Malaria cases in environmental context

The distribution of reported malaria cases can also be viewed to advantage in environmental context, thus demonstrating the relationship between case numbers, differential vector breeding sites, population habitat and activity.

Two methods of data presentation have been utilized for this purpose in relation to elevation. The first method shows large, local concentrations of malaria cases, giving striking emphasis to the degree of macro-clustering of cases that can occur. The second method depicts the same data at higher resolution, at the level of micro-clusters.

Figure 12a,b depicts some striking variance in the macro-cluster data 3 years apart (1998 *versus* 2001). While, for example, a very large cluster persists in southwest Myanmar near the Bangladesh border, many other focal clusters have decreased in size, have shifted or disappeared. This is particularly apparent in Lao PDR and Cambodia. The concentration of the remaining macro-clusters tends to be in plentifully watered plain or lower foothill areas while fewer appear to occur in the high mountainous areas or high foothills.

Figure 13a,b demonstrates the alternate way of depicting the same malaria case numbers in 1998 and 2001, in the form of micro-clusters. Despite their apparently different superficial appearances, the two methods of display are complimentary in reality. Both demonstrate the non-uniformity of malaria case distribution in relation to various factors pertaining to elevation-dependence.

In contrast to the macro-clustering seen in Figure 12, micro-clusters show a more uniform distribution in the areas where they occur, but also present a clearer picture of the areas of low malaria occurrence, *e.g.* northeast Thailand and the Viet Nam delta. Of course, neither approach provides a village level interpretation of malaria but they both can contribute usefully to epidemiologic analysis and planning.

Overlaying the same malaria data for 1998 and 2001 depicted in Figure 12 on the satellite remote-sensing map of forest cover (Figure 14a,b) provides another integral picture of importance in relation to malaria epidemiology. Large case clusters tend to be associated with densely forested areas, while deforested areas have relatively fewer cases *e.g.* northeast Thailand and parts of Myanmar. Cultivated areas in Thailand and the Mekong delta in Viet Nam appear to be largely malaria free. The striking impression overall is of the strong association between forested areas and malaria case numbers. However, detailed studies in selected areas have shown that converting forest to plantations can lead to significant sites

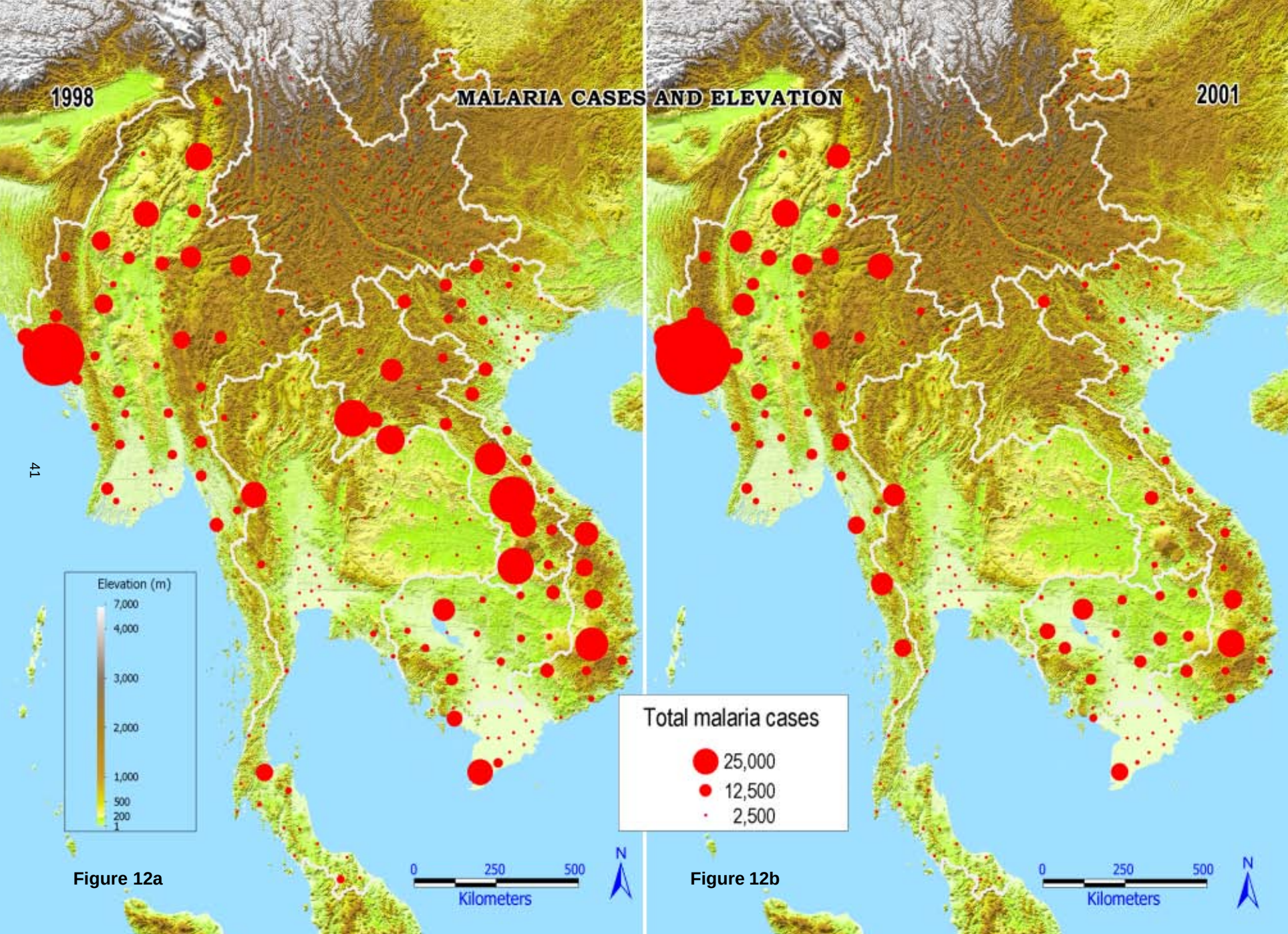

Figure 12a

Figure 12b

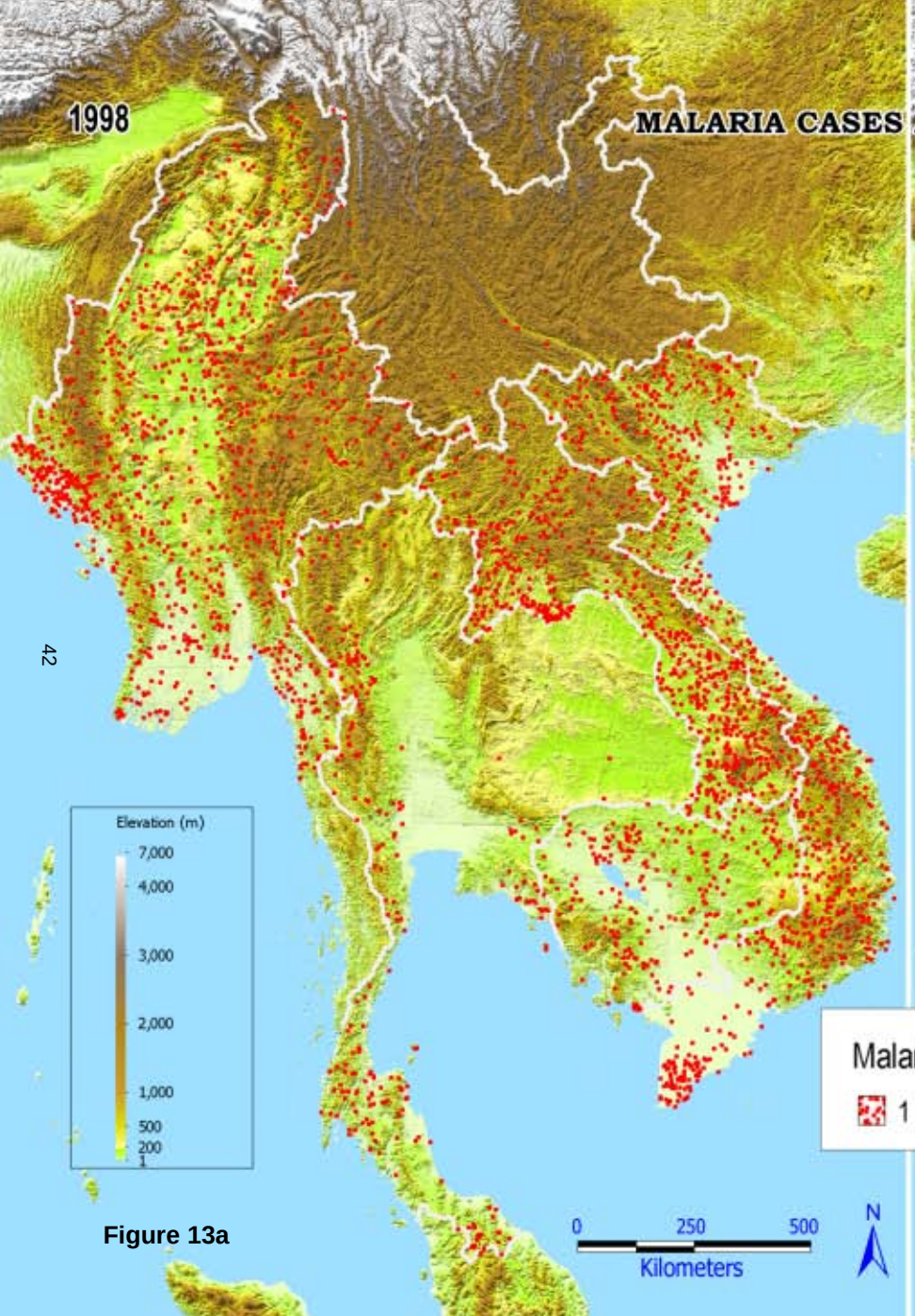

Figure 13a

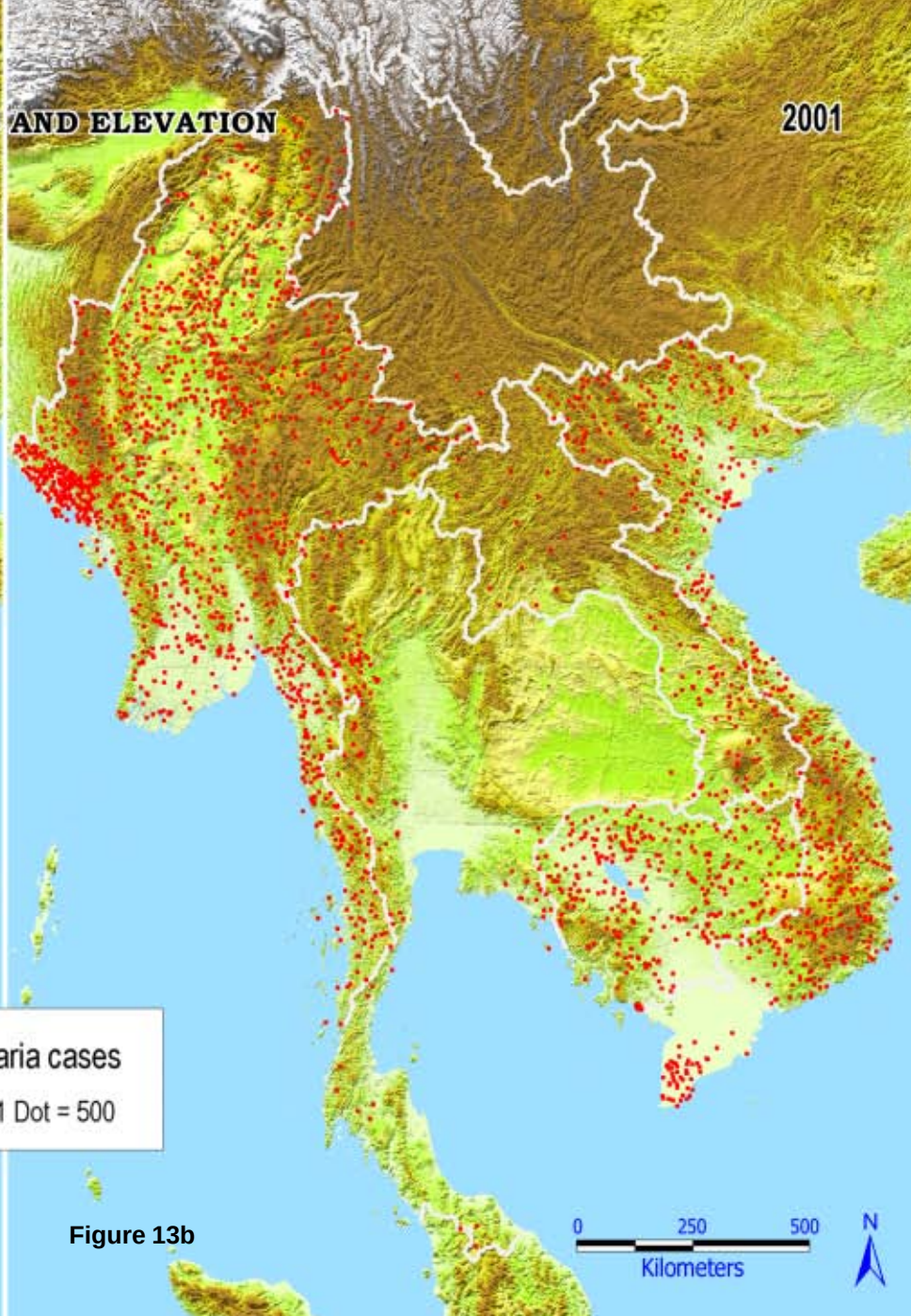

Figure 13b

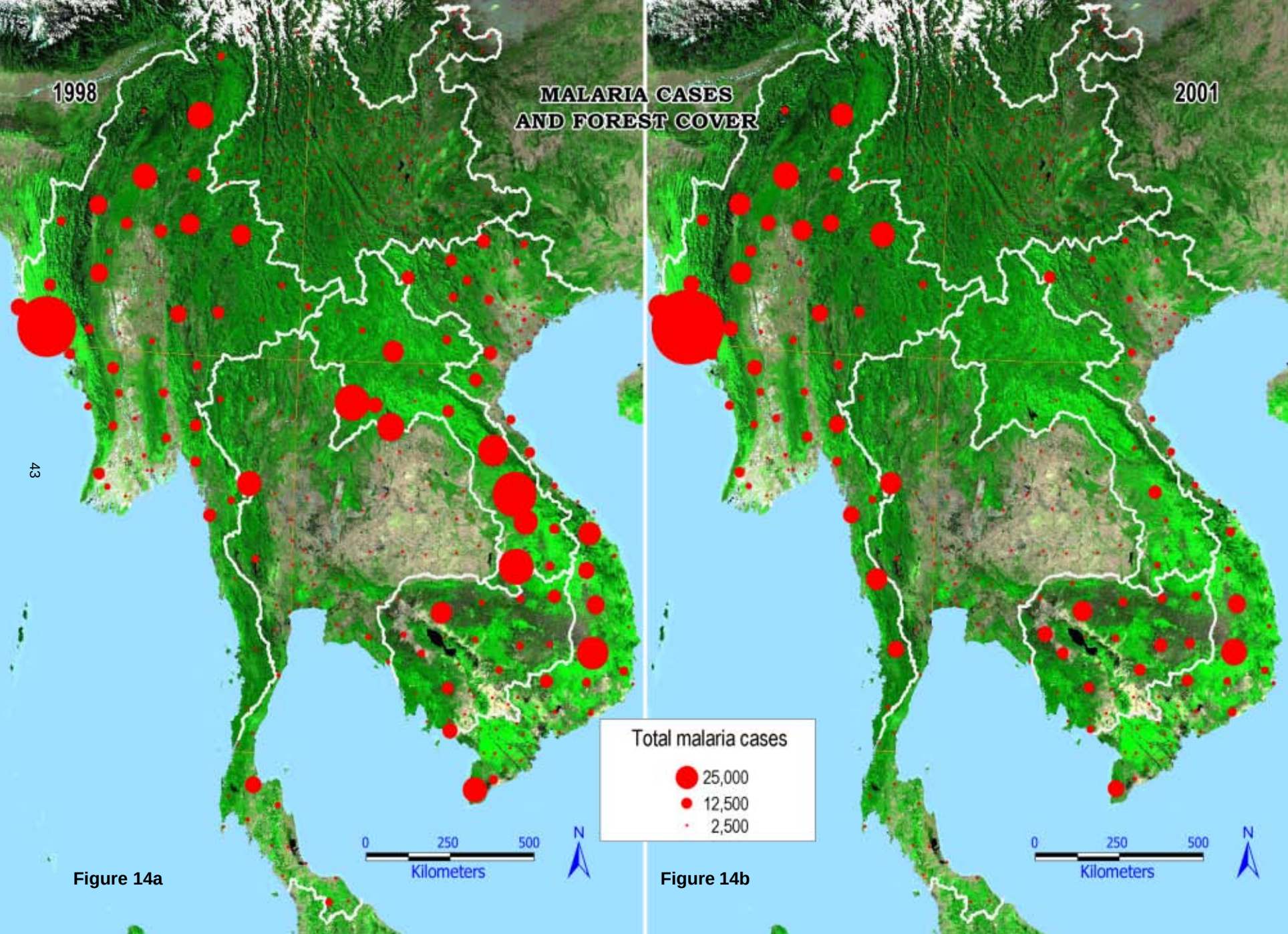

Figure 14a

Figure 14b

of malaria transmission in addition to the forest and foothills areas in Southeast Asia where efficient vectors such as *An. dirus* and *An. minimus* are prevalent and have adapted to such ecosystems (Singhasivanon *et al*, 1999).

More precise dissection of the disease pattern in relation to the terrain at local level could potentially assist prediction of disease outbreaks. In the context of human agricultural activity such analysis at local level has much to offer with respect to disease control in economic terms.