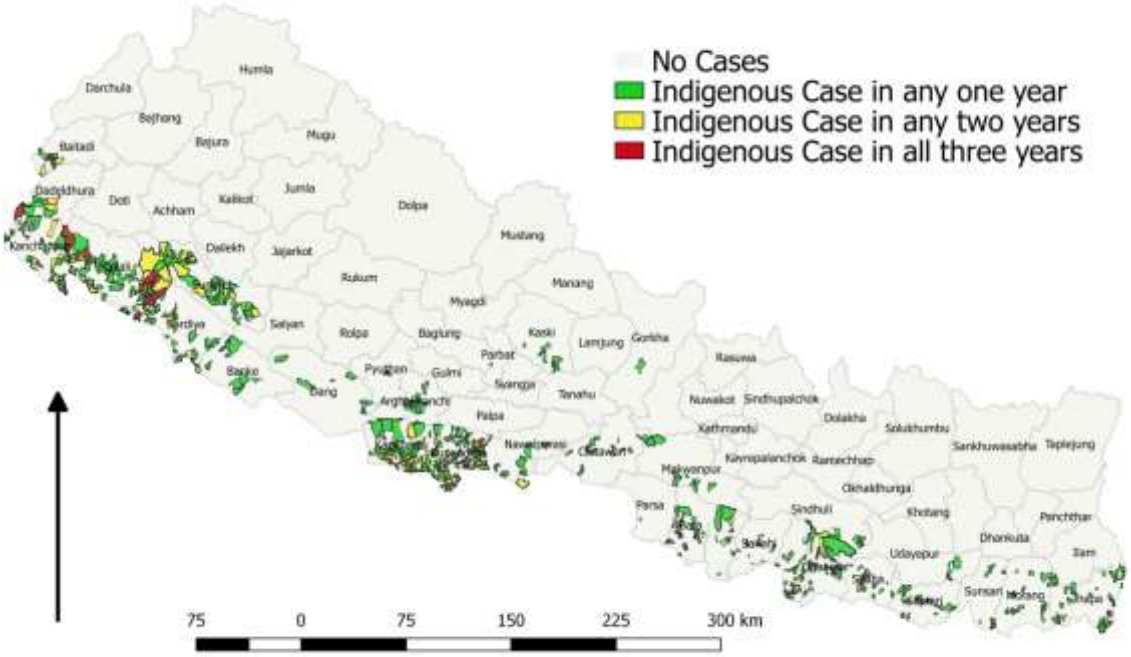




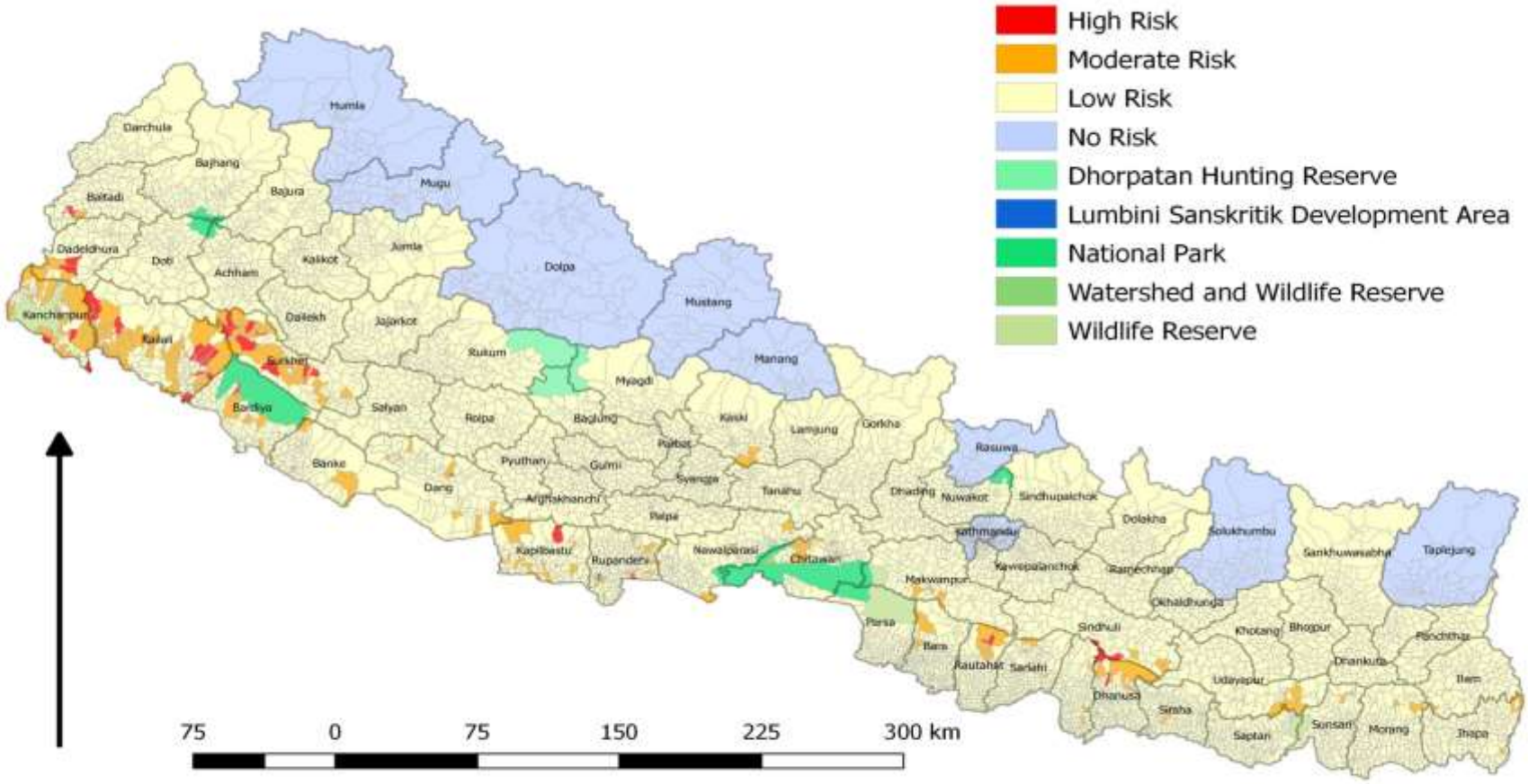
Indigenous cases in 2016(Ward Level)



Indigenous cases in three years(2014-16)



Annex 5: Ward Level Risk Classification Map (MS 2016)



Annex 6: List of High & Moderate Risk Wards (MS 2016)

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
1	Far-Western Region	Baitadi	Maharudra	8	547	High
2	Far-Western Region	Baitadi	Shibanath	1	1017	High
3	Far-Western Region	Baitadi	Shibanath	5	563	High
4	Far-Western Region	Baitadi	Shibanath	6	539	High
5	Far-Western Region	Dadeldhura	Parsuram N.P.	1	2852	High
6	Far-Western Region	Dadeldhura	Parsuram N.P.	12	3490	High
7	Far-Western Region	Kailali	Chaumala	8	6401	High
8	Far-Western Region	Kailali	Dhansinghapur	3	2721	High
9	Far-Western Region	Kailali	Dhansinghapur	6	1069	High
10	Far-Western Region	Kailali	Dhansinghapur	7	486	High
11	Far-Western Region	Kailali	Durgauli	1	3181	High
12	Far-Western Region	Kailali	Durgauli	5	882	High
13	Far-Western Region	Kailali	Godawari	1	846	High
14	Far-Western Region	Kailali	Godawari	2	1623	High
15	Far-Western Region	Kailali	Godawari	3	1920	High
16	Far-Western Region	Kailali	Godawari	4	746	High
17	Far-Western Region	Kailali	Godawari	5	2112	High
18	Far-Western Region	Kailali	Godawari	6	3603	High
19	Far-Western Region	Kailali	Godawari	7	855	High
20	Far-Western Region	Kailali	Godawari	9	1365	High
21	Far-Western Region	Kailali	Lamki Chuha N.P.	2	15386	High
22	Far-Western Region	Kailali	Lamki Chuha N.P.	3	1711	High
23	Far-Western Region	Kailali	Lamki Chuha N.P.	4	4055	High
24	Far-Western Region	Kailali	Lamki Chuha N.P.	5	6958	High
25	Far-Western Region	Kailali	Lamki Chuha N.P.	6	3496	High
26	Far-Western Region	Kailali	Lamki Chuha N.P.	8	3758	High
27	Far-Western Region	Kailali	Lamki Chuha N.P.	10	5901	High
28	Far-Western Region	Kailali	Lamki Chuha N.P.	11	1357	High
29	Far-Western Region	Kailali	Lamki Chuha N.P.	12	3553	High
30	Far-Western Region	Kailali	Lamki Chuha N.P.	14	1975	High
31	Far-Western Region	Kailali	Lamki Chuha N.P.	15	3351	High
32	Far-Western Region	Kailali	Masuriya	1	5638	High
33	Far-Western Region	Kanchanpur	Belauri N.P.	13	4345	High
34	Far-Western Region	Kanchanpur	Purnabash N.P.	1	4412	High
35	Far-Western Region	Kanchanpur	Sankarpur	4	1143	High
36	Mid Region	Dhanusa	Chireswornath N.P.	9	2805	High
37	Mid Region	Dhanusa	Ganeshman Charnath N.P.	10	3859	High
38	Mid Region	Dhanusa	TulsiChauda	4	808	High
39	Mid Region	Rautahat	Chandrapur N.P.	1	7856	High
40	Mid Region	Sindhuli	Ranibas	6	858	High
41	Mid Western Region	Bardiya	Babai N.P.	3	4623	High

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
42	Mid Western Region	Dang	Ghorahi N.P.	11	21137	High
43	Mid Western Region	Surkhet	Bidyapur	7	1491	High
44	Mid Western Region	Surkhet	Bijaura	5	1011	High
45	Mid Western Region	Surkhet	Ghatgaun	1	250	High
46	Mid Western Region	Surkhet	Hariharpur	7	534	High
47	Mid Western Region	Surkhet	Salkot	7	722	High
48	Mid Western Region	Surkhet	Satakhani	2	810	High
49	Mid Western Region	Surkhet	Satakhani	7	2356	High
50	Mid Western Region	Surkhet	Tatopani	7	741	High
51	Mid Western Region	Surkhet	Tatopani	9	1258	High
52	Western Region	Kapilbastu	Buddhabhatika N.P.	12	1584	High
53	Western Region	Rupandehi	Siddharthnagar N.P.	1	6103	High
54	Western Region	Rupandehi	Siddharthnagar N.P.	3	7087	High
55	Eastern Region	Ilam	Chulachuli	8	2051	Moderate
56	Eastern Region	Jhapa	Bahundangi	1	3523	Moderate
57	Eastern Region	Jhapa	Bahundangi	3	4630	Moderate
58	Eastern Region	Jhapa	Bahundangi	7	2012	Moderate
59	Eastern Region	Jhapa	Mechinagar N.P.	10	15287	Moderate
60	Eastern Region	Jhapa	Prithivinagar	6	1267	Moderate
61	Eastern Region	Morang	Letang N.P.	11	3024	Moderate
62	Eastern Region	Morang	Madhumalla	1	2772	Moderate
63	Eastern Region	Morang	Madhumalla	3	2202	Moderate
64	Eastern Region	Morang	Madhumalla	4	2511	Moderate
65	Eastern Region	Morang	Madhumalla	5	2695	Moderate
66	Eastern Region	Morang	Urlabari N.P.	2	3696	Moderate
67	Eastern Region	Saptari	Saptakoshi N.P.	1	4740	Moderate
68	Eastern Region	Saptari	Saptakoshi N.P.	2	2477	Moderate
69	Eastern Region	Siraha	Arnamalalpur	6	689	Moderate
70	Eastern Region	Siraha	Golbazaar N.P.	12	5432	Moderate
71	Eastern Region	Siraha	Mahanaur	1	551	Moderate
72	Eastern Region	Sunsari	Dharan N.P.	11	12520	Moderate
73	Eastern Region	Sunsari	Dharan N.P.	17	10756	Moderate
74	Eastern Region	Sunsari	Dharan N.P.	23	6324	Moderate
75	Eastern Region	Udayapur	Beltar Bashaha N.P.	7	3047	Moderate
76	Eastern Region	Udayapur	Sundarpur	2	1513	Moderate
77	Eastern Region	Udayapur	Tapeswori	1	4861	Moderate
78	Eastern Region	Udayapur	Tapeswori	7	809	Moderate
79	Eastern Region	Udayapur	Tapeswori	9	2325	Moderate
80	Eastern Region	Udayapur	Thoksila	8	2624	Moderate
81	Far-Western Region	Baitadi	Melauli	8	267	Moderate
82	Far-Western Region	Baitadi	Shibanath	4	549	Moderate
83	Far-Western Region	Baitadi	Shibanath	7	555	Moderate
84	Far-Western Region	Baitadi	Shibanath	8	802	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
85	Far-Western Region	Baitadi	Shibanath	9	715	Moderate
86	Far-Western Region	Dadeldhura	Parsuram N.P.	4	4518	Moderate
87	Far-Western Region	Dadeldhura	Parsuram N.P.	5	3050	Moderate
88	Far-Western Region	Dadeldhura	Parsuram N.P.	6	2549	Moderate
89	Far-Western Region	Dadeldhura	Parsuram N.P.	7	3495	Moderate
90	Far-Western Region	Dadeldhura	Parsuram N.P.	10	4544	Moderate
91	Far-Western Region	Kailali	Attariya N.P.	1	4902	Moderate
92	Far-Western Region	Kailali	Attariya N.P.	2	8098	Moderate
93	Far-Western Region	Kailali	Attariya N.P.	3	4525	Moderate
94	Far-Western Region	Kailali	Attariya N.P.	5	6668	Moderate
95	Far-Western Region	Kailali	Attariya N.P.	6	4890	Moderate
96	Far-Western Region	Kailali	Attariya N.P.	7	7675	Moderate
97	Far-Western Region	Kailali	Attariya N.P.	9	2998	Moderate
98	Far-Western Region	Kailali	Attariya N.P.	12	6167	Moderate
99	Far-Western Region	Kailali	Attariya N.P.	13	9127	Moderate
100	Far-Western Region	Kailali	Bhajani Trishakti N.P.	1	5301	Moderate
101	Far-Western Region	Kailali	Bhajani Trishakti N.P.	2	4808	Moderate
102	Far-Western Region	Kailali	Bhajani Trishakti N.P.	3	1924	Moderate
103	Far-Western Region	Kailali	Bhajani Trishakti N.P.	4	4171	Moderate
104	Far-Western Region	Kailali	Bhajani Trishakti N.P.	6	2396	Moderate
105	Far-Western Region	Kailali	Bhajani Trishakti N.P.	7	4218	Moderate
106	Far-Western Region	Kailali	Bhajani Trishakti N.P.	8	2430	Moderate
107	Far-Western Region	Kailali	Bhajani Trishakti N.P.	11	2071	Moderate
108	Far-Western Region	Kailali	Chaumala	1	2500	Moderate
109	Far-Western Region	Kailali	Chaumala	2	2720	Moderate
110	Far-Western Region	Kailali	Chaumala	3	5097	Moderate
111	Far-Western Region	Kailali	Chaumala	4	3084	Moderate
112	Far-Western Region	Kailali	Chaumala	5	2037	Moderate
113	Far-Western Region	Kailali	Chaumala	7	4474	Moderate
114	Far-Western Region	Kailali	Dhangadhi N.P.	1	15334	Moderate
115	Far-Western Region	Kailali	Dhangadhi N.P.	2	13329	Moderate
116	Far-Western Region	Kailali	Dhangadhi N.P.	3	14495	Moderate
117	Far-Western Region	Kailali	Dhangadhi N.P.	5	12457	Moderate
118	Far-Western Region	Kailali	Dhangadhi N.P.	7	9674	Moderate
119	Far-Western Region	Kailali	Dhangadhi N.P.	8	6463	Moderate
120	Far-Western Region	Kailali	Dhangadhi N.P.	9	1906	Moderate
121	Far-Western Region	Kailali	Dhangadhi N.P.	11	2472	Moderate
122	Far-Western Region	Kailali	Dhangadhi N.P.	12	10708	Moderate
123	Far-Western Region	Kailali	Dhangadhi N.P.	13	3190	Moderate
124	Far-Western Region	Kailali	Dhangadhi N.P.	15	5160	Moderate
125	Far-Western Region	Kailali	Dhangadhi N.P.	16	5764	Moderate
126	Far-Western Region	Kailali	Dhangadhi N.P.	17	5325	Moderate
127	Far-Western Region	Kailali	Dhangadhi N.P.	18	7430	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
128	Far-Western Region	Kailali	Dhangadhi N.P.	19	5832	Moderate
129	Far-Western Region	Kailali	Dhangadhi N.P.	20	8678	Moderate
130	Far-Western Region	Kailali	Dhansinghapur	2	1363	Moderate
131	Far-Western Region	Kailali	Dhansinghapur	4	923	Moderate
132	Far-Western Region	Kailali	Dhansinghapur	9	479	Moderate
133	Far-Western Region	Kailali	Dododhara	7	6363	Moderate
134	Far-Western Region	Kailali	Durgauli	2	1501	Moderate
135	Far-Western Region	Kailali	Durgauli	6	2315	Moderate
136	Far-Western Region	Kailali	Durgauli	7	1286	Moderate
137	Far-Western Region	Kailali	Durgauli	9	2254	Moderate
138	Far-Western Region	Kailali	Goda Godi N.P.	1	8039	Moderate
139	Far-Western Region	Kailali	Goda Godi N.P.	2	3814	Moderate
140	Far-Western Region	Kailali	Goda Godi N.P.	3	3360	Moderate
141	Far-Western Region	Kailali	Goda Godi N.P.	4	3641	Moderate
142	Far-Western Region	Kailali	Goda Godi N.P.	6	6650	Moderate
143	Far-Western Region	Kailali	Goda Godi N.P.	7	4929	Moderate
144	Far-Western Region	Kailali	Goda Godi N.P.	8	9732	Moderate
145	Far-Western Region	Kailali	Goda Godi N.P.	13	4330	Moderate
146	Far-Western Region	Kailali	Godawari	8	3589	Moderate
147	Far-Western Region	Kailali	Lamki Chuha N.P.	1	6083	Moderate
148	Far-Western Region	Kailali	Lamki Chuha N.P.	7	2909	Moderate
149	Far-Western Region	Kailali	Lamki Chuha N.P.	9	2377	Moderate
150	Far-Western Region	Kailali	Lamki Chuha N.P.	13	2767	Moderate
151	Far-Western Region	Kailali	Masuriya	2	2801	Moderate
152	Far-Western Region	Kailali	Masuriya	3	1446	Moderate
153	Far-Western Region	Kailali	Masuriya	4	4200	Moderate
154	Far-Western Region	Kailali	Masuriya	5	1759	Moderate
155	Far-Western Region	Kailali	Masuriya	7	3795	Moderate
156	Far-Western Region	Kailali	Masuriya	8	1609	Moderate
157	Far-Western Region	Kailali	Munuwa	3	1086	Moderate
158	Far-Western Region	Kailali	Pathariya	4	3445	Moderate
159	Far-Western Region	Kailali	Pathariya	5	1514	Moderate
160	Far-Western Region	Kailali	Pathariya	7	1518	Moderate
161	Far-Western Region	Kailali	Pathariya	8	2984	Moderate
162	Far-Western Region	Kailali	Pathariya	9	2702	Moderate
163	Far-Western Region	Kailali	Sugarkhal	2	4658	Moderate
164	Far-Western Region	Kailali	Sugarkhal	9	1900	Moderate
165	Far-Western Region	Kailali	Tikapur N.P.	1	2447	Moderate
166	Far-Western Region	Kailali	Tikapur N.P.	4	2282	Moderate
167	Far-Western Region	Kailali	Tikapur N.P.	7	1812	Moderate
168	Far-Western Region	Kailali	Tikapur N.P.	8	7251	Moderate
169	Far-Western Region	Kailali	Tikapur N.P.	9	37398	Moderate
170	Far-Western Region	Kanchanpur	Baisi Bichawa	4	1454	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
171	Far-Western Region	Kanchanpur	Baisi Bichawa	5	3216	Moderate
172	Far-Western Region	Kanchanpur	Baisi Bichawa	6	1916	Moderate
173	Far-Western Region	Kanchanpur	Baisi Bichawa	7	977	Moderate
174	Far-Western Region	Kanchanpur	Bedkot N.P.	2	4228	Moderate
175	Far-Western Region	Kanchanpur	Bedkot N.P.	3	3728	Moderate
176	Far-Western Region	Kanchanpur	Bedkot N.P.	4	4973	Moderate
177	Far-Western Region	Kanchanpur	Bedkot N.P.	6	4568	Moderate
178	Far-Western Region	Kanchanpur	Bedkot N.P.	7	3137	Moderate
179	Far-Western Region	Kanchanpur	Bedkot N.P.	9	3832	Moderate
180	Far-Western Region	Kanchanpur	Bedkot N.P.	12	3754	Moderate
181	Far-Western Region	Kanchanpur	Bedkot N.P.	13	2808	Moderate
182	Far-Western Region	Kanchanpur	Belauri N.P.	1	3389	Moderate
183	Far-Western Region	Kanchanpur	Belauri N.P.	3	3426	Moderate
184	Far-Western Region	Kanchanpur	Belauri N.P.	6	5479	Moderate
185	Far-Western Region	Kanchanpur	Belauri N.P.	8	3885	Moderate
186	Far-Western Region	Kanchanpur	Belauri N.P.	11	3578	Moderate
187	Far-Western Region	Kanchanpur	Belauri N.P.	12	4627	Moderate
188	Far-Western Region	Kanchanpur	Belauri N.P.	14	2953	Moderate
189	Far-Western Region	Kanchanpur	Beldandi N.P.	1	3909	Moderate
190	Far-Western Region	Kanchanpur	Beldandi N.P.	2	1421	Moderate
191	Far-Western Region	Kanchanpur	Beldandi N.P.	3	2964	Moderate
192	Far-Western Region	Kanchanpur	Beldandi N.P.	4	1166	Moderate
193	Far-Western Region	Kanchanpur	Beldandi N.P.	5	2194	Moderate
194	Far-Western Region	Kanchanpur	Beldandi N.P.	6	2862	Moderate
195	Far-Western Region	Kanchanpur	Beldandi N.P.	8	2052	Moderate
196	Far-Western Region	Kanchanpur	Beldandi N.P.	10	1807	Moderate
197	Far-Western Region	Kanchanpur	Bhimdatta N.P.	7	5314	Moderate
198	Far-Western Region	Kanchanpur	Bhimdatta N.P.	8	4804	Moderate
199	Far-Western Region	Kanchanpur	Bhimdatta N.P.	9	7539	Moderate
200	Far-Western Region	Kanchanpur	Bhimdatta N.P.	18	18202	Moderate
201	Far-Western Region	Kanchanpur	Dekhatbhuli	1	2905	Moderate
202	Far-Western Region	Kanchanpur	Dekhatbhuli	6	2440	Moderate
203	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	3	4879	Moderate
204	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	4	4446	Moderate
205	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	5	2541	Moderate
206	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	6	3861	Moderate
207	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	7	5466	Moderate
208	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	8	3427	Moderate
209	Far-Western Region	Kanchanpur	Dodhara Chandani N.P.	9	3806	Moderate
210	Far-Western Region	Kanchanpur	Jhalari Pipaladi N.P.	2	2104	Moderate
211	Far-Western Region	Kanchanpur	Jhalari Pipaladi N.P.	4	3483	Moderate
212	Far-Western Region	Kanchanpur	Jhalari Pipaladi N.P.	5	5511	Moderate
213	Far-Western Region	Kanchanpur	Jhalari Pipaladi N.P.	7	5652	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
214	Far-Western Region	Kanchanpur	Jhalari Pipaladi N.P.	8	4975	Moderate
215	Far-Western Region	Kanchanpur	Krishnapur N.P.	1	5962	Moderate
216	Far-Western Region	Kanchanpur	Krishnapur N.P.	2	10398	Moderate
217	Far-Western Region	Kanchanpur	Krishnapur N.P.	4	7229	Moderate
218	Far-Western Region	Kanchanpur	Krishnapur N.P.	5	3297	Moderate
219	Far-Western Region	Kanchanpur	Krishnapur N.P.	6	4439	Moderate
220	Far-Western Region	Kanchanpur	Krishnapur N.P.	8	3177	Moderate
221	Far-Western Region	Kanchanpur	Krishnapur N.P.	9	1682	Moderate
222	Far-Western Region	Kanchanpur	Purnabash N.P.	7	2594	Moderate
223	Far-Western Region	Kanchanpur	Raikawar Bichawa	1	1408	Moderate
224	Far-Western Region	Kanchanpur	Raikawar Bichawa	4	3046	Moderate
225	Far-Western Region	Kanchanpur	Raikawar Bichawa	5	2979	Moderate
226	Far-Western Region	Kanchanpur	Raikawar Bichawa	8	2646	Moderate
227	Far-Western Region	Kanchanpur	Sankarpur	1	1275	Moderate
228	Far-Western Region	Kanchanpur	Sankarpur	2	526	Moderate
229	Far-Western Region	Kanchanpur	Sankarpur	9	626	Moderate
230	Mid Region	Bara	Amlekhganj	2	351	Moderate
231	Mid Region	Bara	Gadimai N.P.	1	7725	Moderate
232	Mid Region	Bara	Gadimai N.P.	5	5487	Moderate
233	Mid Region	Bara	Gadimai N.P.	6	2390	Moderate
234	Mid Region	Bara	Gadimai N.P.	8	3811	Moderate
235	Mid Region	Bara	Gadimai N.P.	11	4722	Moderate
236	Mid Region	Chitawan	Bharatpur N.P.	6	8140	Moderate
237	Mid Region	Chitawan	Bharatpur N.P.	11	22471	Moderate
238	Mid Region	Chitawan	Bharatpur N.P.	14	4380	Moderate
239	Mid Region	Chitawan	Bharatpur N.P.	16	4934	Moderate
240	Mid Region	Chitawan	Bharatpur N.P.	19	4132	Moderate
241	Mid Region	Chitawan	Bharatpur N.P.	20	3346	Moderate
242	Mid Region	Chitawan	Bharatpur N.P.	23	2716	Moderate
243	Mid Region	Chitawan	Bharatpur N.P.	25	2211	Moderate
244	Mid Region	Chitawan	Bharatpur N.P.	26	2270	Moderate
245	Mid Region	Chitawan	Bharatpur N.P.	27	3367	Moderate
246	Mid Region	Chitawan	Chitrawan N.P.	2	1589	Moderate
247	Mid Region	Chitawan	Chitrawan N.P.	3	2455	Moderate
248	Mid Region	Chitawan	Kalika N.P.	7	3690	Moderate
249	Mid Region	Chitawan	Khairahani N.P.	1	5329	Moderate
250	Mid Region	Chitawan	Khairahani N.P.	7	3237	Moderate
251	Mid Region	Chitawan	Narayani N.P.	1	6814	Moderate
252	Mid Region	Chitawan	Narayani N.P.	7	2349	Moderate
253	Mid Region	Chitawan	Narayani N.P.	10	4325	Moderate
254	Mid Region	Dhanusa	Ganeshman Charnath N.P.	1	5455	Moderate
255	Mid Region	Dhanusa	Ganeshman Charnath N.P.	2	4146	Moderate
256	Mid Region	Dhanusa	Ganeshman Charnath N.P.	3	3977	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
257	Mid Region	Dhanusa	Ganeshman Charnath N.P.	5	2546	Moderate
258	Mid Region	Dhanusa	Mithila N.P.	4	3857	Moderate
259	Mid Region	Dhanusa	Mithila N.P.	7	4674	Moderate
260	Mid Region	Dhanusa	Mithila N.P.	8	4423	Moderate
261	Mid Region	Dhanusa	Puspalpur	5	199	Moderate
262	Mid Region	Dhanusa	Sabela N.P.	3	2933	Moderate
263	Mid Region	Dhanusa	TulsiChauda	2	802	Moderate
264	Mid Region	Mahottari	Bardibas N.P.	1	6144	Moderate
265	Mid Region	Mahottari	Khuttapiparadhi	7	844	Moderate
266	Mid Region	Mahottari	Pipra	2	1058	Moderate
267	Mid Region	Makwanpur	Hetauda N.P.	5	12276	Moderate
268	Mid Region	Makwanpur	Hetauda N.P.	7	4666	Moderate
269	Mid Region	Makwanpur	Hetauda N.P.	10	7723	Moderate
270	Mid Region	Makwanpur	Hetauda N.P.	13	5129	Moderate
271	Mid Region	Makwanpur	Hetauda N.P.	14	4963	Moderate
272	Mid Region	Makwanpur	Hetauda N.P.	15	3422	Moderate
273	Mid Region	Makwanpur	Hetauda N.P.	19	3790	Moderate
274	Mid Region	Makwanpur	Hetauda N.P.	22	3969	Moderate
275	Mid Region	Rautahat	Chandrapur N.P.	2	7535	Moderate
276	Mid Region	Rautahat	Chandrapur N.P.	3	6253	Moderate
277	Mid Region	Rautahat	Chandrapur N.P.	4	3774	Moderate
278	Mid Region	Rautahat	Chandrapur N.P.	6	4722	Moderate
279	Mid Region	Rautahat	Chandrapur N.P.	11	6935	Moderate
280	Mid Region	Rautahat	Chandrapur N.P.	12	5211	Moderate
281	Mid Region	Rautahat	Chandrapur N.P.	13	4383	Moderate
282	Mid Region	Rautahat	Chandrapur N.P.	14	7008	Moderate
283	Mid Region	Sarlahi	Hariyon N.P.	1	3712	Moderate
284	Mid Region	Sarlahi	Hariyon N.P.	7	2700	Moderate
285	Mid Region	Sarlahi	Ishworpur N.P.	1	4061	Moderate
286	Mid Region	Sindhuli	Dudhouli N.P.	3	1829	Moderate
287	Mid Region	Sindhuli	Dudhouli N.P.	5	3728	Moderate
288	Mid Region	Sindhuli	Dudhouli N.P.	6	2407	Moderate
289	Mid Region	Sindhuli	Dudhouli N.P.	7	3031	Moderate
290	Mid Region	Sindhuli	Hatpate	9	1113	Moderate
291	Mid Region	Sindhuli	Ranibas	4	557	Moderate
292	Mid Region	Sindhuli	Ranibas	5	794	Moderate
293	Mid Western Region	Banke	Baijapur	3	2155	Moderate
294	Mid Western Region	Banke	Baijapur	5	1035	Moderate
295	Mid Western Region	Banke	Chisapani	5	1598	Moderate
296	Mid Western Region	Banke	Chisapani	9	1302	Moderate
297	Mid Western Region	Banke	Katkuiya	8	1071	Moderate
298	Mid Western Region	Bardiya	Babai N.P.	1	1654	Moderate
299	Mid Western Region	Bardiya	Babai N.P.	2	4101	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
300	Mid Western Region	Bardiya	Babai N.P.	4	2271	Moderate
301	Mid Western Region	Bardiya	Babai N.P.	5	3174	Moderate
302	Mid Western Region	Bardiya	Babai N.P.	6	3311	Moderate
303	Mid Western Region	Bardiya	Babai N.P.	7	3413	Moderate
304	Mid Western Region	Bardiya	Babai N.P.	8	2399	Moderate
305	Mid Western Region	Bardiya	Babai N.P.	9	1503	Moderate
306	Mid Western Region	Bardiya	Babai N.P.	10	3334	Moderate
307	Mid Western Region	Bardiya	Baniyabhar	5	2232	Moderate
308	Mid Western Region	Bardiya	Dhadhawar	3	2666	Moderate
309	Mid Western Region	Bardiya	Dhadhawar	6	4672	Moderate
310	Mid Western Region	Bardiya	Dhodhari	6	1017	Moderate
311	Mid Western Region	Bardiya	Kalika	2	1377	Moderate
312	Mid Western Region	Bardiya	Magaragadi	1	2146	Moderate
313	Mid Western Region	Bardiya	Magaragadi	2	2063	Moderate
314	Mid Western Region	Bardiya	Magaragadi	4	4165	Moderate
315	Mid Western Region	Dang	Dhanauri	1	1353	Moderate
316	Mid Western Region	Dang	Gadhawa	6	1353	Moderate
317	Mid Western Region	Dang	Ghorahi N.P.	1	3732	Moderate
318	Mid Western Region	Dang	Ghorahi N.P.	8	4507	Moderate
319	Mid Western Region	Dang	Ghorahi N.P.	10	11962	Moderate
320	Mid Western Region	Dang	Gobardiya	2	1994	Moderate
321	Mid Western Region	Dang	Gobardiya	9	1886	Moderate
322	Mid Western Region	Dang	Lalmatiya	1	1199	Moderate
323	Mid Western Region	Dang	Lalmatiya	9	2786	Moderate
324	Mid Western Region	Dang	Pawannagar	3	1017	Moderate
325	Mid Western Region	Dang	Shreegaun	3	689	Moderate
326	Mid Western Region	Surkhet	Babiyachaur	1	848	Moderate
327	Mid Western Region	Surkhet	Babiyachaur	2	1297	Moderate
328	Mid Western Region	Surkhet	Babiyachaur	4	1247	Moderate
329	Mid Western Region	Surkhet	Babiyachaur	5	945	Moderate
330	Mid Western Region	Surkhet	Babiyachaur	6	1495	Moderate
331	Mid Western Region	Surkhet	Bheriganga N.P.	3	2050	Moderate
332	Mid Western Region	Surkhet	Bheriganga N.P.	4	1338	Moderate
333	Mid Western Region	Surkhet	Bheriganga N.P.	13	2092	Moderate
334	Mid Western Region	Surkhet	Bheriganga N.P.	14	1970	Moderate
335	Mid Western Region	Surkhet	Bidyapur	2	401	Moderate
336	Mid Western Region	Surkhet	Bidyapur	3	824	Moderate
337	Mid Western Region	Surkhet	Bidyapur	6	667	Moderate
338	Mid Western Region	Surkhet	Bidyapur	8	905	Moderate
339	Mid Western Region	Surkhet	Bijaura	1	503	Moderate
340	Mid Western Region	Surkhet	Bijaura	2	389	Moderate
341	Mid Western Region	Surkhet	Bijaura	6	723	Moderate
342	Mid Western Region	Surkhet	Bijaura	7	1114	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
343	Mid Western Region	Surkhet	Birendranagar N.P.	1	3670	Moderate
344	Mid Western Region	Surkhet	Birendranagar N.P.	2	3342	Moderate
345	Mid Western Region	Surkhet	Birendranagar N.P.	3	2880	Moderate
346	Mid Western Region	Surkhet	Birendranagar N.P.	5	5341	Moderate
347	Mid Western Region	Surkhet	Birendranagar N.P.	10	4347	Moderate
348	Mid Western Region	Surkhet	Birendranagar N.P.	11	6929	Moderate
349	Mid Western Region	Surkhet	Birendranagar N.P.	12	1782	Moderate
350	Mid Western Region	Surkhet	Birendranagar N.P.	13	4122	Moderate
351	Mid Western Region	Surkhet	Birendranagar N.P.	14	4220	Moderate
352	Mid Western Region	Surkhet	Birendranagar N.P.	17	4982	Moderate
353	Mid Western Region	Surkhet	Birendranagar N.P.	19	3352	Moderate
354	Mid Western Region	Surkhet	Birendranagar N.P.	20	2908	Moderate
355	Mid Western Region	Surkhet	Birendranagar N.P.	22	2498	Moderate
356	Mid Western Region	Surkhet	Birendranagar N.P.	23	1939	Moderate
357	Mid Western Region	Surkhet	Birendranagar N.P.	24	1285	Moderate
358	Mid Western Region	Surkhet	Dasarathpur	5	839	Moderate
359	Mid Western Region	Surkhet	Ghatgaun	6	960	Moderate
360	Mid Western Region	Surkhet	Ghatgaun	9	854	Moderate
361	Mid Western Region	Surkhet	Guthu	4	1252	Moderate
362	Mid Western Region	Surkhet	Guthu	5	1173	Moderate
363	Mid Western Region	Surkhet	Guthu	7	932	Moderate
364	Mid Western Region	Surkhet	Guthu	8	1576	Moderate
365	Mid Western Region	Surkhet	Guthu	9	827	Moderate
366	Mid Western Region	Surkhet	Hariharpur	6	680	Moderate
367	Mid Western Region	Surkhet	Kalyan	3	983	Moderate
368	Mid Western Region	Surkhet	Kunathari	1	1786	Moderate
369	Mid Western Region	Surkhet	Kunathari	8	414	Moderate
370	Mid Western Region	Surkhet	Lekhgaun	6	484	Moderate
371	Mid Western Region	Surkhet	Salkot	1	1192	Moderate
372	Mid Western Region	Surkhet	Salkot	4	1445	Moderate
373	Mid Western Region	Surkhet	Salkot	5	1523	Moderate
374	Mid Western Region	Surkhet	Salkot	6	1221	Moderate
375	Mid Western Region	Surkhet	Salkot	8	642	Moderate
376	Mid Western Region	Surkhet	Satakhani	1	667	Moderate
377	Mid Western Region	Surkhet	Satakhani	4	1715	Moderate
378	Mid Western Region	Surkhet	Satakhani	8	1944	Moderate
379	Mid Western Region	Surkhet	Subhaghat Gangamala N.P.	2	1905	Moderate
380	Mid Western Region	Surkhet	Taranga	5	1113	Moderate
381	Mid Western Region	Surkhet	Tatopani	4	512	Moderate
382	Western Region	Kapilbastu	Bahadurganj	3	1653	Moderate
383	Western Region	Kapilbastu	Banganga N.P.	11	6384	Moderate
384	Western Region	Kapilbastu	Bedauli	8	830	Moderate
385	Western Region	Kapilbastu	Bhalubari	4	621	Moderate

S.No	Region	District	VDC/MP	Ward No.	Population	Risk Type
386	Western Region	Kapilbastu	Dumara	8	718	Moderate
387	Western Region	Kapilbastu	Ganeshpur	3	438	Moderate
388	Western Region	Kapilbastu	Harduona	1	487	Moderate
389	Western Region	Kapilbastu	Kapilbastu N.P.	1	2929	Moderate
390	Western Region	Kapilbastu	Kushhawa	2	413	Moderate
391	Western Region	Kapilbastu	Maharajganj	4	2426	Moderate
392	Western Region	Kapilbastu	Pakadi	3	1605	Moderate
393	Western Region	Kapilbastu	Shivagadhi	4	677	Moderate
394	Western Region	Kapilbastu	Shivraj N.P.	1	4607	Moderate
395	Western Region	Kapilbastu	Shivraj N.P.	2	3542	Moderate
396	Western Region	Kapilbastu	Shivraj N.P.	3	3964	Moderate
397	Western Region	Kapilbastu	Shivraj N.P.	4	2739	Moderate
398	Western Region	Kapilbastu	Shivraj N.P.	13	1585	Moderate
399	Western Region	Kapilbastu	Singhkhor	7	1026	Moderate
400	Western Region	Kaski	Lekhanath N.P.	8	4954	Moderate
401	Western Region	Kaski	Lekhanath N.P.	9	2679	Moderate
402	Western Region	Kaski	Lekhanath N.P.	14	2801	Moderate
403	Western Region	Kaski	Lekhanath N.P.	16	2745	Moderate
404	Western Region	Kaski	Lekhanath N.P.	17	4922	Moderate
405	Western Region	Nawalparasi	Mainaghat	4	607	Moderate
406	Western Region	Nawalparasi	Pakalihawa	2	1580	Moderate
407	Western Region	Nawalparasi	Ratanapur	8	584	Moderate
408	Western Region	Rupandehi	Butwal N.P.	4	6940	Moderate
409	Western Region	Rupandehi	Butwal N.P.	13	30162	Moderate
410	Western Region	Rupandehi	Devadaha N.P.	6	6547	Moderate
411	Western Region	Rupandehi	Devadaha N.P.	10	3818	Moderate
412	Western Region	Rupandehi	Dhakadhai	6	950	Moderate
413	Western Region	Rupandehi	Farena	3	731	Moderate
414	Western Region	Rupandehi	Farena	8	610	Moderate
415	Western Region	Rupandehi	Lumini Sanskrit N.P.	1	5045	Moderate
416	Western Region	Rupandehi	Lumini Sanskrit N.P.	8	3067	Moderate
417	Western Region	Rupandehi	Lumini Sanskrit N.P.	15	3612	Moderate
418	Western Region	Rupandehi	Siddharthnagar N.P.	4	5242	Moderate
419	Western Region	Rupandehi	Siddharthnagar N.P.	6	9662	Moderate
420	Western Region	Rupandehi	Siddharthnagar N.P.	9	7348	Moderate
421	Western Region	Rupandehi	Sikatahan	9	2861	Moderate
422	Western Region	Rupandehi	Tilottama N.P.	1	3143	Moderate
423	Western Region	Rupandehi	Tilottama N.P.	14	4710	Moderate
424	Western Region	Rupandehi	Tilottama N.P.	16	4458	Moderate

Annex 7: Micro-stratification Form

Government of Nepal

Ministry of Health, Department of Health Services

Epidemiology and Disease Control Division, Teku, Kathmandu

Micro-Stratification of Malaria Risk in Nepal

Ward Based Basic Malaria Information

Strat. Form 1, P-1.

District:..... 2.1. VDC/Municipality:..... 2. 2. Ward No./Tol..... 3. Health Facility:.....

4. Geography:	4.1 Plain terai ☐	4.2 Forest, forest fringe and foot hill ☐	4.3 Inner terai ☐	4.4 Hill, hill river valleys ☐	4.5 Mountain ☐	4.6. GPS	**Lat0**	**Long0** .....
5. Metereology:	5.1 Temperature (Celsius)	5.1.1 Max:	5.1.2 Min:	5.2 Average rainfall (mm):	5.3 Relative humidity (%)	Max:	Min:	
	5.4 Water Resources:	5.4.1 River:	5.4.2 Stream:	5.4.3 Irrigation canal:	5.4.4 No. of Ponds:			
6. Forest Coverage:	6.1 Percentage Coverage:							
7. Altitude: (meter above the sea level):								
8. Demography:	8.1 Total population:	8.2 Total no. of household:	8.3 Population<5 yrs male:	8.4 Population <5yrs female:				
	8.5 Population >5yrs male:	8.6 Population >5yrs female:	8.7 Total male population.....	8.8 Total female population:				
	8.9 No. of Animal Shed/Huts (Goth):							
9. Socio-economic factors: (Related to malaria risk of vulnerability)								
9.1 Main occupation:	9.1.1 Agriculture/ farmer ☐	9.1.2 Labour ☐	9.1.3 Business ☐	9.1.4 If Others Specify:				
9.2 Population movement:	9.2.1 Regular movement to the forest ☐	9.2.2 Limited movement towards the forest ☐	9.2.3 Movement within the country for economic persuits ☐					
	9.2.4 Development projects in Ward (or near by) ☐	9.2.5 Resettlement in Ward (or near by) ☐	9.2.6 Movement to other countries ☐					

Government of Nepal

Ministry of Health, Department of Health Services

Epidemiology and Disease Control Division, Teku, Kathmandu

Micro-Stratification of Malaria Risk in Nepal

Ward Based Basic Malaria Information

Strat. Form 1, P-2.

Year:……

District:…… 2.1. VDC/Municipality:…… 2. 2. Ward No./Tol…… 3. Health Facility:……

11. Annual Malaria Information					
11.1 Microscopic Examination: Yes ☐ No ☐	11.1.1 If Yes, Total slide collected: ……	11.1.2 Total Slide examined: ……	11.1.3 Total Positive: ……		
	11.1.4 SPR (%): ……	11.1.5 Total PV: ……	11.1.6 Total PF: ……	11.1.7 Total Mix: ……	
	11.1.8 Percentage PF: ……	11.1.9 If lab not available where they refer to: ……			
11.2 RDT Carried Out: Yes ☐ No ☐	11.2.1 If Yes, RDT Examined: ……	11.2.2 Total Positive: ……	11.2.3 Total PV: ……	11.2.4 Total PF: ……	
	11.2.5 Total Mix: ……	11.2.6 Percentage of RDT Positive: ……			
11.3 Total Positive (Microscope and RDT): ……	11.3.1 Total PV: ……	11.3.2 Total PF: ……	11.3.3 Total Mix……		
	11.3.4 No.of <5 Yrs Positive……	11.3.5 No. of >5 Yrs Positive……			
11.4 Classification:	11.4.1 Indigenous: ……	11.4.1.1 PV: ……	11.4.1.2 PF: ……	11.4.1.3 Mix: ……	
	11.4.2 Imported: ……	11.4.2.1 PV: ……	11.4.2.2 PF: ……	11.4.2.3 Mix: ……	
11.5 Case Management:	11.5.1 Severe Pf Cases: ……	11.5.1.1 Death: ……	11.5.1.2 Recovered: ……	11.5.2Confirmed Malaria Death: ……	11.5.3 Suspected Malaria Death: ……
11.6 Morbidity:	11.6.1 API/1000: ……	**11.7 Mortality:**	11.7.1 Mortality Rate: ……	11.7.2 Case fatality Rate: …… (%)	
11.8 Drug Resistance: (Yes/No)	11.8.1 Resistance to PF: ……	11.8.1.1 To Chloroquine: ……	11.8.1.2 To SP: ……	11.8.1.3 Artemether: ……	11.8.1.4 Others: ……