Leprosy Elimination Monitoring Tool

The Leprosy Elimination Monitoring Tool accompanies the WHO Technical guidance on interruption of transmission and elimination of leprosy disease

World Health Organization

Leprosy Elimination Monitoring Tool: The LEMT is a tool accompanying the Technical guidance on interruption of transmission and elimination of leprosy

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1. Introduction

The Leprosy Elimination Monitoring Tool (LEMT) has been developed based on the Leprosy Elimination Framework.

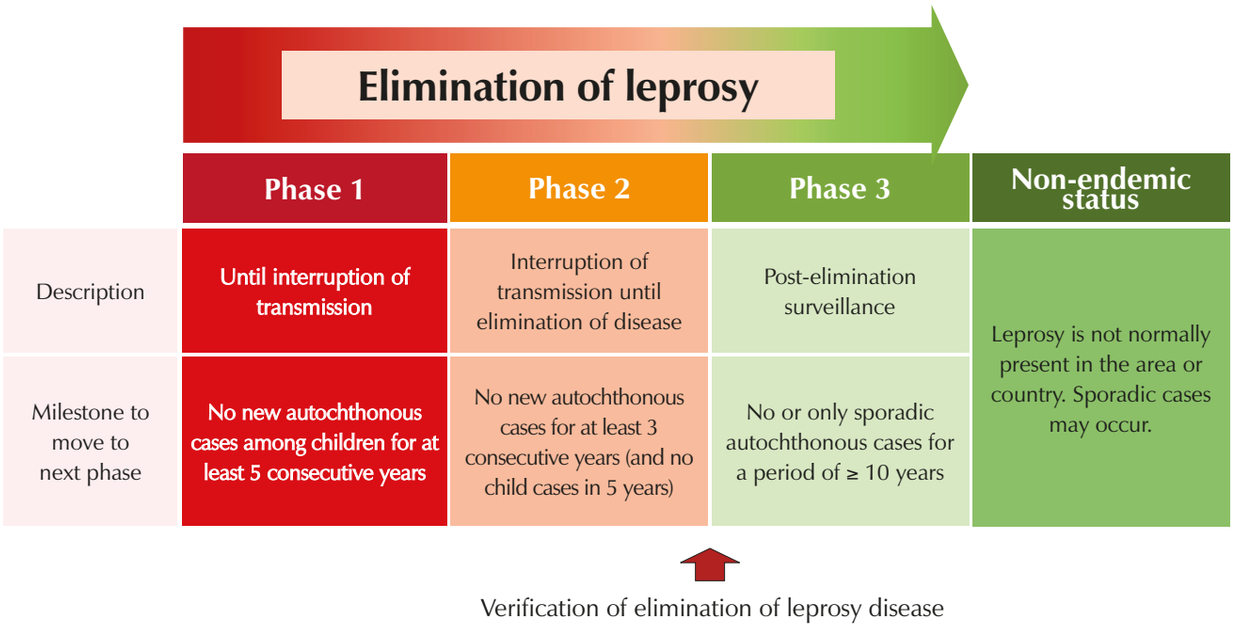
- Promote a standard way to monitor progress towards interruption of transmission and elimination of leprosy disease in detail, and to
- Promote a bottom-up process of building up evidence for interruption of transmission and elimination of leprosy disease.

The Leprosy Elimination Framework was developed based on the work and recommendations of the taskforce on criteria for elimination of leprosy (TFCEL) with the aim to identify key concepts, definitions, indicators and milestones to be used by countries on the road to interruption of transmission and elimination of leprosy disease. The Leprosy Elimination Framework provides a systematic and standardised way of tracking country progress in their fight against leprosy. WHO has developed technical guidance for countries working to achieve the milestones of interruption of transmission and elimination of leprosy disease using the Leprosy Elimination Framework. The technical guidance highlights important concepts and definitions regarding leprosy elimination and includes the newly developed Leprosy Elimination Framework showing the phases of elimination and the associated indicators and milestones. The LEMT is based on these 'phases of elimination' and visually displays country progress towards the milestones on a national and subnational level, using the traffic light-colouring scheme that corresponds to the Leprosy Elimination Framework.

The Leprosy Elimination Framework distinguishes two phases of elimination, a post-elimination phase and the subsequent non-endemic status (Figure 1). An area or country transitions to the next phase when it achieves the corresponding milestone. To visualise and assess the progress in detail, the LEMT can be applied at any subnational level for which long-term data are available. The sub-national levels can then be added up to show progress at higher administrative levels. The status of elimination is likely to vary greatly between different administrative units at one particular level, e.g., district or municipal level, and across the administrative levels. At a national level, certain countries may seem far from achieving the milestones, however, the leprosy situation may look more favourable at provincial/state or district/municipal level. Implementation of the LEMT at a subnational level stimulates a bottom-up process in which each of the administrative areas individually pursues the achievement of the set milestones. Hence, when all districts (or equivalent) in a province (or equivalent) have reached a certain milestone, that province will have reached the set milestone also. Ministries of health are encouraged to verify and acknowledge these achievements. At the same time, areas shown to be in Phase 1 or 2 should be flagged as needing additional resources to help them achieve the milestones also. Once the milestones of interruption of transmission and elimination of leprosy disease have been reached at the national level, a country can request WHO for formal verification.

[1] The technical guidance document is to be published in July 2023

Figure 1: Leprosy Elimination Framework



1.1 Phase 1 – Until interruption of transmission

Interruption of transmission is achieved when an area has reported zero new autochthonous child cases in the last five years. Past epidemiological research has shown that when the incidence of leprosy declines, age at detection shifts towards older ages (Hambridge et al., 2021). M. leprae has a long incubation period ranging from 4 to 20 years or even longer. *M. lepromatosis* has been identified as another pathogen for leprosy with similar characteristics. Manifestation of disease in children under 15 years of age thus indicates relatively recent transmission. Consequently, the rate, proportion or number of autochthonous cases among children (<15 years of age) are used as proxy indicators for recent transmission. The milestone for interruption of transmission has been defined as 'zero new autochthonous cases among children (<15 years of age) for at least 5 consecutive years'. When this milestone is reached, the area transitions into Phase 2 according to the Leprosy Elimination Framework. However, sporadic child cases can still occur during Phase 2. It is recommended that achievement of this milestone is formally evaluated as it can also be a result from lack of awareness, inadequate reporting systems or inadequate diagnostic services.

1.2 Phase 2 – From interruption of transmission until elimination of leprosy disease

Elimination of leprosy disease is achieved when an administrative area has not diagnosed any new autochthonous cases for at least three consecutive years. Ideally, the achievement should be verified by carrying out a Leprosy Programme and Transmission Assessment (LPTA). If confirmed, the area transitions into Phase 3, the Post-elimination surveillance phase. Due to the long incubation period, sporadic cases are still likely to occur from time to time. Theoretically, leprosy could re-emerge in a given area. Re-emergence should be considered when the following criterion is met 'the occurrence of 3 or more cases of leprosy on average in 3 consecutive years in one area'. Such an observation should be carefully investigated. If no operational reason for the increased incidence is found, and if new cases continue to occur at the same or an increased level, the health authorities may decide to reverse the area to the previous phase of elimination. Each sporadic child case should also be investigated

closely to assess whether infection is likely to have been acquired locally, to see if an index case can be established and whether there are any secondary cases among contacts. Targeted interventions may be started, such as active case finding through contact screening and, depending on the leprosy control policy, administration of single dose rifampicin (SDR) as part of post-exposure prophylaxis (PEP) to contacts who have no signs and symptoms of leprosy.

1.3 Phase 3 – Post-elimination surveillance phase

After achieving the elimination of leprosy disease milestone, an area or country transitions into the Post-elimination surveillance phase. Due to the long incubation period of *M. leprae*, sporadic new cases of leprosy may still occur. It is very important that sporadic new cases are investigated thoroughly to assess whether infection is likely to have been acquired locally, to see if an index case can be established. Contact screening should also be done in this phase to investigate whether there are any secondary cases among contacts. Evidence suggests that, at this stage of endemicity, the risk of secondary cases occurring is very low. Robust surveillance is still essential during this phase to detect, diagnose, treat and report any 'sporadic cases' that may occur. Sporadic cases should be unrelated to other concurrent local cases. In other words, they should not be connected by contact in recent years. Theoretically, a re-emergence of leprosy could still occur in a given area, but available evidence suggests that this is very rare.

1.4 Non-endemic status

An area or country has achieved 'Non-endemic status' if no or only sporadic new autochthonous cases have been detected for a minimum of 10 years. An robust surveillance and response system should be in place to detect, diagnose, treat and report any 'sporadic cases' that may occur. Regular surveillance should be continued for early detection of sporadic cases among non-autochthonous population.

2. How to use the Leprosy Elimination Monitoring Tool?

The LEMT is developed to display subnational and national historical data on (autochthonous) new leprosy cases in at least two categories of age at detection: adults and children (<15 years of age). For most countries investigated to date, the LEMT comprised a time span of 20 years, starting in 2000. However, the LEMT can be applied to any area for which a minimum of 10 years of data are available. Areas that are still in Phase 1 or 2 should be noted by programme managers as needing additional resources to help them achieve the milestones also.

2.1 Tool legend

As noted above, the colour scheme in the LEMT matches those of the Leprosy Elimination Framework. Simple traffic light colouring is used to distinguish the individual phases, thus phase transition is marked by the colour change of the row. Table 1 includes the legend for the LEMT.

Leprosy Elimination Monitoring Tool Legend	
	Phase 1 – Until interruption of transmission Milestone: Five consecutive years no autochthonous child cases (< 15 years of age)
	Phase 2 – Until elimination of leprosy disease Milestone: Three consecutive years no autochthonous cases, both adult and child cases[1]
	Phase 3 – Post-elimination phase Milestone: At least 10 consecutive years no autochthonous cases, both adult and child cases[2]
	Non-endemic status Definition: No autochthonous leprosy cases have been detected for 10 years or more[2]
1	Sporadic adult case Definition: Single adult case occurring during Phase 3
1	Sporadic child case Definition: Single child case occurring Phase 2 or 3
	Definition: 3 or more cases of leprosy in three consecutive years on average in one area; re-emergence should be investigated[3]

[1] During this phase sporadic child cases may still occur

[2] During this phase sporadic child or adult cases may still occur. The administrative area continues progression in the designated elimination phase.

[3] Theoretically, re-emergence of leprosy could happen during Phase 2 or 3, but is a very rare event. So any occurrence of multiple new cases should be investigated to see if operational factors might explain the increase in cases detected. Re-emergence during Phase 2 (3 or more new child cases on average in 3 consecutive years) is theoretically possible but has not been observed in any dataset until now.

2.2 Entering data and reading the tool

The tool is divided into several columns and rows, depending on the time span and the number and level of administrative areas to be included. The names of the Level 1 administrative areas are shown in the first column. The type of area depends on the availability of data across the different administrative levels of a country. These can be provinces or equivalent, districts or equivalent or even villages. The second column describes Unique Area Code (UAC) of these Level 1 areas. The third and fourth columns describe the Area names and UAC of the Level 2 areas, often districts or municipalities. The fifth column contains the Age group of the leprosy cases. From the sixth column onwards, the annual case counts are entered for each area and age group. These should be updated annually as new statistics become available.

Data can be imported from an external database in Excel or csv format into the first worksheet of the LEMT. The data format and column headings are shown below in Section 2.3.1. The LEMT includes a facility to automatically transfer data in the first worksheet into the LEMT table. For this work, use of 'macro-enabled MS Excel' is required. The transfer is done by navigating to the Control Panel tab worksheet and clicking on the 'Data Transfer' button. More details on how this database should be organised will be explained further down. Once this is done, classification and colouring of the phases and sporadic cases can be done automatically by clicking on the 'Automatic Phase Classification' button on the Control Panel worksheet (Figure 2).

For the automatic transfer of data to work correctly, it is necessary that the database contains data in the Area L2 field because the macro uses the Area L2 name to automatically fill the LEMT. If the country uses only Level 1 areas for the analysis, another version called "Level 1 Leprosy Elimination Monitoring Tool" is available for use. For example, for the Thailand data used in Figure 3, the information about Level 2, area and UAC, was not available. So the Level 1 LEMT was used for the automatic data transfer to work correctly.

The results should be checked carefully since some data anomalies can lead to incorrect colouring. The colouring can also be done or corrected manually. The colours can be applied by right-clicking on a cell or selection of cells and choosing the appropriate colour from the 'Fill Colour' tool. It is possible to sort the areas or UAC in alphabetical or numerical order by clicking on the filter symbol ( ) present in each of these fields.

LEGEND

Area L1 - Area Name Level 1
UAC L1 - Unique Area code Level 1
Area L2 - Area Name Level 2
UAC L2 - Unique Area code Level 2

Area names **Age groups** **Leprosy case counts**

Area L1	UAC L1	Area L2	UAC L2	Age group	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
South Central	MV004	Alif Alif Atoll	MV004008	Children																							
				Adults																			1				
				Total new cases																			1				
South Central	MV004	Alif Dhaal Atoll	MV004020	Children	2																						
				Adults	1	1		1		1									1								
				Total new cases	3	1		1		1									1								
North Central	MV002	Baa Atoll	MV002007	Children	2																						
				Adults	1									1													
				Total new cases	3									1													
South Central	MV004	Dhaalu Atoll	MV004012	Children																							
				Adults											1	1											
				Total new cases											1	1											
South Central	MV004	Faafu Atoll	MV004011	Children		2		1																			
				Adults				1				1		2				1			1		2		2		
				Total new cases		2		2				1		2				1			1		2		2		
South	MV005	Gaafu Alif Atoll	MV005016	Children				3																			
				Adults	1		1	2				2				1			1					1			
				Total new cases	1		1	5				2				1			1					1			

Figure 2: Part of the LEMT with Maldives data

In the above LEMT, using data from Maldives as example, data for Level 1 and 2 were available. The LEMT starts counting from the year 2000 onwards, which means that each administrative area starts in Phase 1 for at least five years. After five consecutive years of not reporting any child cases, an area progresses into Phase 2, to be visually marked by the colour change from red to orange.

Area L1	UAC L1	Area L2	UAC L2	Age group	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Amnat Charoen	THA_26			Children		1										1											
Amnat Charoen	THA_26			Adults	4	2	5	3		1	3	1				1		2	1	1	1				1		
Amnat Charoen	THA_26			Total new cases	4	3	5	3		1	3	1				2		2	1	1	1				1		
Ang Thong	THA_06			Children						1																	
Ang Thong	THA_06			Adults	2	1	2	1	1	3	1						1		1	1							
Ang Thong	THA_06			Total new cases	2	1	2	1	1	4	1						1		1	1							
Ayutthaya	THA_05			Children																							
Ayutthaya	THA_05			Adults	6	5	1	5	5	3	3	1	1			1							1	3	1		
Ayutthaya	THA_05			Total new cases	6	5	1	5	5	3	3	1	1			1							1	3	1		
Bangkok	THA_01			Children			2		1		1	1							1								
Bangkok	THA_01			Adults	48	48	43	34	33	39	25	22	22	16	13	11	10	9	7	6	9	5	7	5	2	1	
Bangkok	THA_01			Total new cases	48	48	45	34	34	39	26	23	22	16	13	11	10	9	8	6	9	5	7	5	2	1	
Bueng Kan	THA_27			Children								1															
Bueng Kan	THA_27			Adults	1	2	4	2	6	6	4	3	1	1		6		2		1	1	1					
Bueng Kan	THA_27			Total new cases	1	2	4	2	6	6	4	4	1	1		6		2		1	1	1					
Buriram	THA_20			Children	5	1	6	3	2		2		2	2	2	1	2	1						1			
Buriram	THA_20			Adults	71	62	73	42	59	44	27	30	13	30	24	21	7	13	20	9	5	9	11	12	9	1	1
Buriram	THA_20			Total new cases	76	63	79	45	61	44	29	30	15	32	26	22	9	14	20	9	5	9	11	13	9	1	1

Figure 3: Part of the LEMT with Thailand data

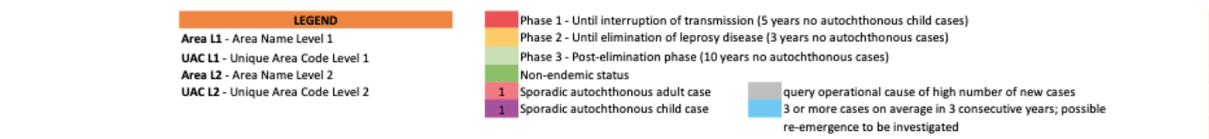
Subsequently, after the Phase 2 area has reported zero autochthonous cases for three consecutive years, it transitions into Phase 3, the Post-elimination phase. This should be visually marked by a colour change from orange to light green. Ultimately, the area achieves non-endemic status after ten or more consecutive years of zero autochthonous cases (with the exception of sporadic cases). For example, this is the case in Amnat Charoen and Ang Thong Provinces, Thailand, shown in the figure above. Sporadic child cases in Phase 2 or 3 and sporadic adult cases in Phase 3 or after Non-endemic status has been reached are marked in the same way used hot pink or light red, as shown in the legend on p.5.

Not every area progresses at equal speed towards the elimination milestones. Figure 3 displays a subset of data from the LEMT applied to Thailand data, to illustrate some example scenarios that can occur, depending on the reported data. Areas that continue to report child cases remain in Phase 1 for longer than five years, as is the case in Buriram province in the example below.

Immediate progression to Phase 3 after the milestone of Phase 1 is achieved is also possible in case an area has not reported *any* case over the previous three years when the 'interruption of transmission' milestone is reached. An example can be seen in Chantaburi, which immediately transitioned into Phase 3 in 2012. If no cases are reported in the first few years of the period for which data are available, it is possible that the area was already in Phase 3 (or even non endemic), even before 2000. This might be the case in Alif Alif Atoll and Dhaalu Atoll in Maldives (Figure 2).

Some areas do not progress into subsequent phases during the current LEMT timespan. For example, Chaiyaphun and Buriram remained in Phase 1 and 2, respectively, until 2022. In future, additional data may become available that should be added to the current tool. Based on this additional data the tool will be modified to display the present elimination status.

Figure 4: leprosy Elimination Monitoring Tool - Thailand data 2000-2022



Area L1	UAC L1	Area L2	UAC L2	Age group	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Bueng Kan	THA_27			Children								1															
Bueng Kan	THA_27			Adults	1	2	4	2	6	6	4	3	1	1		6		2		1	1	1					
Bueng Kan	THA_27			Total new cases	1	2	4	2	6	6	4	4	1	1		6		2		1	1	1					
Buriram	THA_20			Children	5	1	6	3	2		2		2	2	2	1	2	1						1			
Buriram	THA_20			Adults	71	62	73	42	59	44	27	30	13	30	24	21	7	13	20	9	5	9	11	12	9	1	1
Buriram	THA_20			Total new cases	76	63	79	45	61	44	29	30	15	32	26	22	9	14	20	9	5	9	11	13	9	1	1
Chachoengsao	THA_15			Children																							
Chachoengsao	THA_15			Adults	7	10	2	1	2	2	4	3									1	1	1		2	1	
Chachoengsao	THA_15			Total new cases	7	10	2	1	2	2	4	3									1	1	1		2	1	
Chainat	THA_09			Children																							
Chainat	THA_09			Adults	1	4	3	1		1	1	1			2	2			1	1	1						
Chainat	THA_09			Total new cases	1	4	3	1		1	1	1			2	2			1	1	1						
Chaiyaphun	THA_25			Children	1		1	1			2				1	1	1			1			1				
Chaiyaphun	THA_25			Adults	33	22	41	25	26	37	23	18	29	22	18	21	5	6	7	10	2	5	2	3	1	3	
Chaiyaphun	THA_25			Total new cases	34	22	42	26	26	37	25	18	29	22	19	22	6	6	7	11	2	5	3	3	1	3	
Chanthaburi	THA_13			Children	2	2			1		1																
Chanthaburi	THA_13			Adults	10	4	7	7	8	7									1	1				1			
Chanthaburi	THA_13			Total new cases	12	6	7	7	9	7	1								1	1				1			

2.3 Producing the LEMT data table

2.3.1 Importing data from a database

Data can be imported from any database that can export data in Excel or csv format. At present, most data are expected to be in aggregated format by area, age group and year. However, data from individual case-level databases can also be imported using a different version of the LEMT. This is available on request to WHO. The data headers should have the exact variables names as shown below. This could of course be changed after importing the data into Excel.

Area names L1	Unique area code L1	Area names L2	Unique area code L2	Agegroup	Year	Cases

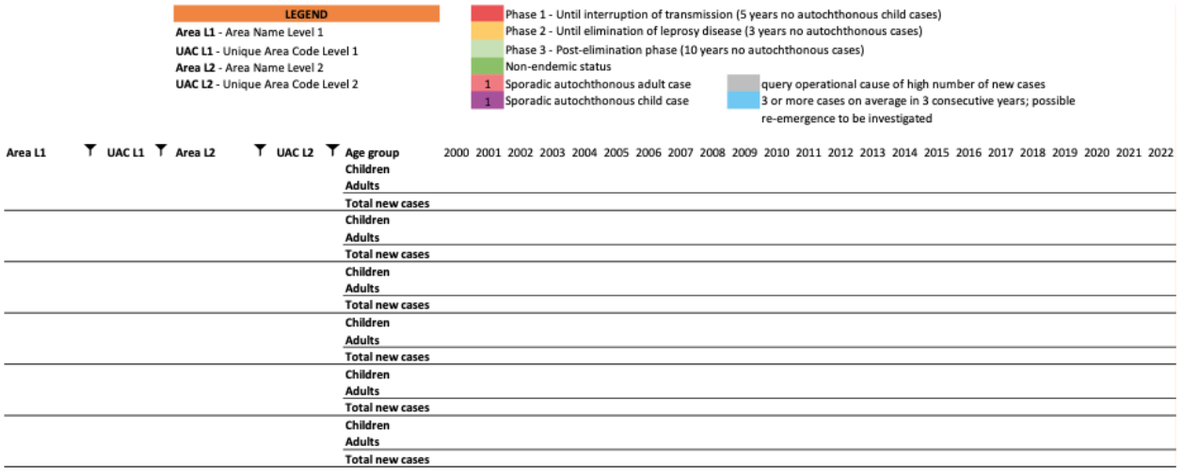
After the import, the data will look something like this. The worksheet should be called Data_leprosy.

Area names L1	Unique area code L1	Area names L2	Unique area code L2	Agegroup	Year	Cases
North	MV001	Haa Alif Atoll	MV001001	Childeren	2000	
North	MV001	Haa Alif Atoll	MV001001	Adults	2000	
North	MV001	Shaviyani Atoll	MV001003	Childeren	2000	
North	MV001	Shaviyani Atoll	MV001003	Adults	2000	
North Central	MV002	Noonu Atoll	MV002004	Childeren	2000	
North Central	MV002	Noonu Atoll	MV002004	Adults	2000	
North Central	MV002	Raa Atoll	MV002006	Childeren	2000	
North Central	MV002	Raa Atoll	MV002006	Adults	2000	1
North Central	MV002	Baa Atoll	MV002007	Childeren	2000	2
North Central	MV002	Baa Atoll	MV002007	Adults	2000	1
North Central	MV002	Lhaviyani Atoll	MV002005	Childeren	2000	1
North Central	MV002	Lhaviyani Atoll	MV002005	Adults	2000	

2.3.2Transferring the data to the LEMT and classifying and colouring areas according to the Leprosy Elimination Framework

The empty LEMT template is found on the Tab called 'Elimination Monitoring Tool'. It looks like this:

Figure 5: LEMT template with classification macro



Next you navigate to the second Tab called 'Control Panel' (see Figure 6). On this worksheet you can perform as well as undo three actions:

- Transferring the data from the database in the Data_leprosy tab to the LEMT (Data Transfer). Click on Data Transfer button to initiate the conversion of the data from the database format to the LEMT. Please note that, depending on the size of the database and the speed of the computer, the conversion to the LEMT format can take few seconds to a few minutes. The screen may also look shaky, but that is just temporary. Please note also that, during this process, the macro that does the conversion generates an additional worksheet called 'PivotTable'. You can ignore this as you won't need this. However, while using Clear Data Transfer function, you will be asked to confirm that this worksheet can be deleted. You can confirm this without consequences. You can study the result of the data conversion on the Elimination Monitoring Tool tab.
- Automatically classifying and colouring the areas according to the phases in the Leprosy Elimination Framework
  Click on the Automatic Phase Classification button to initiate the automatic classification and colouring of the areas according to the phases in the Leprosy Elimination Framework. This is usually quite quick. You can again study the result of this on the Elimination Monitoring Tool tab. Please note that another new worksheet called 'AreasAndPhases' is generated during this process. The macro labels each colour with a number to facilitate transfer to a mapping programme, such as the Epi Info Mapping Module, Geoda or QGIS. You won't need this worksheet unless you want to proceed with making serial maps. Please note that when you use the Clear Auto phase classification function, you will be asked to confirm that this worksheet can be deleted. You can confirm this without consequences.
- Hiding or unhiding Level 1 areas
  If you are studying data from Level 2 jurisdictions only (e.g. districts), you may want to hide the Level 1 area names and codes. This can be done by clicking on the Hide L1 button on the Control Panel. Unhide L1 has the reverse effect.

An empty LEMT template will be available from the WHO Global Leprosy Programme website.

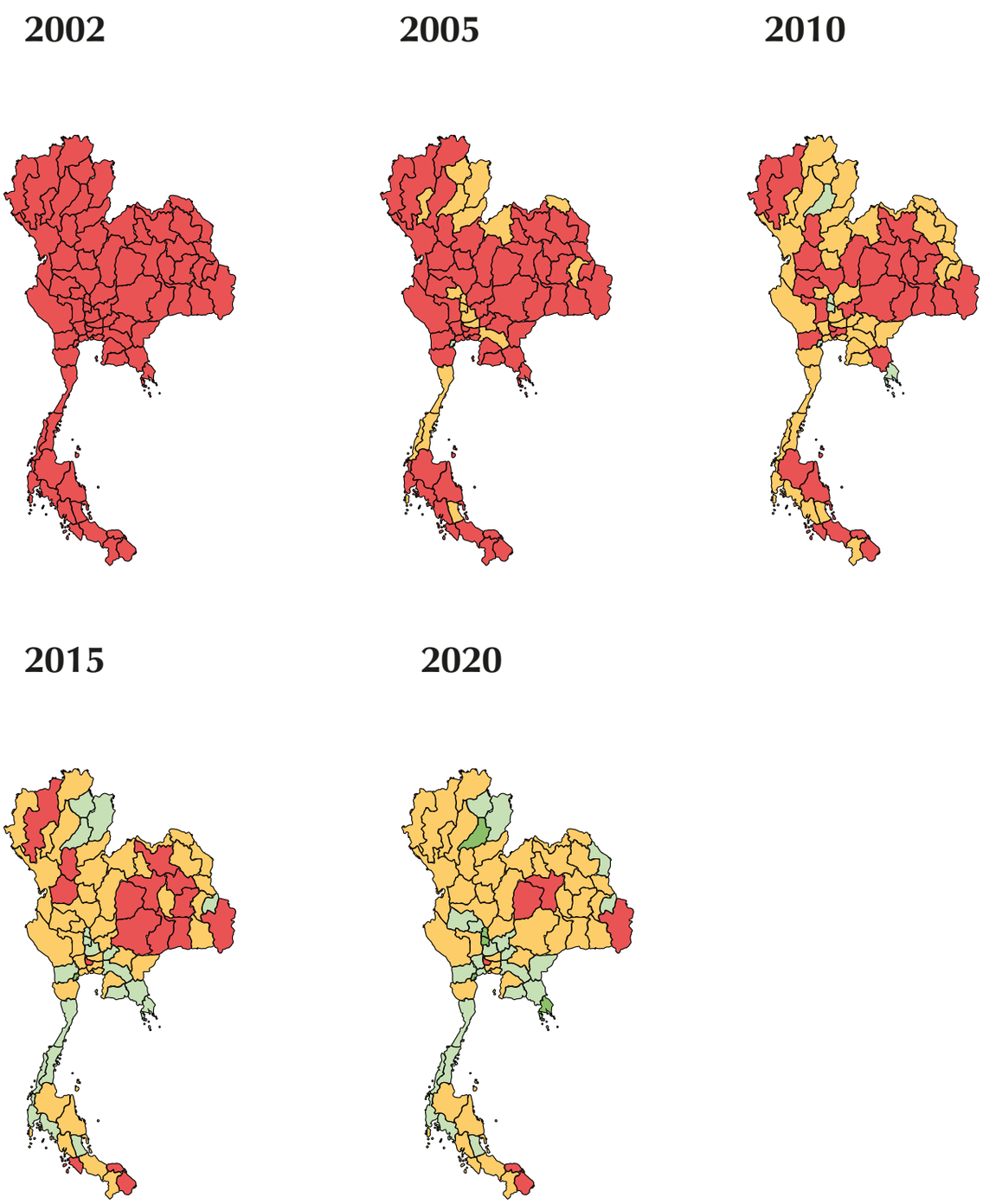
Figure 6: LEMT Controle Panel Page

2.4 Producing serial maps

The template can be populated using annual new case data as explained above in Section 2.3.2. Based on this, serial maps can be generated as explained in the separate standard operating procedure for leprosy elimination mapping. An example is shown in Figure 7 below. To generate the maps below from the AreasAndPhases worksheet that is automatically generated by the Automatic Phase Classification macro, the mapping module of Epi Info v7.2 was used.

Together these tools can be used to record, monitor, report and present the history and progress of areas and countries towards interruption of transmission and elimination of leprosy disease and document the achievement of the corresponding milestones.

Figure 7: Serial maps showing the progression of Thailand through the phases of elimination of leprosy



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