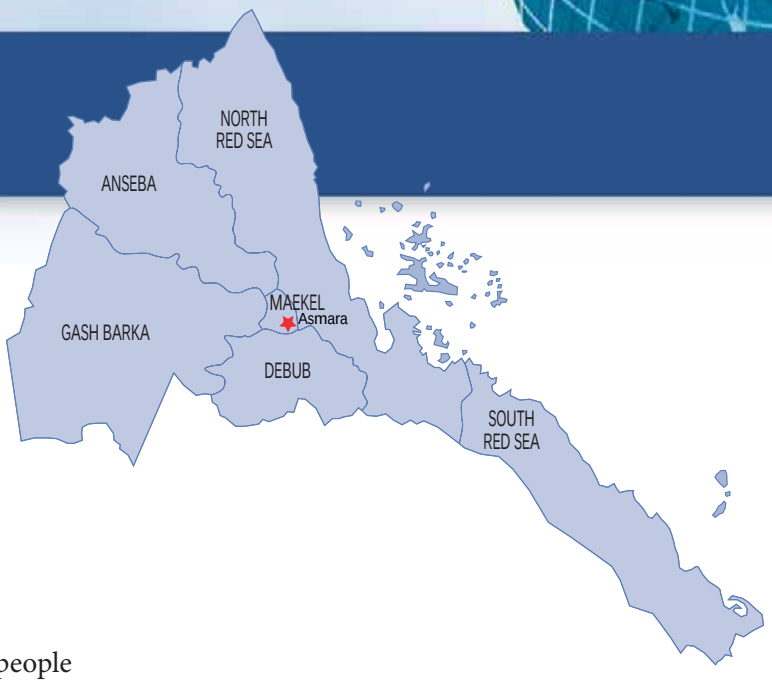
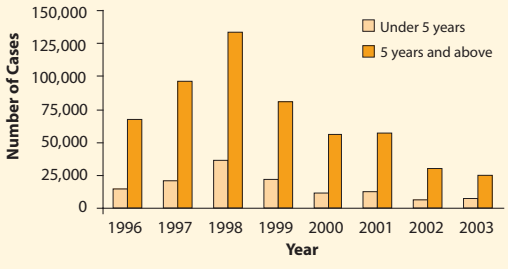
Combating Malaria in Eritrea



About two-thirds of Eritrea's population of 3.5 million people lives in malaria endemic or epidemic-prone areas where the disease is seasonal, highly focal, and unstable. In 1997 and 1998, Eritrea experienced a series of malaria epidemics that produced more than 424,000 cases, with over 500 inpatient malaria deaths in 1998 alone.

Following these severe outbreaks, Eritrea established a comprehensive National Malaria Control Program (NMCP) with support from the World Health Organization, the U.S. Agency for International Development (USAID), and the World Bank. Over the next several years, the NMCP introduced a new first-line antimalarial drug and implemented an integrated vector control program using insecticide-treated nets (ITNs), indoor spraying in selected areas, and other interventions. From 1999 to 2003, Eritrea succeeded in halving the malaria mortality rate among children under 5, reducing the number of malaria fatalities to one of the lowest levels in Africa. These approaches have helped Eritrea meet targets set at the African Summit on Roll Back Malaria in Abuja, Nigeria, in April 2000, one of which is to reduce malaria incidence by at least 60 percent before 2010.

Annual number of clinical malaria cases treated at 252 hospitals, health centers, and health stations in Eritrea by age group, 1996–2003



Source: National Malaria Control Program and NHMIS, Eritrea.

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Technical Support to the Eritrea National Malaria Control Program

The success of Eritrea's NMCP can be attributed to its staff, who are capable, experienced, and determined to succeed. From 1998 to 2005, NMCP had operational funds from external partners including the World Bank, UNICEF, USAID, the World Health Organization, the Global Fund for HIV/AIDS, Tuberculosis, and Malaria, and the Italian Cooperation for Sustainable Development. NMCP staff also have political support from senior Eritrean Ministry of Health officials, effective leadership from the NMCP manager, and cooperation from other government ministries. The NMCP has an effective organizational structure in which zonal coordinators have primary responsibility for program operations, with support from the national center for setting policies, managing resources, and providing training and supervision. RTI International was privileged to assist the NMCP by providing useful data and insightful analyses that have not only helped the program succeed, but have also helped it evaluate and understand the factors that have contributed to its success.

From 1998 to 2005, RTI and its partners provided technical assistance to the NMCP to help strengthen its surveillance systems, vector control activities, and operational research. Specifically, these activities

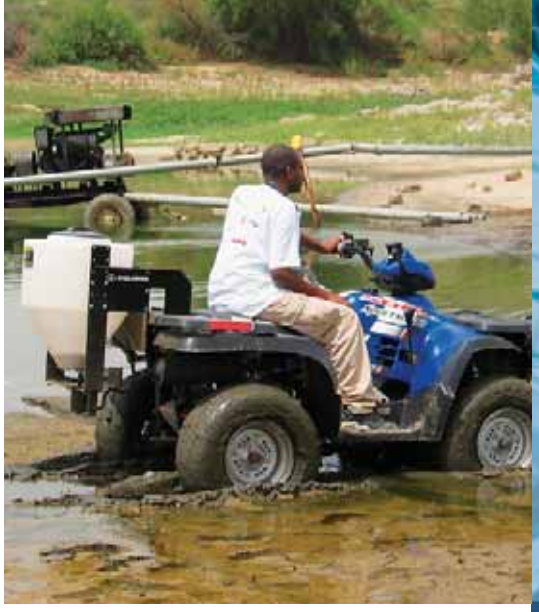
- strengthened entomological and epidemiological surveillance;
- assembled and analyzed historical databases;
- identified locations for sentinel surveillance sites and improved the NMCP's understanding of malaria stratification and seasonality in Eritrea;
- developed tools for epidemic detection and response;
- demonstrated the efficacy of bacterial larvicides for treating mosquito breeding sites and developed operational protocols for their routine use;
- developed and implemented a Malaria Early Warning System;
- improved routine vector control operations, with a focus on refining the use of larvicides and the timing and targeting of indoor spraying of residual insecticides; and,
- helped the NMCP evaluate the impact of its program and the effectiveness of individual interventions.

Advancing Malaria Surveillance

Surveillance underpins Eritrea's efforts to strengthen malaria control and prepare for epidemics. RTI and its partners contributed to the NMCP's surveillance program by developing databases, analyzing historical data, providing protocols and training for malaria sentinel sites, analyzing seasonal patterns of malaria transmission, and creating tools for forecasting and detecting malaria epidemics. The following three important products emerged from this assistance:

Epidemic detection thresholds specific to each health facility. Thresholds were defined based on routine clinical records for the period 1996–2003. Such clinical records were assembled and analyzed for the first time during this effort.

A detailed map of malaria stratification and seasonality. Data from 1998 to 2004 on malaria case reports, rainfall, changes in vegetation, and other environmental factors were analyzed to better understand the spatial and temporal patterns of malaria transmission. The analysis revealed five distinct patterns of malaria seasonality and transmission; the areas exhibiting each pattern can be considered a geographic "stratum" for which a particular combination and schedule of interventions will be most appropriate.

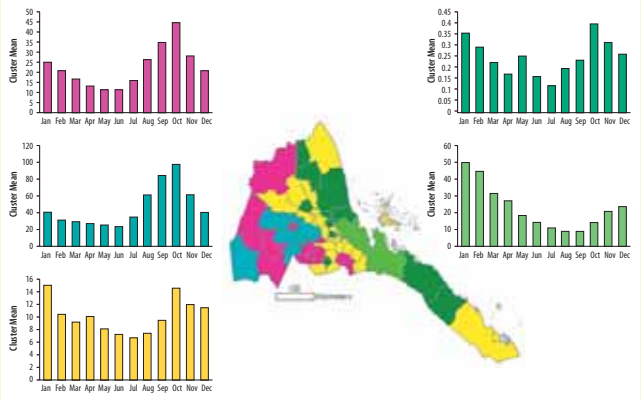


The Malaria Early Warning System (MEWS). The MEWS builds upon the stratification map, which provides the basis for spatial and temporal forecasts of potential malaria epidemics. The MEWS integrates these data with a geographic information system (GIS) and satellite imagery to identify locations at which recent rainfall exceeds expected levels. The NMCP downloads data every 10 days and uses the system to notify its field staff, putting them on alert to inspect potential mosquito breeding sites and to watch for an increase in malaria cases.

Improving Vector Control

The primary malaria vector in Eritrea is *Anopheles arabiensis;* the NMCP's strategy includes the use of ITNs, indoor residual spraying (IRS), larvicides, and environmental management to control these and other mosquitoes. The technical support program in Eritrea included many activities to better understand the ecology and behavior of anopheline mosquitoes and to improve the effectiveness of vector control interventions. The following key results emerged from the program:

Map of Malaria incidence with sub-districts grouped into five clusters. Graphs show profile of mean malaria incidence within clusters, 1996–2003.



Key facts of mosquito ecology and behavior informed the integrated vector control strategy. RTI's work in Eritrea demonstrated that *Anopheles arabiensis* feeds as frequently on domesticated animals as on humans; it bites outdoors as much as indoors, and it bites in the early evening and late morning, not only in the middle of the night. Also, many of its breeding sites (ponds, run-off streams, road-side ditches, and borrow pits) are created by human activity. Thus, ITNs will not work as a singular intervention, since they are most effective against mosquitoes that bite indoors during sleeping hours. These results provide an empirical foundation for using an integrated approach to vector control that utilizes indoor interventions (nets and IRS) as well as environmental management and larvicides to eliminate or control breeding sites.

Protocols for the routine use of larvicides were established. The NMCP, with help from RTI, evaluated the effectiveness of bacterial larvicides, an alternative to the chemical larvicide temephos that is lethal to nontarget species and, when used intensively, can lead to vector resistance. Results demonstrated that bimonthly application of *Bacillus thuringiensis israelensis (Bti)* and *Bacillus sphaericus (Bs)* to stream bed pools, rain pools, and similar habitats would maintain control of anopheline mosquito populations. A 2-year pilot program established protocols for the use of *Bti* and *Bs* and demonstrated the effectiveness and logistical requirements of routine larviciding.

Protocols to improve the use of IRS were implemented. RTI's resident advisor observed IRS operations in progress in 2004 and helped the NMCP improve its operations in 2005. Among the key improvements were changes to the training program and supervision for spray teams and the maintenance of compression sprayers. The NMCP also adjusted its IRS schedule to spray houses in several zones earlier than had been done in the past, based on the new understanding of malaria stratification and seasonality.

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The contribution of each vector control method was verified. The program team was able to prove the effectiveness of the NMCP strategy by measuring the effect of each vector control intervention. Since 1998, the NMCP has used several vector control methods and has seen a substantial decline in malaria incidence; over the same period, the region's climate has become generally drier. The NMCP wanted to understand whether the control program, the weather, or both were responsible for the reduction in malaria cases between 1998 and 2003. An analysis of monthly data on clinical malaria cases and satellite-derived climate variables found that the NMCP's activities have been effective and that climate, while significant, is not the only explanation for the recent decline in malaria cases in Eritrea. Both IRS (with DDT or malathion) and ITNs were significantly associated with reduction in cases, as was larval control in one area.

Strengthening Operations Research

RTI and its partners provided technical assistance to the NMCP to conduct many key studies and surveys, including

- a national survey of vector distribution and abundance;
- longitudinal studies of larval ecology and adult mosquito biting behavior;
- a national survey of malaria prevalence;
- efficacy and pilot operational studies of bacterial larvicides;
- the malaria stratification analysis described above;
- field studies of factors affecting ITN ownership and usage; and
- a cost-effectiveness analysis of the NMCP's malaria control interventions.

Training and Integrating Public Health Technicians

The Eritrean Ministry of Health made an important commitment to training and deploying a new cadre of health workers, Public Health Technicians (PHTs), to build health system staffing at the subzone level. This has improved staff capacity to address malaria and other environmental health issues such as water, sanitation, medical waste, and market inspections. RTI assisted the Ministry in this effort by

- revising the curriculum for PHT pre-service training;
- conducting in-field interviews of PHTs and their supervisors to review their job descriptions, preparedness for assigned duties, quality of supervision, and needs for continued in-service training; and to provide regular feedback to zonal and central level managers for improving the PHT program; and
- providing specialized workshops for in-service training of PHTs, supervisors, and clients on high priority topics such as environmental sanitation and waste management at health facilities.

Acknowledgments

RTI performed the work described through two USAID contracts: the Environmental Health Project (1998–2004); and its successor, the Integrated Vector Management (IVM) Task Order (2004–2006), issued under the Population, Health and Nutrition Technical Assistance and Support Contract (TASC2). RTI's partners in these projects included: Tulane University, EpiVec Consulting, the International Research Institute for Climate and Society at Columbia University, and the International Centre of Insect Physiology and Ecology.

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RTI-2746 12/2005