New approaches to risk stratification to support malaria elimination: an example from Cambodia

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Introduction

Accurate, reproducible malaria stratification is essential for effective targeting of interventions but is difficult to achieve in pre-elimination settings where malaria transmission is typically low and patchy. Here, estimates of malaria risk at sub-district or village level are needed but routine, aggregated surveillance data are not well suited to this task. Strengthening and modifying these systems is required if routinely generated case data are to be used to stratify malaria risk and guide the transition between pre-elimination to elimination phases. We explored the utility of routine malaria surveillance data collected through Cambodia's Malaria Information System (MIS) for the stratification of malaria risk in Cambodia, where the target is malaria elimination by 2025

The Malaria Information System

MIS development started in 2008 as part of a wider strategy to contain artemisinin tolerant malaria parasites in Southeast Asia (ARCE). In 2010 the MIS was scaled up to include all malaria risk districts in Cambodia (Figure 1). The MIS enables districts to compile village-level summaries of malaria case data reported by government health facilities and village malaria workers (VMWs). It also incorporates village census information and intervention coverage data. Each month district teams use a customized Access database to enter new malaria case data and email updated data extracts to the national programme (CNM).

To gauge the utility of the MIS for malaria stratification we analyzed MIS data for the period January 2010 to June 2012.

Figure 1. Current MIS coverage in 45 operational districts
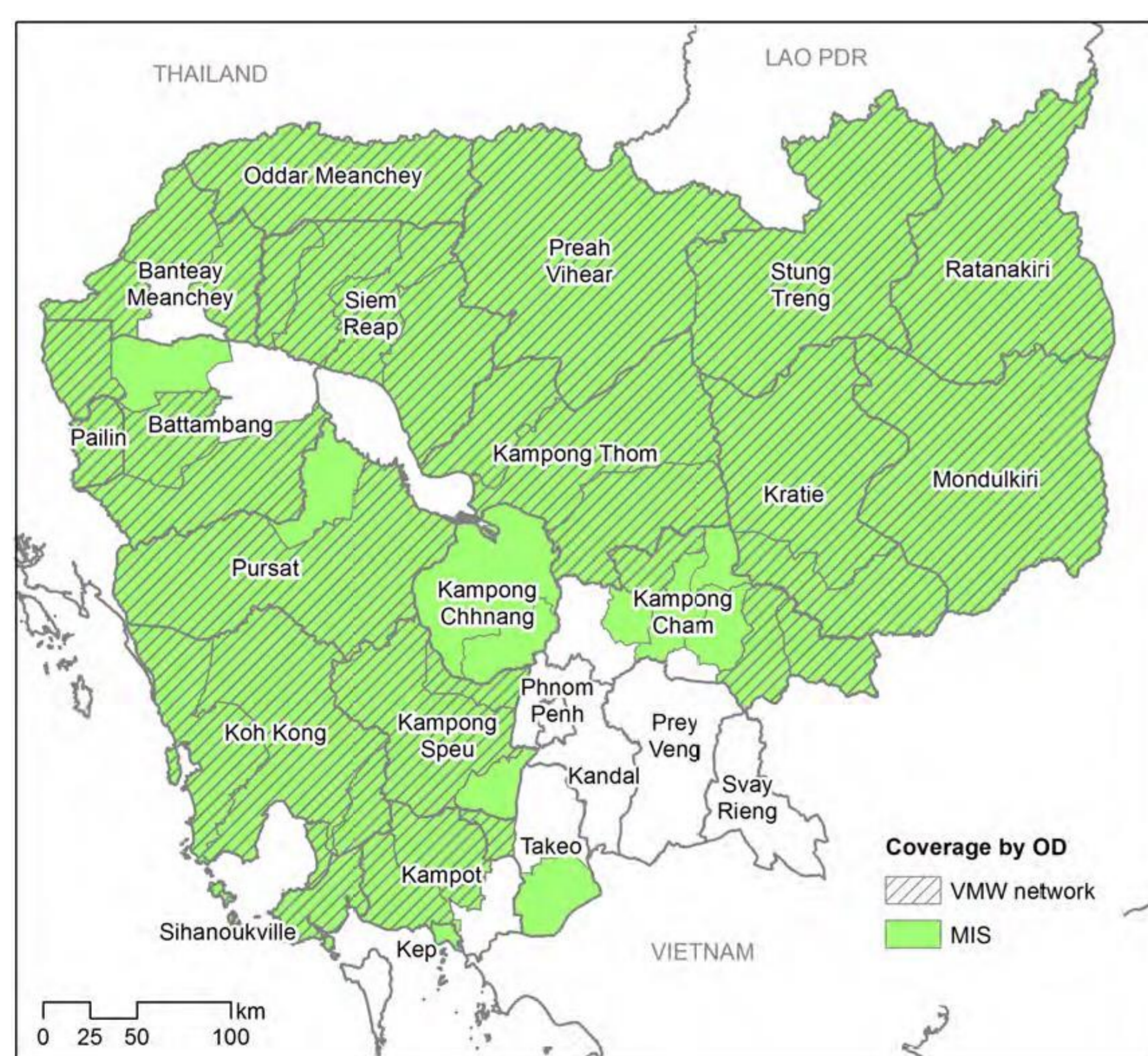
Results

Coverage and completeness

Health Facilities: the MIS covers 681 facilities (61% of the national total). 91.5% reported data during the study period. The overall reporting rate was 76.1% but was highest in 2011 (81.6%).

VMWs: the MIS covers all VMW districts (Figure 1). At the start of 2012, the VMW network incorporated 24.5% of MIS health facilities and 15.1% of villages. The reporting rate for VMWs was 96.5%. The number of active VMWs increased from 1385 to 1520 over the study period.

Malaria cases in 2011

86,684 cases were reported, 55.9% by VMWs. A small percentage (1.3%) were excluded from subsequent analysis due to coding errors or lack of a definitive diagnosis. 5,713 MIS villages reported cases in 2011 (57.8%). Of 1,489 VMW villages, 1,371 (92.1%) reported malaria.

Figure 2. The proportion of health facilities/villages villages suitable for stratification for different completeness thresholds
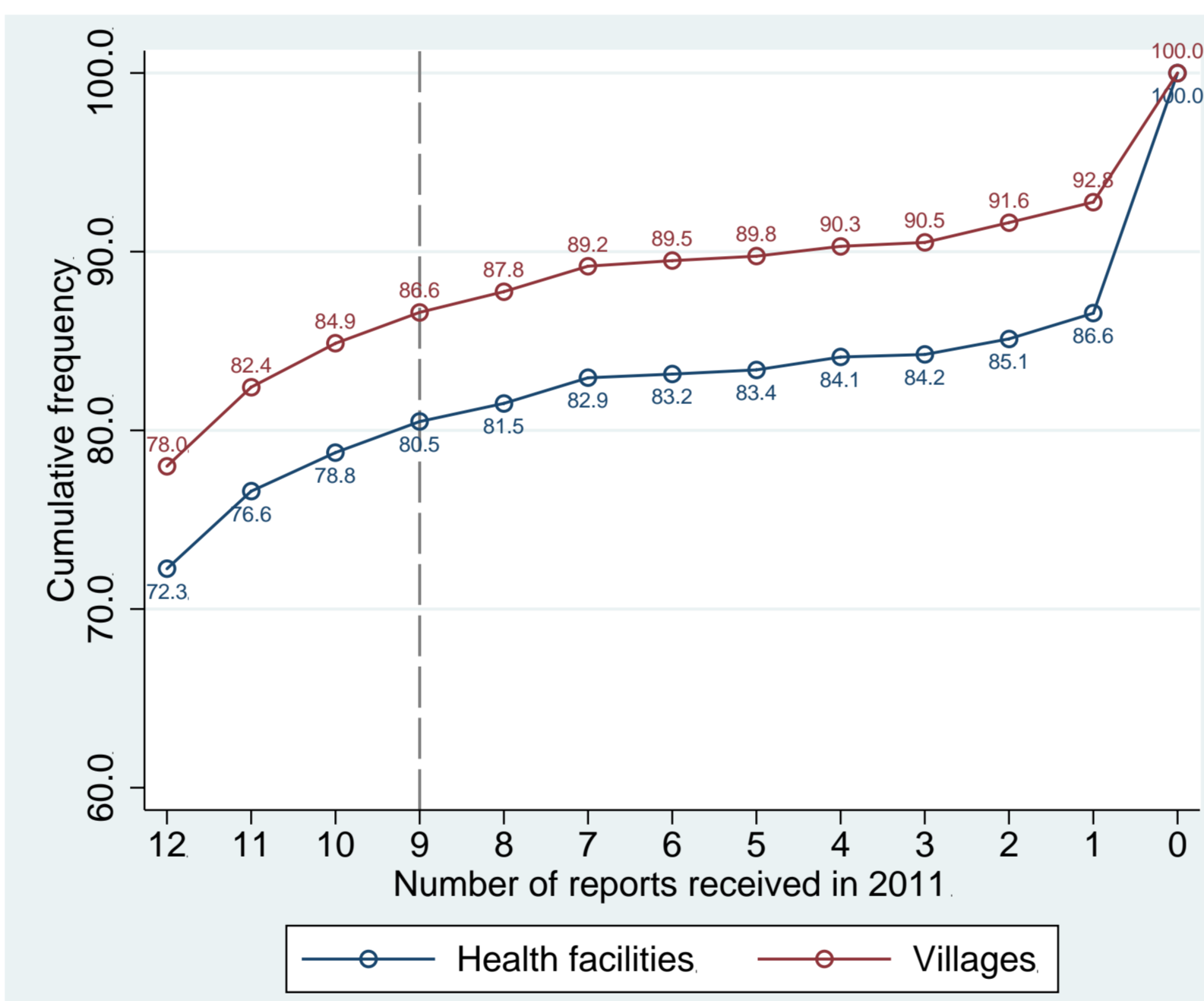
Data rules for stratification

Completeness: suitable inclusion criteria are required to maximize stratification coverage and reliability. Gaps in the stratification need to be minimized while maintaining the validity of individual village estimates (Figure 2).

Seasonality: >70% of cases occur between June and December.

Inclusion criteria: a threshold of 9 monthly reports over the year, including at least 3 reports from the high transmission season (Jun-Dec), was selected. Incidence estimates were considered valid if reporting from either VMWs or health facilities met this threshold. 1,048 villages were excluded from the stratification (10.6% of all MIS villages) as a result.

Incidence-based stratification for 2011

Village-level case data were matched to population data (resulting in the exclusion of 4.5% of villages), leaving a total of **8,420 villages – or**

Figure 3. District estimates for API in 2011
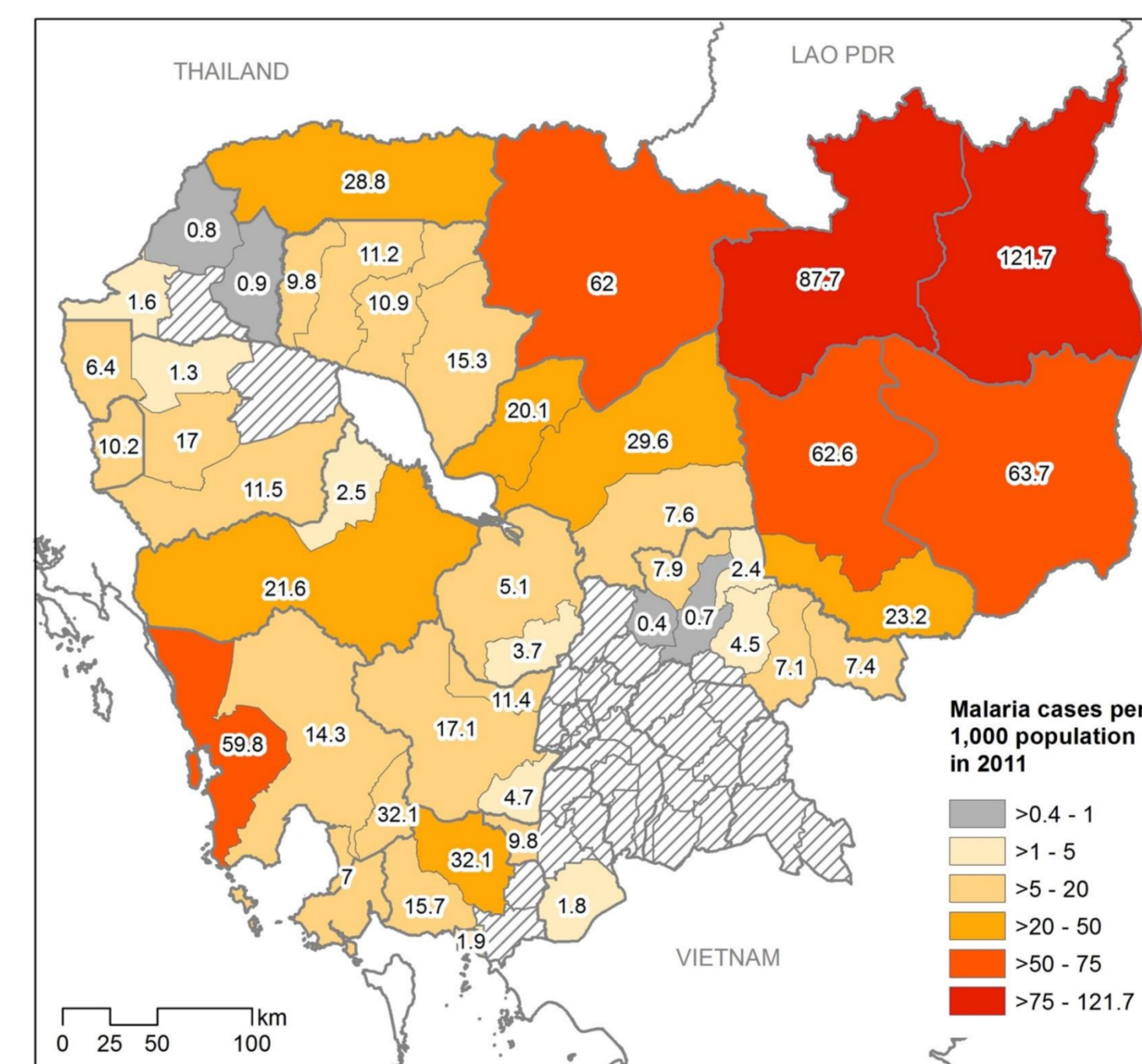
85.3% of all villages covered by the MIS - within the stratification. Table 1 shows the number of villages and population per incidence class. Median malaria incidence per district was 0-33.4/1,000 population in 2011 (overall median village incidence=1.9). Highest rates were in eastern and northern parts of the country (Figure 3). Overall, *P. falciparum* and mixed infections accounted for 57.7% of treated cases.

### Targeting of surveillance activities

The MIS currently covers 45 of 78 districts in Cambodia and its is assumed that malaria transmission does not occur outside this zone. In 2011 5,250 cases (5% of cases reported nationally) were reported outside the MIS zone by the Cambodia HMIS was 5,250. Of these, 1,728 cases (1.6% of all reported cases) presented in 16 districts bordering the MIS zone. Realistically, these can be considered potential instances of local transmission outside the MIS zone.

Table 1. Number of village and population per incidence band (all parasite species)

API	No. of villages	(% of total)	Pop (1000s)	(% of total)
0	3,052	36.2	2,225	30.6
>0-1	328	3.9	720	9.9
>1-5	2,126	25.2	2,083	28.7
>5-20	1,612	19.1	1,373	18.9
>20-50	623	7.4	506	7.0
>50	679	8.1	359	4.9

Discussion and recommendations

- Incidence-based stratification at village level is possible for large majority of villages within MIS, but still significant gaps
- Core malariometric data required for the micro-stratification can be generated routinely and automatically, allowing for regular updates that can guide transition between control to elimination phases
- Infection likely to often occur outside the resident village: likely to be a large (but unknown) number of infections attributed to the wrong location
- HMIS data for 2011 indicate likelihood of some non-MIS districts supporting transmission
- In 2011 8% of VMW villages reported no malaria cases; in selected provinces this figure was as high as 17%
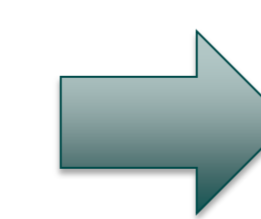
- Analysis of HMIS data at the level of health facility catchment required to inform potential scaling up of MIS
- Village risk estimates should be screened by experts at national, province and district level and upgraded or downgraded as necessary
- In the short term expert opinion can also be used to allocate risk categories to villages excluded from the stratification. Use of geo-statistical techniques to impute missing data and as a means of semi-automated mapping should also be explored
- Currently there is no way to capture travel history information from routine data; this should be addressed in the medium term
- The MIS stratification represents an objective, reproducible means of targeting interventions and resources. It is already apparent that adjustments to the VMW network are necessary

President's Malaria Initiative