Background
In 2000, the Burundi highlands experienced a severe malaria outbreak at a time of civil unrest, insecurity, and nutritional emergency. In 2002, a 4-year vector control programme was started with the aim of preventing malaria epidemics in the highlands. Our activities were based on indoor residual spraying and insecticide treated nets, which are effective control measures. In the highlands, transmission is generally focused around valleys, which contain the most productive breeding sites. We targeted our strategy before the highest transmission months and to the houses near the valleys. The expectation was that treated valleys would act as a protective shield for hill-top populations. We aimed to reduce the malaria vector population, transmission, and prevalence in the intervention treated valleys and non-treated hill tops.

Methods
Since 2002, 23% of houses (about 16 700) in Karuzi province were sprayed yearly with residual insecticide (deltamethrin). Two long lasting insecticidal nets (Permanet) were provided per household. To assess the impact of the interventions, nine cross-sectional studies (randomised clusters) compared indoor resting vector density, malaria transmission and prevalence in intervention (valley: treated; top hill: not treated) and control areas (valley and top hill not treated), 3 and 9 months after indoor residual spraying. Ethics approval was obtained.

Results
Coverage with spraying was high every year (95%). Retention of nets ranged from 77% of net used in 2002 to 28% in 2006. In valleys, Anopheles density fell 2.5 to 26 fold in intervention compared to control areas. In control valleys the risk of capturing malaria-infected mosquitoes was 2.5 (95%CI:1.3-4.8, p=0.008) times higher than intervention valleys. Reduction of malaria prevalence was 12 to 57% in children aged 1-9 years and 14 to 59% in the older age group. In sprayed houses an additional reduction of 77% (95% CI:35-83, p=0.001) in Anopheles was observed when nets were used. Despite lower vector density in the intervention valleys, no significant impact was observed in the hills.

Conclusion
Our results suggest that the programme has a high impact on the vector population and malaria transmission and a moderate effect on malaria prevalence in valleys. There was no protective effect in hill tops of intervention areas, probably because breeding sites were more dispersed than initially thought. However, in the 4 years of the programme, the province did not reach malaria epidemic threshold, although some alerts were reported in surrounding provinces. The operational expertise acquired has made large-scale prevention activities possible within MSF.

Prevention of malaria epidemics in the Burundi Highlands
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