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Perspective

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Methodology of the joint malaria prevention recommendations of Switzerland, Germany, Belgium and The Netherlands

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Background

National malaria prevention recommendations for travellers vary widely. For example, in the USA, almost all travellers to malaria-endemic areas are advised to take malaria chemoprophylaxis[1] while in the UK chemoprophylaxis is mainly recommended for those visiting sub-Saharan Africa.[2] These differences reflect diverse methodological approaches, as well as differences in health systems, culture, medico-legal aspects and risk tolerance.[3] However, such variations can be confusing for clinicians and travellers, as the reasons behind them are not always transparent. In an ongoing effort to discuss and align malaria prevention recommendations according to available evidence, the Swiss Expert Committee for Travel Medicine (ECTM, a committee of the Swiss Society of Tropical and Travel Medicine) and the

Table 1 Definition of the malaria risk categories and corresponding malaria prevention strategy

Malaria risk	Annual incidence of malaria cases in local population of malaria endemic destinations	Prevention measure against malaria[a] (see Figure S1)
High	AFI > 10 per 1000 population	Chemoprophylaxis (in addition to mosquito bite protection)
Moderate	AFI > 1 to ≤ 10 per 1000 population or AVI > 10 per 1000 population	Mosquito bite protection (for risk situations: carry SBET[a])
Low	AFI > 0 to ≤ 1 per 1000 population or AVI ≤ 10 per 1000 population	Mosquito bite protection
None	Zero autochthonous cases within the last 3 years	None

AFI, annual parasite index for *Plasmodium falciparum;* AVI, annual parasite index for *Plasmodium vivax*; SBET, standby emergency treatment.
[a]For details, see Supplement, Figures S1 and S2; Belgium usually does not advise SBET, but chemoprophylaxis against malaria for risk groups going to regions with moderate malaria risk.

German Society for Tropical Medicine, Travel Medicine and Global Health (DTG) have collaborated for over 20 years. As epidemiological data quality has improved, regional malaria risk assessment has become more objective, leading to more detailed recommendations. Simultaneously, the methodology for data collection and analysis has been refined, enhancing transparency and comprehensiveness. The Belgium Study Group of Travel Medicine and the Netherlands National Coordination Center for Travellers Health Advice (LCR) joined this harmonization initiative in 2021 and 2022, respectively (note: Austria just joined the panel while this article was being written). Here we describe the methodology underlying these joint recommendations, used since 2023. We aim to transparently explain the background and rationale behind the recommendations so as to promote their acceptance and implementation by travel medicine advisors and travellers alike.

Development and regular revision of the recommendations

The development and regular revision of the recommendations follow a stepwise process: (1) defining or redefining malaria risk categories, (2) compiling data on malaria incidence in endemic regions, (3) compiling raw risk maps, (4) adjusting raw risk maps based on discussion and consideration of region-specific issues, and (5) publishing the final recommendations. Step 1 only occurs if there is a consensus to change the malaria risk categories. Steps 2 and 3 are managed by a member of the Swiss ECTM. Step 4 involves discussion among members of the involved national malaria expert groups, and step 5 includes publication of the final recommendations by each national society.

Step 1: Defining malaria risk categories

Risk categories are established through consensus among members of collaborating expert groups and classify the malaria risk for international travellers into four levels: high, moderate, low and none. They are based on the annual reported numbers of malaria cases in endemic areas per 1000 local population (Table 1). These categories serve as a surrogate of the risk and determine the recommended prevention strategies (Table 1, Figure S1) taking into account the estimated risk of acquiring malaria and the potential adverse effect from chemoprophylaxis.[4]

Step 2: Compiling the available data

The local malaria incidence rates for the past 3 years are sourced from data provided by the respective countries to the World Health Organization (WHO) for the World Malaria Reports (WMR).[5] (Note: for the 2024 update, the local malaria incidence rates from 2019 were exceptionally taken into account to cover possible underreporting during the COVID-19 pandemic). These data include the annual parasite indices for both *Plasmodium falciparum* (AFI) and *Plasmodium vivax* (AVI), which represent the number of cases per 1000 population per year for each species. Maps showing AFI and AVI by country are provided by WHO. Additional epidemiological data, including malaria risk in urban areas or altitude thresholds in mountainous regions, are collected from the Centers for Disease Control and Prevention[1] and WHO.[6]

Step 3: Compiling *raw risk maps*

For all regions, data on local malaria incidence collected in step 2 are analysed, selecting the highest incidence rate from the past 3 years to account for the effect of year-to-year fluctuations. If recent AFI or AVI data are unavailable, the latest data reported to the WHO or national data from the respective country's Ministry of Health are used. These data are then used to create spatial *raw risk maps* (Figure 1) by applying cut-off values for local malaria cases (Table 1).

Step 4: Adjusting the *raw risk maps*

Members of the contributing national malaria expert groups review and discuss the raw risk maps in detail to assess region-specific adaptation. They ensure that adaptations respect identifiable geographic landmarks, such as rivers, national parks, and convert inconsistent and patchy regions into harmonized, user-friendly risk maps (see Figures 2 and 3). If data are available, malaria risk categories in urban areas and altitude thresholds are adjusted. Other national recommendations providing country specific information (such as France, the UK, Spain, USA) are also considered to guide adjustments in areas with unclear data and differing opinions. In cases of disagreement among the group, consensus is reached through discussion and voting.

For the southern cone of Africa and the Sahel zone, seasonal malaria risk is considered if reliable data are available

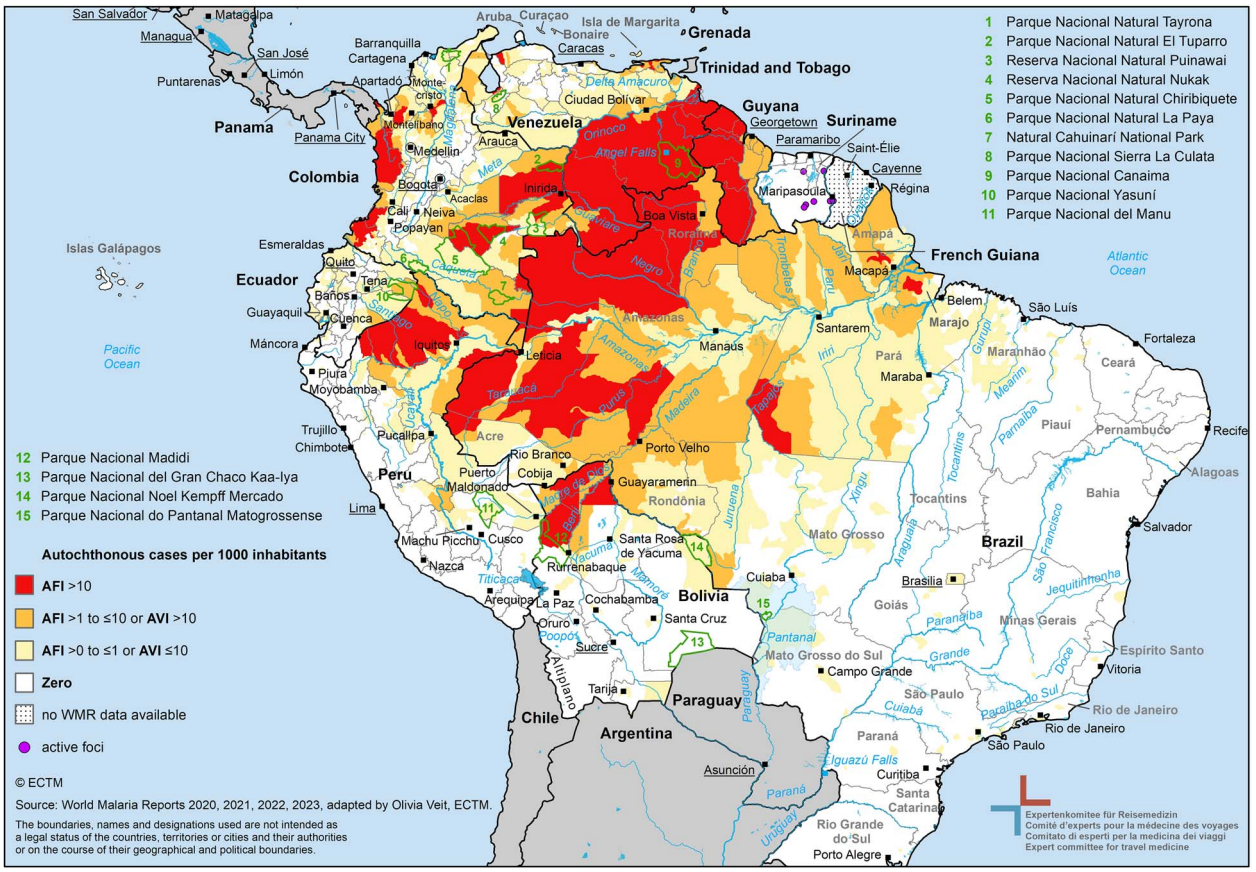

Figure 1 Raw risk map depicting incidence of local malaria in the South American region, based on the annual parasite index for *Plasmodium falciparum* (AFI) and *Plasmodium vivax* (AVI) in the local population. The map illustrates the highest reported AFI and AVI values to the WHO for the years 2019*, 2020, 2021 and 2022. (*Note: For the 2024 update, the local malaria incidence rates from 2019 were exceptionally also taken into account to cover possible underreporting during the COVID-19 pandemic).

on local case seasonality (such as Senegal[7]) and/or if seasonal chemoprophylaxis is advised by national health authorities (e.g. in the Sahel zone[5]) or recommended in national malaria prevention guidelines for travellers within the respective country (e.g. in South Africa[8]). For countries with political instability (e.g. Afghanistan, Myanmar, Venezuela, Yemen), a more cautious approach is taken, placing them in a higher malaria risk category to accommodate potential uncertainties in malaria surveillance and treatment availability.

Step 5: Publication of the final recommendations

The final recommendations are published by each national society in their respective national language(s) and are available either through a digital internet platform (Switzerland: www.healthytravel.ch; Belgium: www.wanda.be; Netherlands: www.mijnlcr.nl) or as a downloadable document (e.g. Germany: www.dtg.org). The region-specific malaria prevention recommendations can be accessed from the maps (e.g. Figures 3 and 4) and from the alphabetical country lists (Figure S3). The latter provides more detailed information, including the percentage distribution of *P. falciparum* and *P. vivax*, based on the latest WMR, as well as information on the last report of autochthonous malaria if the country has not been declared malaria-free by the WHO.

Discussion and outlook

The systematical application of the methodology described above by expert groups from Belgium, Germany, The Netherlands and Switzerland has successfully harmonized national recommendations on malaria prevention for travellers across these four countries (note: Austria just joined the panel while this article was being written). Despite broad endorsement from a panel of experts representing all participating national societies, the methodology is subject to several limitations that need to be considered.

Firstly, the malaria risk categories described rely primarily on incidence rates in endemic populations reported to the WHO, considered to be the most consistent and standardized information available. To minimize fluctuations in incidence and surveillance quality, the methodology uses the highest incidence rate of the past 3 years. While some travel medicine experts argue that travellers face lower risks than local populations due to the use of preventive measures that reduce exposure (e.g. using repellents, impregnated clothing, availability of bed nets at tourist accommodations and chemoprophylaxis),[9] but evidence is lacking. On the other hand, travellers may be at increased risk for severe malaria due to lack of malaria semi-immunity. Taking this argument into account and given the scarcity of granular data on the precise geography of travel-related malaria, local

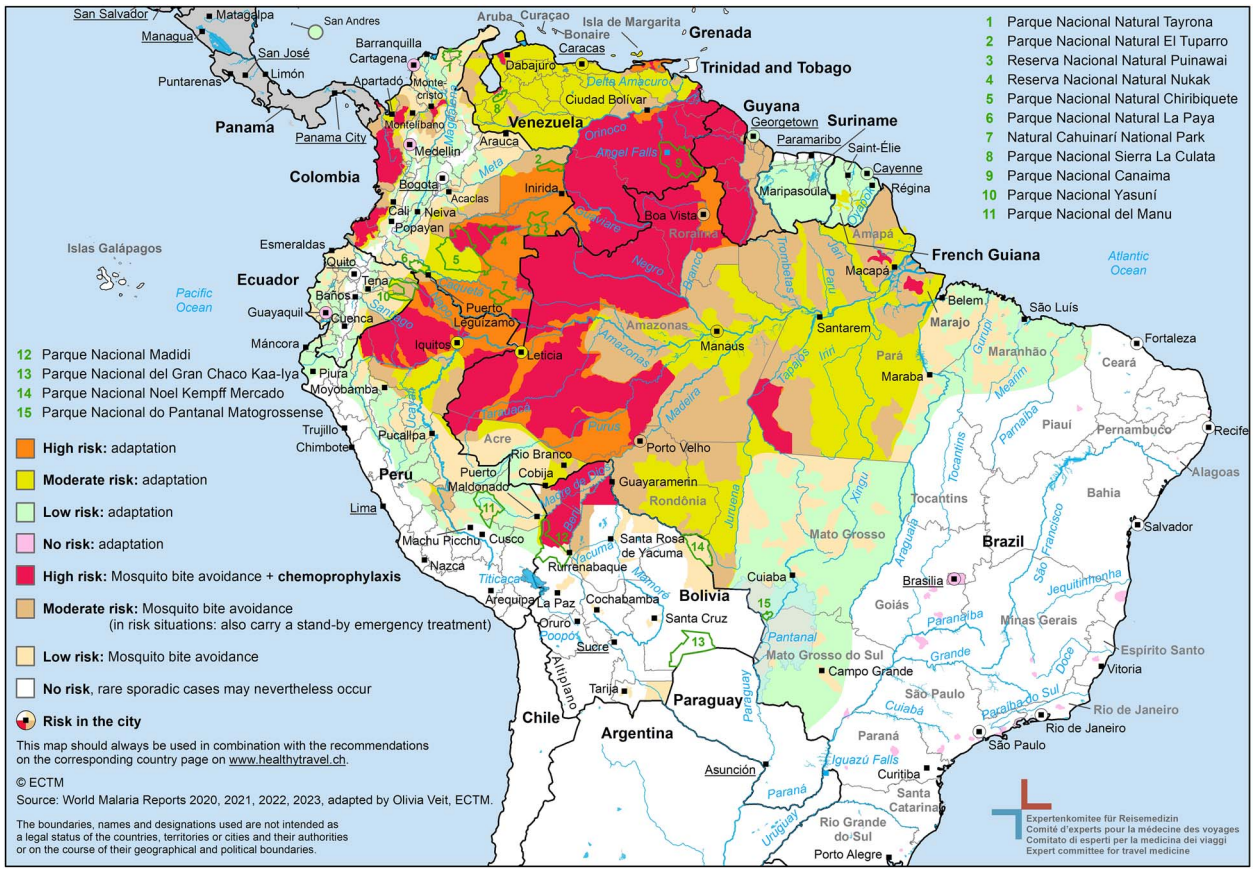

Figure 2 Adjustments to raw risk map for South America, 2024. Adjustments to raw risk map, which are based on the total annual parasitic index for *P. falciparum* (AFI) and *P. vivax* (AVI) in the local population, showing the highest AFI and AVI incidences reported to WHO for the years 2019*, 2020, 2021 and 2022. (*Note: For the 2024 update, the local malaria incidence rates from 2019 were exceptionally also taken into account to cover possible underreporting during the COVID-19 pandemic).

malaria transmission rates currently remain the most reliable indicator of malaria burden.

Secondly, threshold values for malaria risk categories are based on expert consensus and interpretation of existing evidence.[3,4]

Thirdly, the chemoprophylactic drugs licensed in Europe are *suppressive* and do not provide *causal* prophylaxis against *P. vivax*, meaning they do not prevent relapses after stopping the medication. Nevertheless, these drugs protect against acute disease and severe manifestations during intake, which is crucial for travellers visiting remote areas with high *P. vivax* incidence and limited healthcare access. Due to the lack of causal chemoprophylaxis against *P. vivax* malaria in Europe, experts from the four countries weighed the risk of overprescribing against the benefit of preventing severe manifestations of *P. vivax* during travel. This led to setting species-specific risk thresholds for recommending chemoprophylaxis (Table 1).

Lastly, it would be beneficial to base the risk categorization not only on incidence rates in endemic populations, but to also integrate data on travel-related imported malaria cases. These additional data would be particularly valuable in situations where local malaria incidence is not well documented or when local incidence rates are close to the boundaries between risk categories. To address this, our group has already agreed on risk category definitions based on annual incidences of imported malaria cases by travellers (including people *visiting friends and relatives* [VFRs]): 'high' if >10 cases per 100 000 travellers, 'moderate' if 1-10 cases per 100 000 travellers, 'low' if <1 case per 100 000 travellers and 'none' if zero imported cases. However, the current application of this approach remains limited. The variability in traveller numbers, destinations, travel patterns and risk behaviour profiles can affect the pattern of imported malaria and may vary among reporting countries.[10,11] Additionally, there are currently insufficient data to determine the exact areas within destination countries where malaria was acquired, or to estimate area-specific travel-related malaria incidence rates (lack of denominator by areas in destination countries). As a result, data on travel-related malaria cases currently serve only as additional information in the methodology described.[7] Although flight arrival and departure statistics can help to estimate travel-related imported malaria incidence,[12] pooled and more comprehensive national data from multiple non-endemic countries—including detailed travel routes and visited areas and methods to exclude refugees and immigrants—are needed to improve the methodology for a better adapted recommendation. The advent of smartphone-based data collection tools is improving access to spatial patterns of tourism within countries,[13] which will better inform our understanding of travellers' exposure risk. Nevertheless, accurately determining the seasonal risk of malaria in affected countries remains challenging due

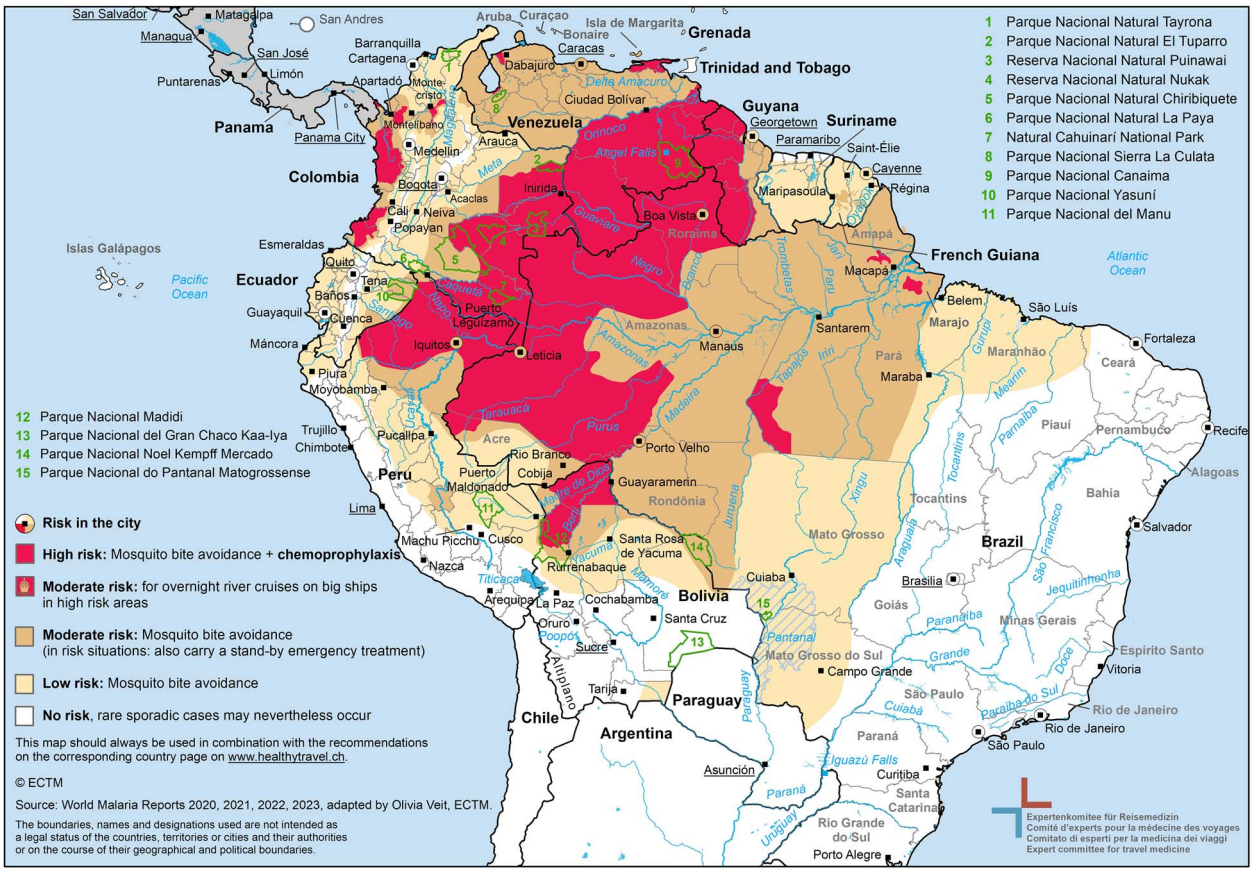

Figure 3 Final map of malaria prevention recommendations for travellers from Belgium, Germany, The Netherlands and Switzerland visiting South America, 2024.

to unpredictable weather patterns and the impact of climate change.

In summary, in an important first step, a harmonization effort was made with a joint methodology in now five countries. This will hopefully contribute to consistent travel advice for the same destinations.

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Authors' contributions

OV, CH and AN conceived the paper and drafted the first manuscript. All co-authors were involved in meeting discussions, and reviewed and edited the manuscript. Olivia Veit (Conceptualization [lead], Methodology [lead], Project administration [lead], Supervision [lead], Validation [lead], Visualization [lead], Writing—original draft [lead], Writing—review & editing [lead]), Ula Maniewski (Methodology [equal], Writing—review & editing [supporting]), Camilla Rothe (Methodology [equal], Writing—review & editing [supporting]), Gilles Eperon (Methodology [equal], Writing—review & editing [supporting]), Margarita Boering (Methodology [supporting], Writing—review & editing [supporting]), Sami Alcedo (Methodology [supporting], Writing—review & editing [supporting]), Gerhard Boecken (Methodology [supporting], Writing—review & editing [supporting]), Michael Ramharter (Methodology [supporting], Writing—review & editing [supporting]), Noud Schel (Writing—review & editing [supporting]), Patrick Soentjens (Methodology [supporting], Writing—review & editing [supporting]), Cornelia Staehelin (Methodology [supporting], Writing—review & editing [supporting]), Michele van Vugt (Methodology [supporting], Writing—review & editing [supporting]), Thomas Weitzel (Methodology [supporting], Writing—review & editing [supporting]), Leo Visser (Methodology [supporting], Writing—review & editing [supporting]), Patricia Schlagenhauf (Methodology [supporting], Writing—review & editing [supporting]), Christoph Hatz (Conceptualization [equal], Methodology [equal], Writing—original draft [equal], Writing—review & editing [equal]), and Andreas Neumayr (Conceptualization [equal], Methodology [equal], Writing—original draft [equal], Writing—review & editing [equal]).

Conflict of interest: None declared.

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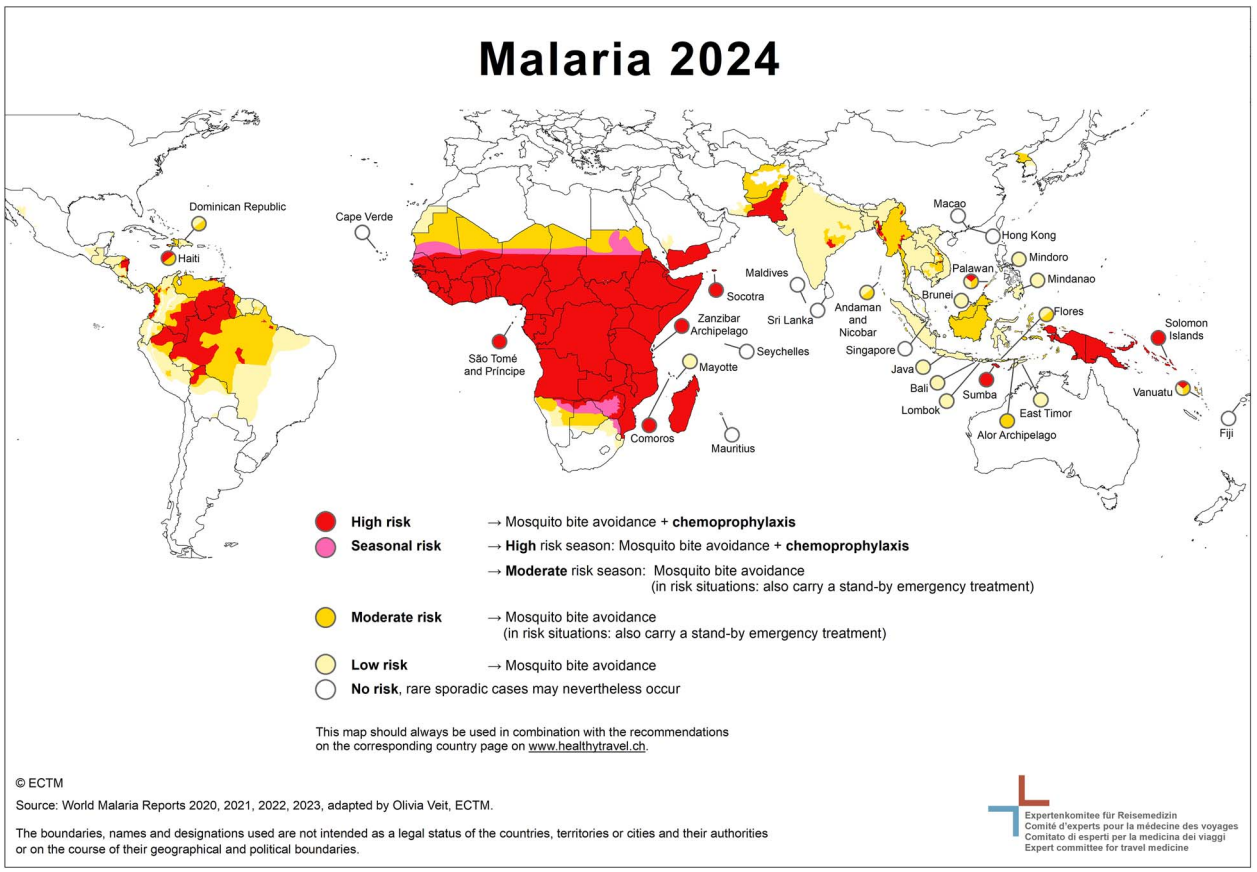

Figure 4 Final world map of malaria prevention recommendations, methodology of Belgium, Germany, The Netherlands and Switzerland, 2024

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