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Discussion and epilogue

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Global change is likely to affect human and animal health, as shown by the preceding chapters. Malaria was chosen as the principle example to demonstrate the complex interactions that may affect a vector-borne disease: the mosquito vector, the parasite, human host, climate, topography, vegetation, aquatic habitat, demography, health care, socio-economic status, to name several aspects that all affect the epidemiology of the disease and, hence, the incidence of morbidity and mortality. Had we chosen to focus this workshop on dengue, or leishmaniasis or human African trypanosomiasis, the overall conclusions would not have been much different. There is no doubt that environmental change caused by anthropogenic activities will impact vector-borne diseases severely. The uncertainty of these effects is the level of change we shall witness, and over what time scale we might expect these changes to occur.

Until recently it seemed difficult to provide concrete evidence that environmental change had caused a significant positive impact on a vector-borne disease, leading to increased disease. The reverse has been reported many times when because of deliberate changes in the environment, malaria was eradicated from entire regions. For example, malaria has been eradicated from Italy by drainage of the Pontine marshes near Rome (Bruce-Chwatt and De Zulueta 1980). By contrast, in this workshop evidence was provided that deforestation in the Brazilian Amazon region has caused a huge increase in the number of malaria cases (Cruz Marques 1987). This was caused by deliberate deforestation causing mosquito breeding sites and simultaneous human immigration into the area. The Brazilian government brought this epidemic under control only in recent years by a dedicated programme for malaria control in many of the affected areas (Massarani 2001, Takken et al., this volume).

It is widely accepted that on a global scale malaria is increasing rather than decreasing. This is caused not so much by enhanced environmental conditions as by increasing poverty and lack of resources to combat the disease (Barat et al. 2004; Malaney, Spielman and Sachs 2004). From simulation models and field evidence presented in this workshop it is evident that without mitigating measures, the world's malaria situation will further deteriorate. Environmental conditions are seen as the main reason for this estimate. It is unlikely that socio-economic status of malaria-affected countries will improve soon, and thus it is these countries that will experience the burden of global environmental change concerning malaria: environmental degradation, accelerated by increased precipitation, and higher temperatures favour malaria mosquitoes and parasites. (This is one additional reason why protocols designed to limit global change, such as the Kyoto protocol, need to be adhered to and implemented as soon as possible.) Hence it is expected that the rate of transmission will increase in these countries, which are often too poor to provide adequate health care. By contrast, and contrary to many suggestions, malaria is unlikely to return to

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former endemic countries because the high standard of living and environmental measures prevent a return of malaria endemicity, even under climate change (Rogers and Randolph 2000).

The workshop also discussed two other vector-borne diseases, dengue and blue tongue. The former is a human disease, the latter affects sheep and cattle. Both are transmitted by blood-feeding insects, which are dependent on environmental conditions for their distribution and survival. Dengue was endemic in Southeast Asia until 50 years ago, when it began to spread to other parts of the globe. Today, the virus is found in many parts of Asia, Africa and Central and South America, including the Caribbean. Dengue is transmitted by bites of the infectious yellow-fever mosquitoes, *Aedes aegypti*. Blue tongue was previously restricted to Africa, where it may cause high mortality in sheep and cattle. The virus is transmitted by biting midges of the genus *Culicoides*. In the last decade, both dengue and blue tongue have shifted their distribution into 'new' geographic areas. The reasons for this are not very well understood, other than that it is ascribed to increased trade and human and animal traffic. However, this explanation is unsatisfactory, as hundreds of such migrations occur annually, and fortunately most do not survive the arrival in a new, hostile, ecosystem. Yet dengue and blue tongue seem to prosper in their newly acquired habitats. It is tempting to relate this to the effects of global change, and although we agree that this is very plausible, detailed studies are required to identify the principle reasons for these shifts in distribution.

To summarize, we can conclude that global environmental changes will cause both increases and decreases in the areas suitable for vector-borne diseases transmission, but many factors will determine the vulnerability of individual countries for these disease. To elaborate more accurately on future vulnerability of populations – especially those that live in high-risk areas – will be necessary, from both an environmental and a socio-economic point of view.

References

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