Micro-stratification of Visceral Leishmaniasis (VL) Endemic Areas to Identify Hotspots and Disease Shifting Patterns in Nepal

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Short Bio

- Director, Public Health and Infectious Disease Research Center, Kathmandu, Nepal (2018-Present)
- Ph.D., Tropical Medicine, Mahidol University, Bangkok, Thailand (1995)
- Public health expert with nearly 30 years of experience driving innovation in health policy, strategies, and
- research. Proven track record of impactful collaborations with governments, UN agencies, and
- multilateral organizations across national and international levels. Specialized in infectious disease
- control and health systems strengthening in resource-limited settings.

Background

- VL, a neglected tropical disease, causes around 50,000 to 90,000 new cases worldwide annually (WHO, 2022)
- Bangladesh has become the first country globally to be validated for elimination of VL on 31 October 2023
- Bangladesh achieved the elimination target of less than one case per 10,000 population at the sub-district (upazilla) level in 2017 and has sustained it to date despite disruptions caused by the COVID-19 pandemic
- Although the number of VL cases has decreased by 90% in Nepal as compared to that of 2005 (WHO, 2022), they have now spread to new areas beyond the previous endemic areas in Nepal
- There is a changing epidemiology of VL in recent years
- In Nepal, previous VL endemic villages have not reported VL cases for many years but new villages appear as new foci

Three critical factors of microstratification of VL

- Disease burden – It is measured in terms of presence of confirmed VL cases (identified by passive surveillance, thus ignoring asymptomatic cases and PKDL) during the last five years.

- Receptivity (ecology) - It is an environment which support the vectors, vector behavior and bionomics that define relative transmission efficiency of the vector, and the duration of transmission.

- Vulnerability- It is measured in terms of population movement, community/household characteristics.

Objectives

- To define the risk of VL at the community level in the country.
- To develop spatial data to map VL risk in the country especially to determine risk of transmission and importation.
- To identify VL hotspots in VL endemic areas and new foci in the country and determine targeted interventions in high risk active foci areas.
- To identify VL shifting pattern over the years in the country.
- To recommend measures to further strengthen the program with view to achieve and sustain VL elimination.

Methodology

Study design

- The micro stratification of VL has been done in Nepal for the first time intending to give a better picture of VL endemicity in the country as well as VL disease shifting pattern over the years.
- This micro stratification exercise is based on secondary data available at the Epidemiology and Disease Control Division (EDCD) Nepal.
- The VL burden data at ward/village level in the country, sandfly vector data at village level, migration data and district collective housing characteristics have been used for micro-stratification.
- The stratification has been done at ward level within the district and is categorized as high, moderate and low endemic villages.

Mapping unit

- Each ward in the municipality of the districts have been stratified as high, moderate and low VL risk areas.

Data collection

- Village (ward) wise VL data of all the districts were obtained from Epidemiology and Disease Control Division (EDCD). The data were collected for five years (2017-2022).
- The housing characteristics of the district published in 2022 was used for scoring.
- The information on migration patterns were used from the IoM Migration Report, 2021.
- Entomology data were compiled from entomological surveys completed/conducted in VL reported villages of 48 districts in Nepal by Public Health and Infectious Disease Research Center, BP Koirala Institute of Health Sciences, and ASCEND Nepal. CDC light traps and manual aspiration collection of sandflies were conducted by those surveys.

Data management

- Database Management- PostgreSQL
- Data cleaning/analysis/manipulation – Microsoft Excel
- Map generation – ArcGIS 10.7 Prerelease
- Data Visualization – Microsoft PowerBI

Parameters	Geographic coverage	Source
Base map	National Boundary (1), Provinces(7), Districts (77), Wards(6743)	Survey Department, Nepal
Altitude	Ward level, All Nepal	Survey Department, Nepal
Temperature		
Housing structure	District level, All Nepal	National Population and Housing Census, 2021, National Statistics Office (previously CBS)
Vector		PHIDReC/ BPKIHS/ASCEND/EDCD
Vulnerability		Vulnerability score of 0.1 has been assigned to all 6543 wards.
Disease burden		Epidemiology and Disease Control Division, Department of Health Services

Data analysis, scoring and stratification

Characteristics	Score
VL burden	0.5
Receptivity	0.4
• Sandfly presence	0.325
• Temperature	0.025
• Altitude	0.025
• Housing condition	0.025
Vulnerability	0.1
• Migration	0.1

Disease burden [0.5]

Coverage- Ward-level

Disease	Risk level	Weightage	Condition
Present	High	0.5	Based on whether or not any person in that ward has been infected
Not present	Low	0	

Receptivity [0.4]

1. Altitude

Range - 64 to 5884 (Meters)
Coverage - Ward-level
Assigned weightage - [0.025]

Altitude (in meters)	Risk Level	Weightage
<=2000	"High"	0.025
>2000 AND <=2500	"Moderate"	0.0125
>2500	"Low"	0.00625

2. Temperature

Range -15.3 to 36.3 (Degree Celsius)
Coverage -Ward-level
Assigned weightage -[0.025]

Temperature (in ^{0}C)	Risk Level	Weightage
>=18 AND <=35	"High"	0.025
>=16 AND <18	"Moderate"	0.0125
<16	"Low"	0.00625

3. Housing structure (NHPC, 2021)

Coverage - District level
Assigned weightage - [0.025]

Housing structure	Risk Level	Weightage	Condition	NHPC categories
Temporary	High	0.025	If Temporary to Permanent ratio is greater than 1	a. Mud bonded bricks/ stone b. Wood / planks c. Bamboo d. Unbaked bricks e. Galvanized sheet f. Other
Permanent	Low	0.0125	If Temporary to Permanent ratio is less than or equal to 1	a. Cement bonded bricks/ stone b. Prefabricated sheet

4. Vector

Assigned weightage - [0.325]

Coverage - Ward-level

Vector	Risk level	Weightage	Condition
Present	High	0.325	Based on whether or not the vector has been seen at that altitude.
Not present	Low	0	

Vulnerability [0.1]

Coverage- Ward-level

Vulnerability	Risk level	Weightage	Condition
It has been assumed that all 6743 wards are vulnerable to VL infection, thus 0.1 has been assigned to all 6743 wards	High	0.1	Based on whether or not any person in that ward has been infected.

VL risk stratification

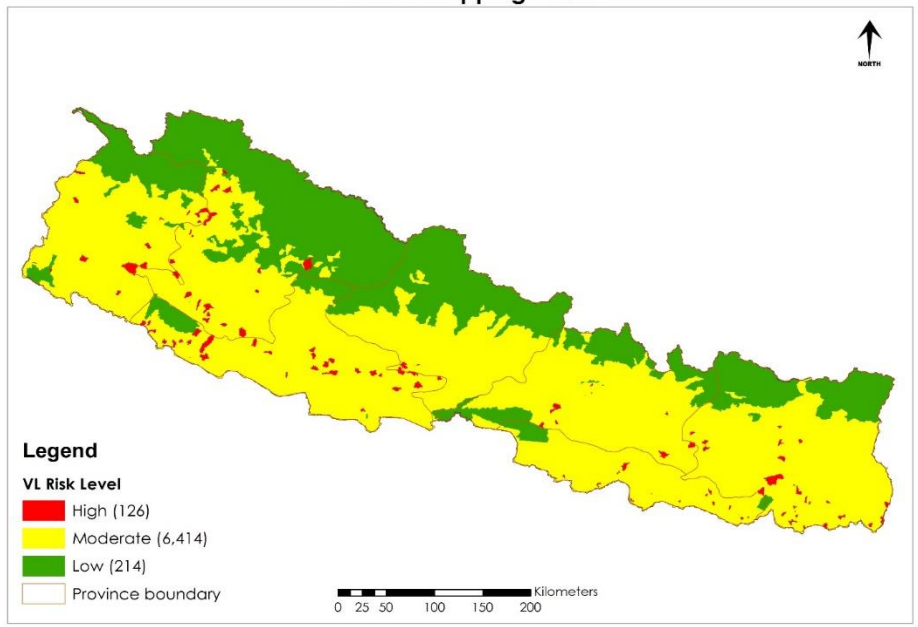
Score	Risk level
> 0.66	High
<=0.66 and >0.33	Moderate
< 0.33	Low

Results

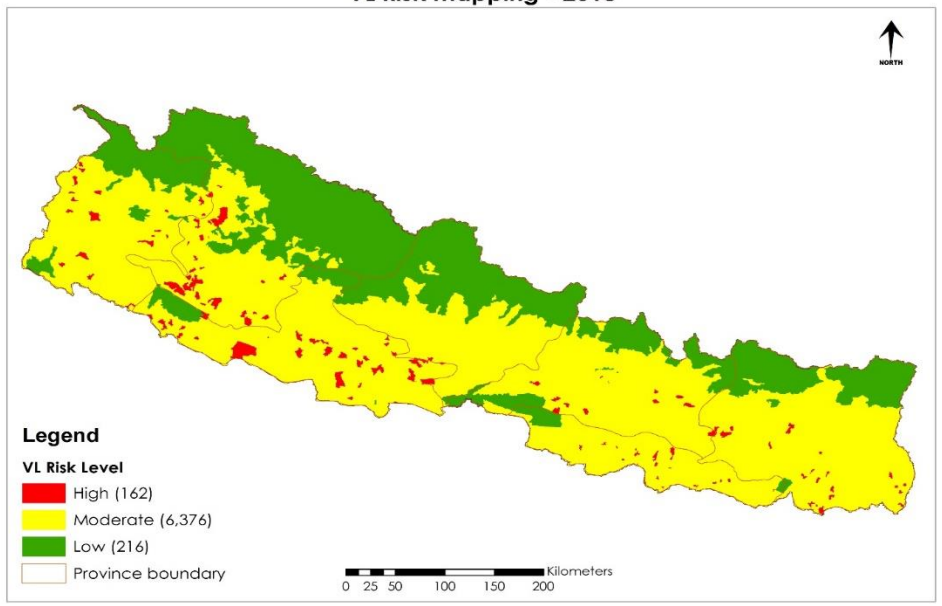
VL micro-stratification results, 2017-2022

Year	Wards at risk		
	High	Moderate	Low
2017	126	6403	214
2018	162	6365	216
2019	173	6359	211
2020	122	6405	216
2021	164	6363	216
2022	191	6339	213

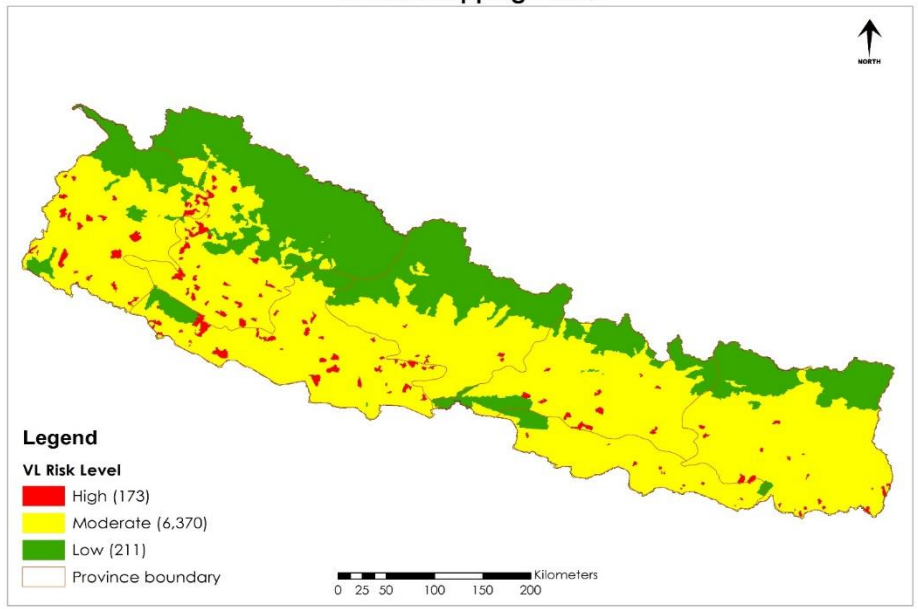
Nepal
VL Risk mapping - 2017



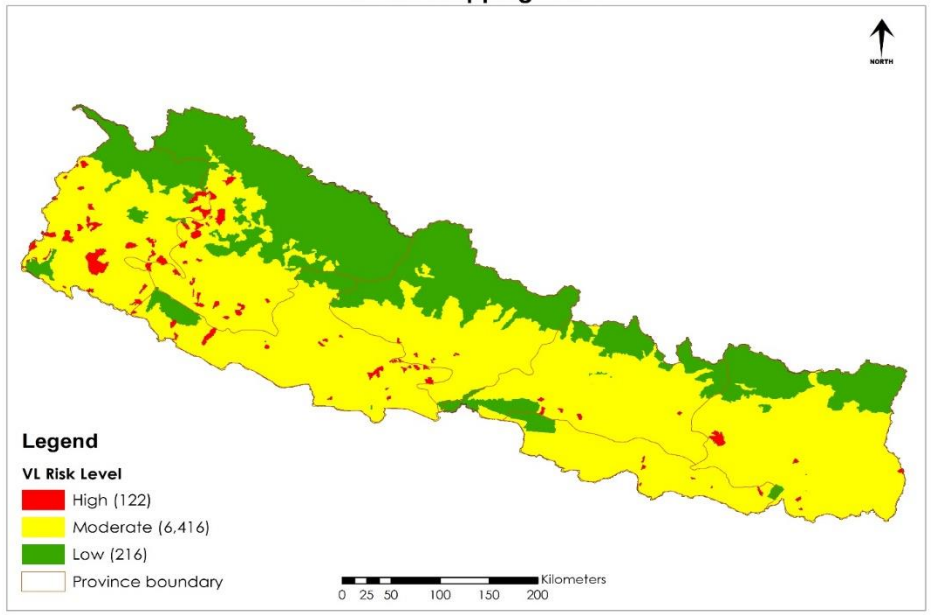
Nepal
VL Risk mapping - 2018



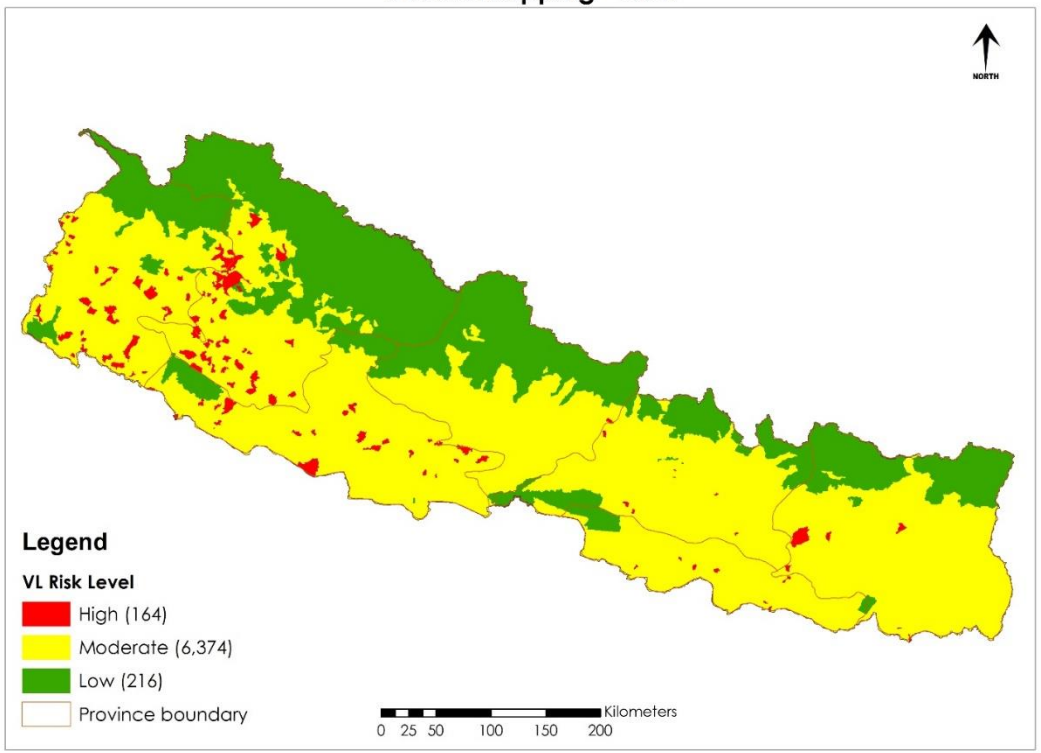
Nepal
VL Risk mapping - 2019



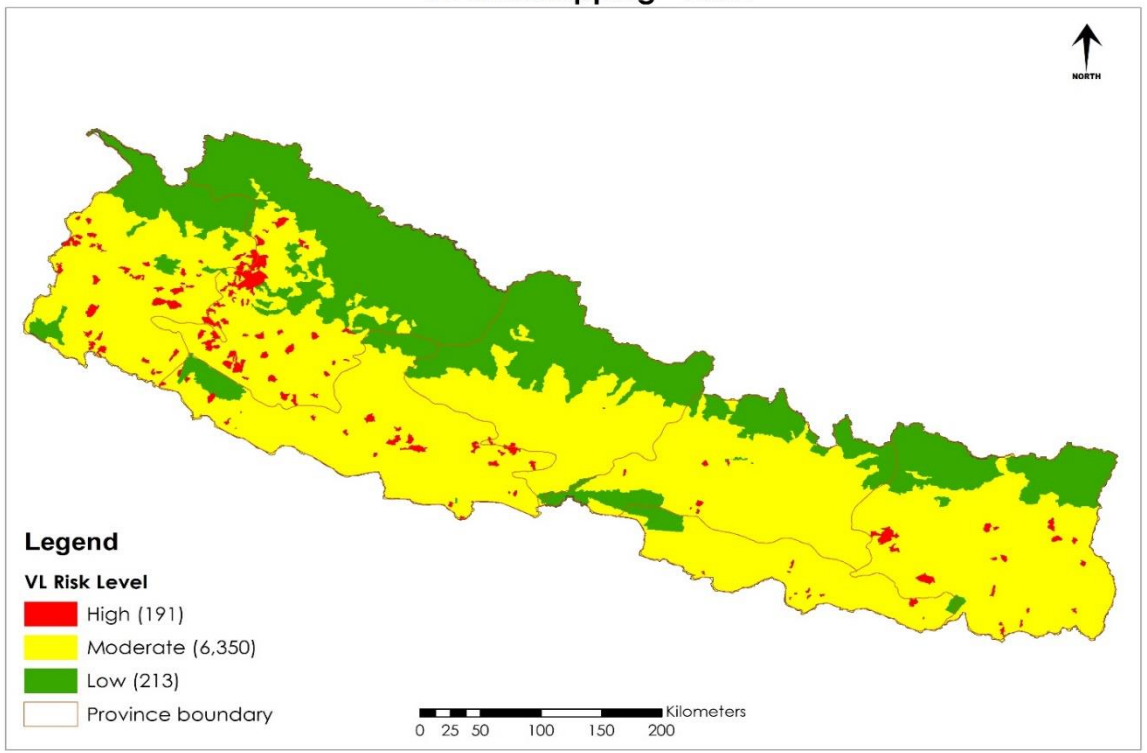
Nepal
VL Risk mapping - 2020



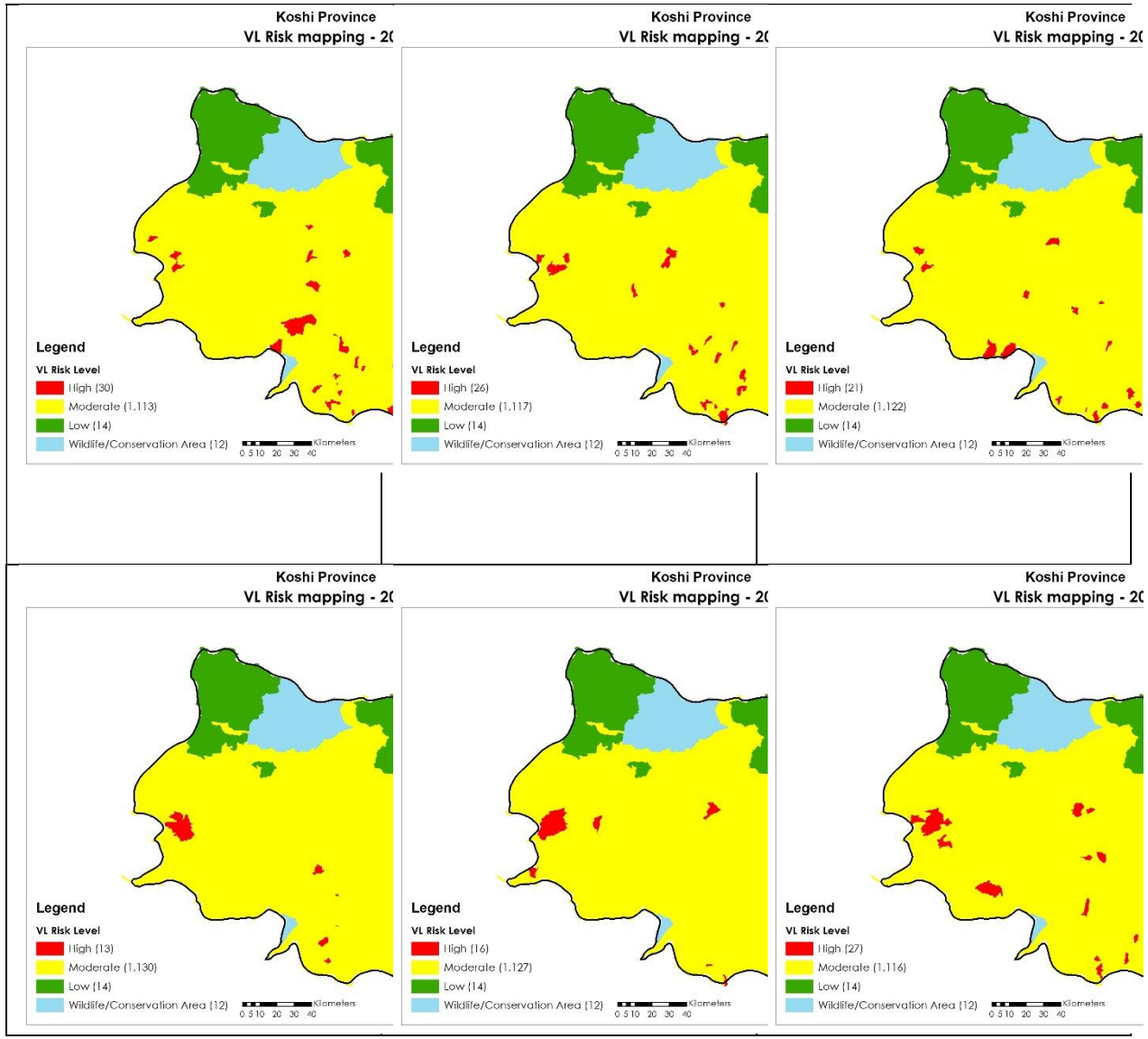
Nepal
VL Risk mapping - 2021



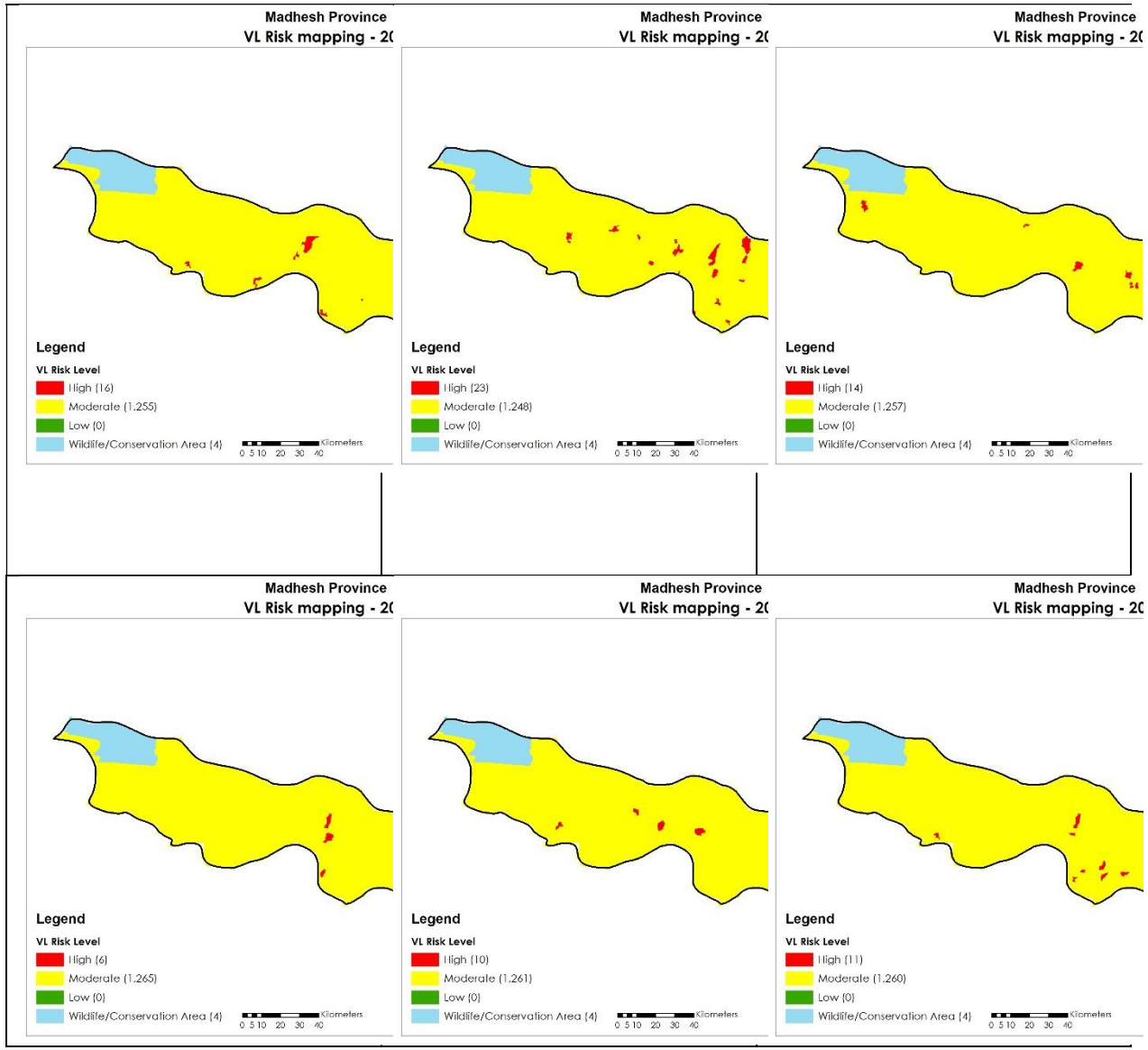
Nepal
VL Risk mapping - 2022



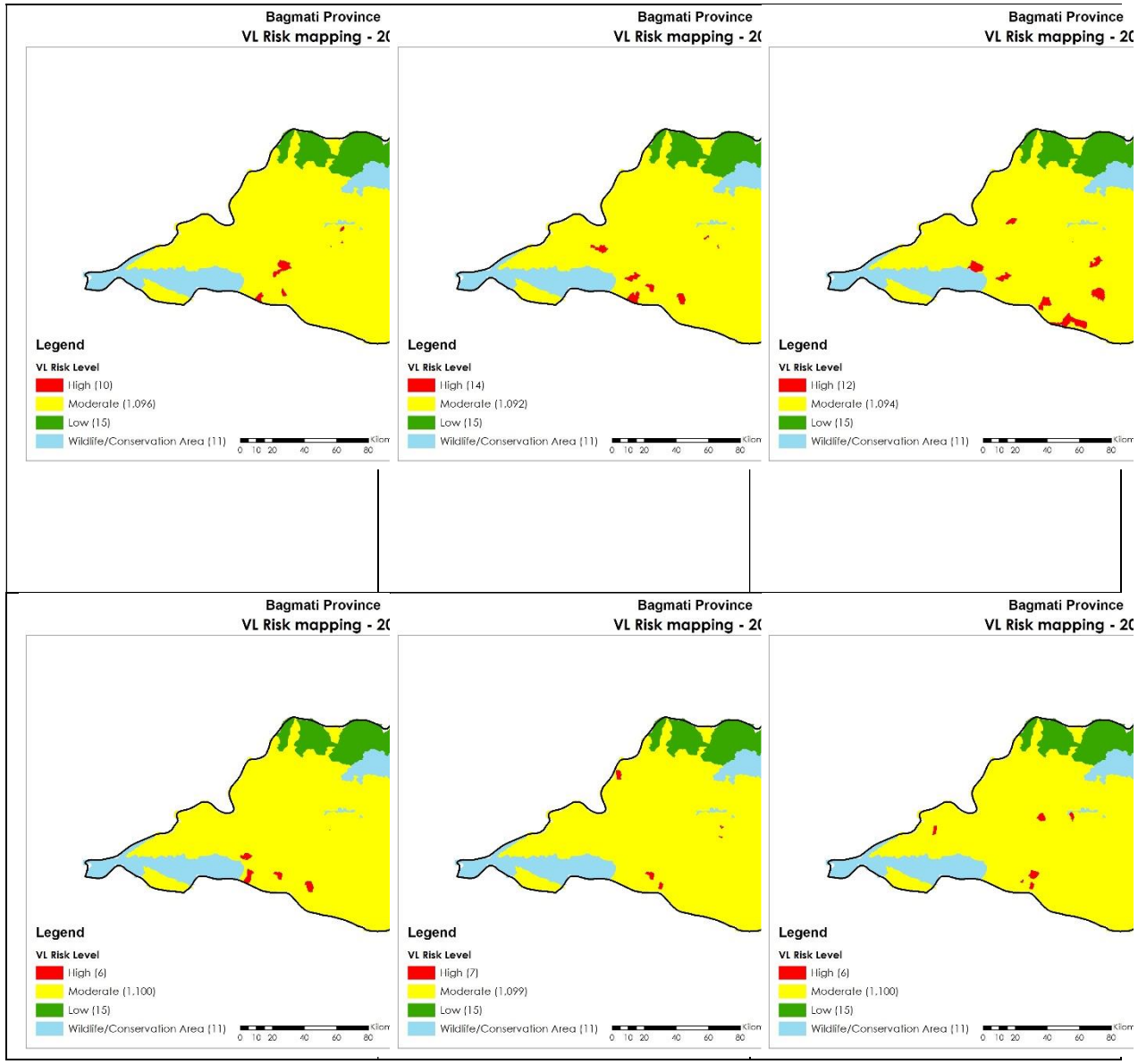
VL risk wards in Koshi province, 2017-2022



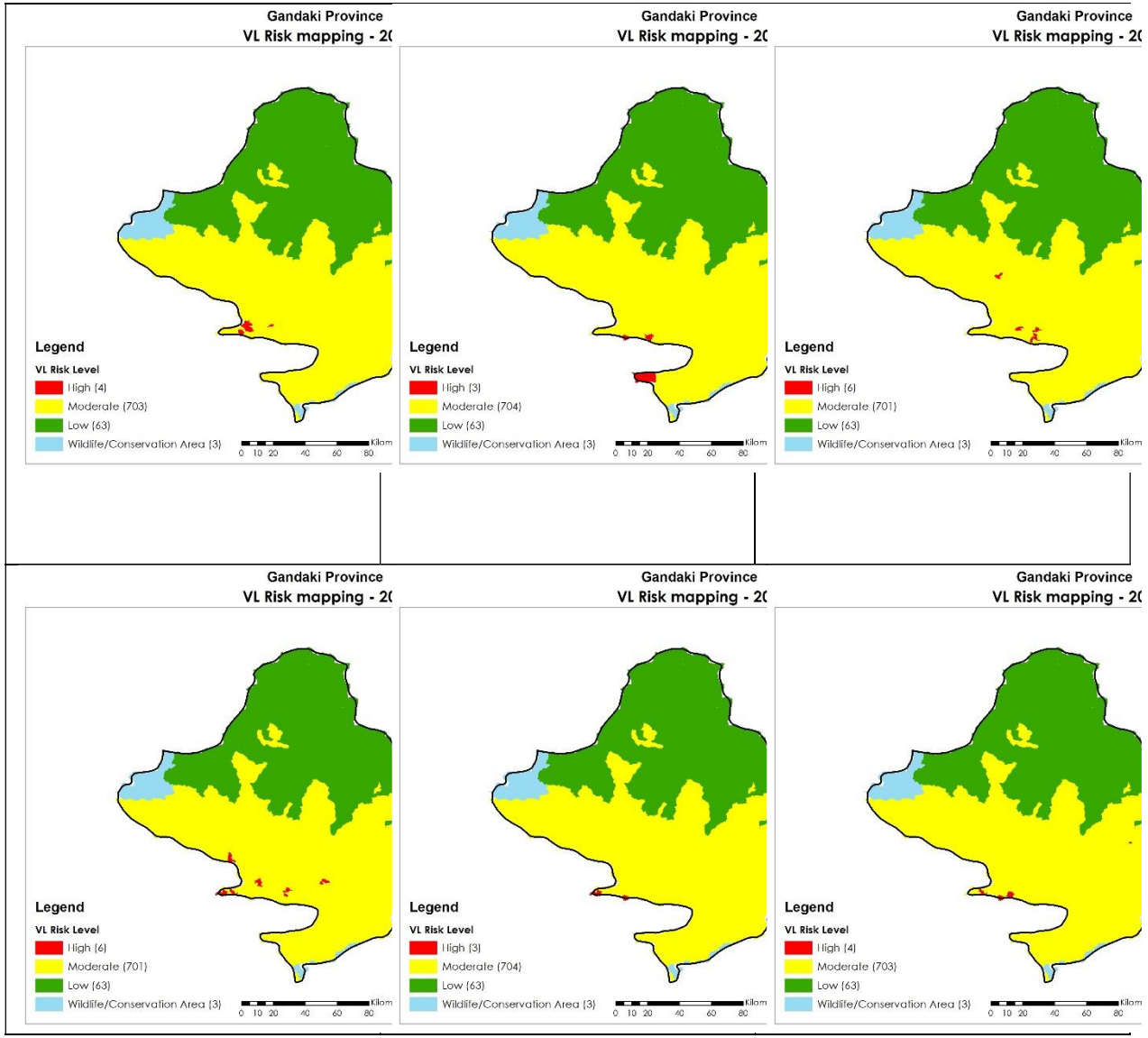
VL risk wards in Madhesh province, 2017-2022



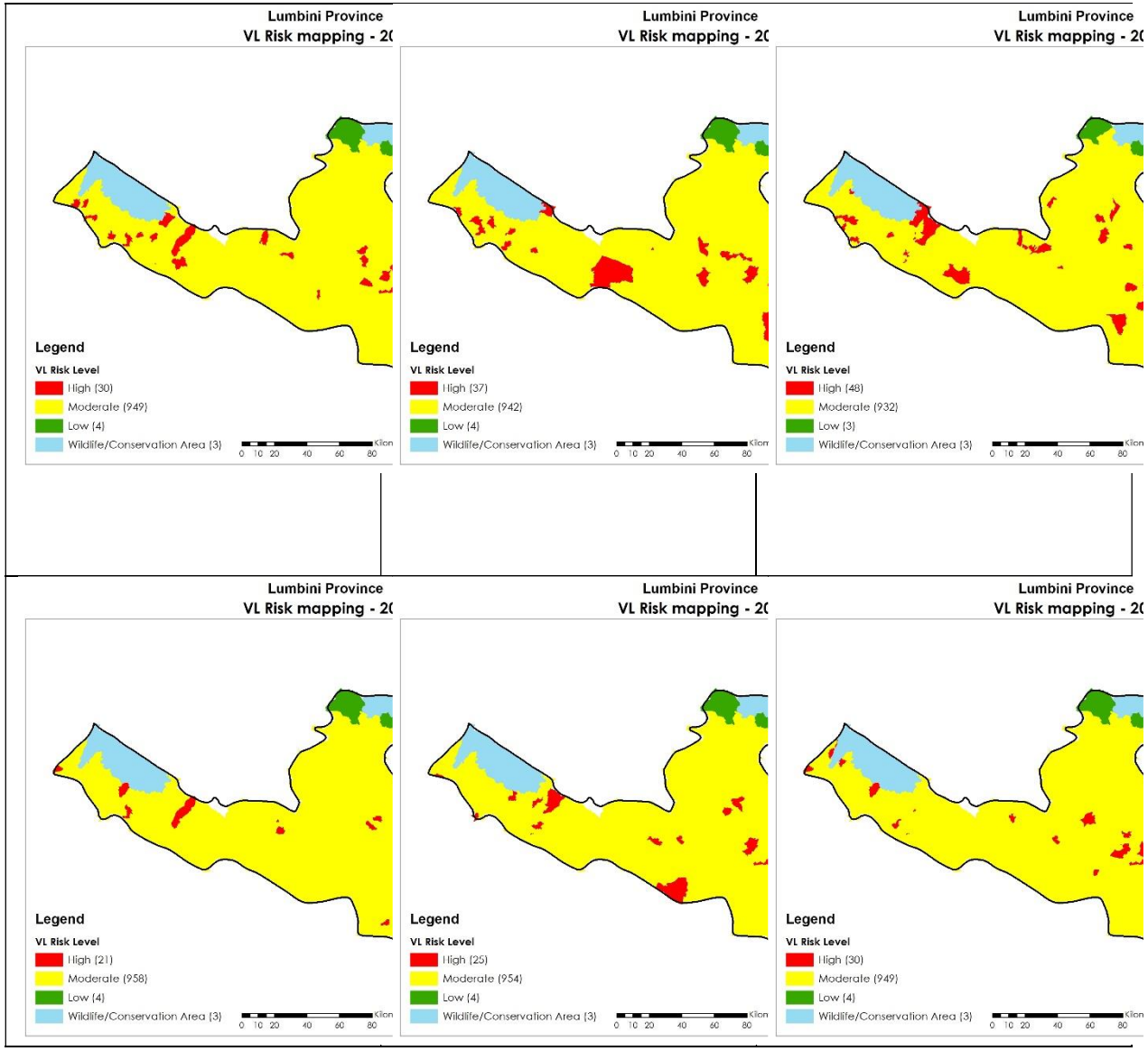
VL risk wards of Bagmati province, 2017-2022



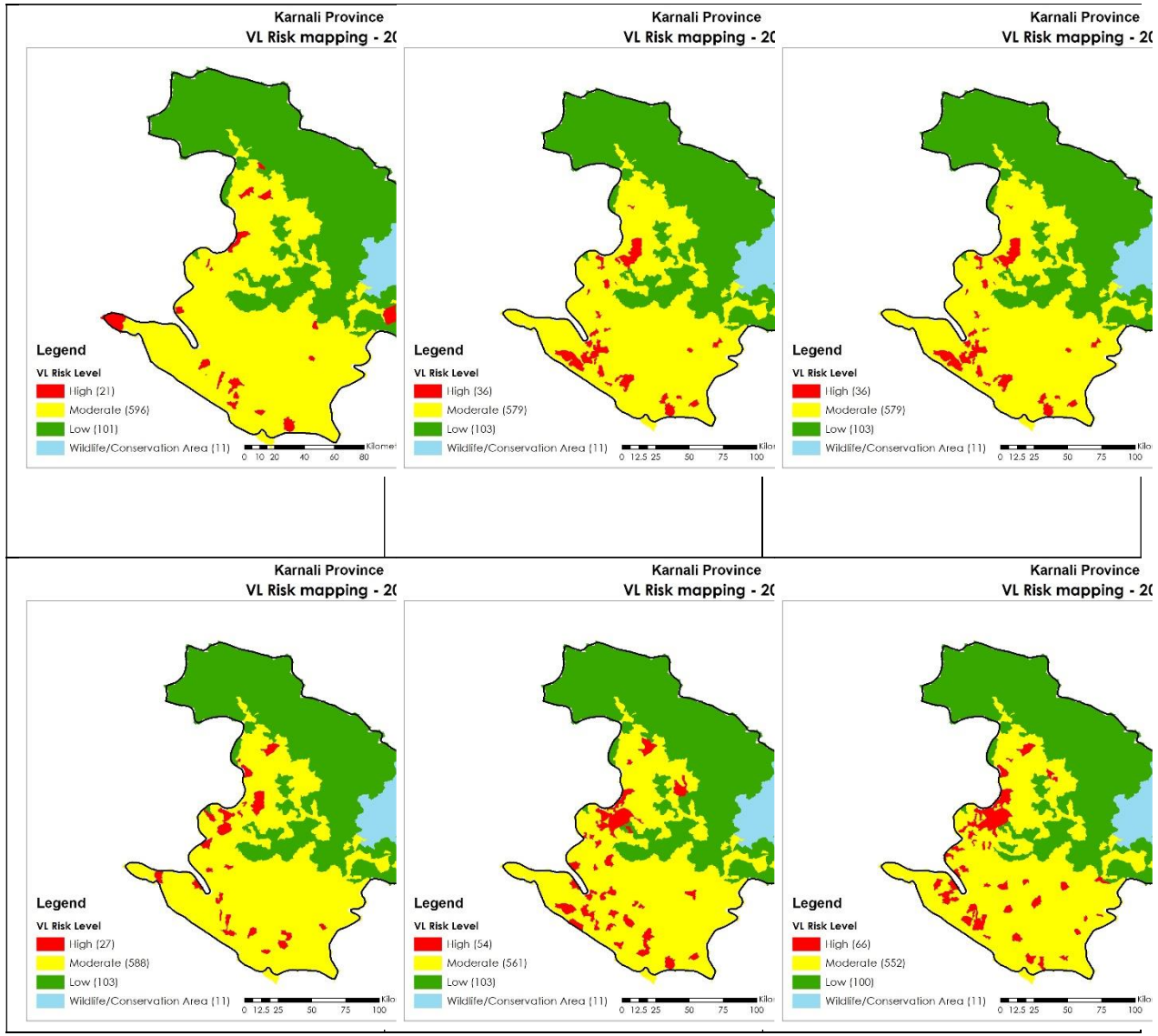
VL risk wards of Gandaki province, 2017-2022



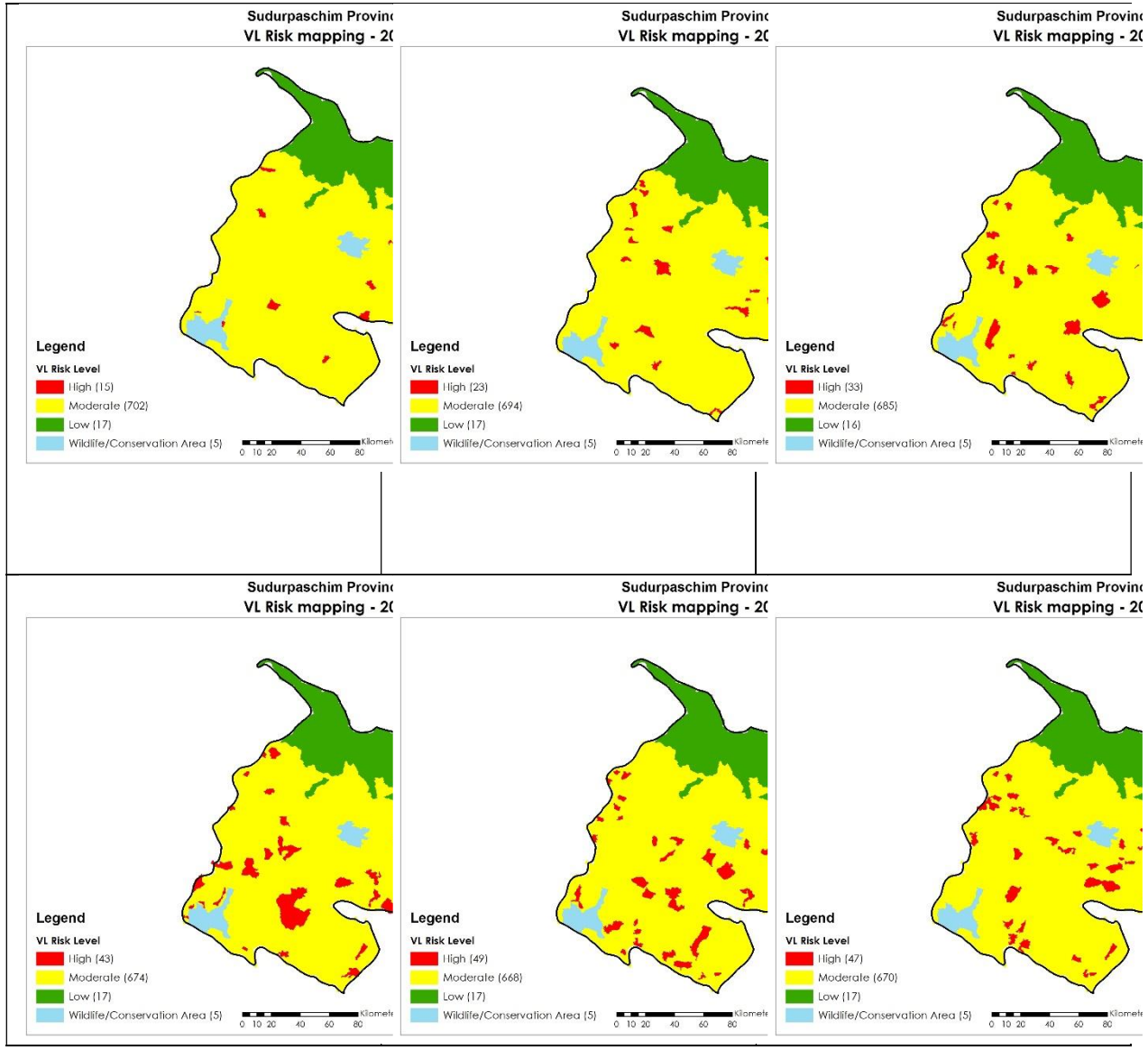
VL risk wards of Lumbini province, 2017-2022



VL risk wards of Karnali province, 2017-2022



VL risk wards of Sudurpaschim province, 2017-2022



Conclusion and recommendations

- There is clear shifting of VL from previous endemic districts (terai region of Koshi and Madhesh provinces) to new foci districts of Koshi, Karnali and Sudurpaschim provinces.

- VL is dying out from previous endemic districts of Koshi and Madhesh provinces. The endemic wards are shrinking in these provinces.

- The number of VL high risk wards are decreasing in Madhesh province over the six years.

- The number of VL high risk wards are increasing every year in Karnali and Sudurpaschim provinces.

- Intensive case management: Strengthen health care facilities in high and moderate risk areas for prompt and effective diagnosis and case management.

- Enhance surveillance: Implement active surveillance to detect and respond to any increase VL cases. Enhance community based case detection using index case approach.

- Vector control measures:
  - Prioritize and intensify indoor residual spraying campaign in high risk and moderate risk areas.
  - Promotion, availability and distribution of insecticide treated nets.

- Health promotion:
  - Conduct targeted health education campaign to increase VL awareness.

THANK YOU !!!