

CIMSiM and DENSiM (Dengue Simulation Model)

Description	<p>CIMSiM is a dynamic life-table simulation entomological model that produces mean-value estimates of various parameters for all cohorts of a single species of <i>Aedes</i> mosquito within a representative 1 ha area (Focks et al., 1993a and b). For each cohort, depending on the life stage, CIMSiM maintains information on abundance, age, development with respect to temperature and size, weight, fecundity, and gonotrophic status. With few exceptions, the various processes are simulated mechanistically. The accounting is made dynamic by calculating on a daily bases the number of each cohort that will pass to the next age or stage as a function of a number of variables and relationships. For example, development times of eggs, larvae, pupae, and gonotrophic cycle are based on temperature using an enzyme kinetics approach. The bases of larval weight gain, food depletion, and fasting are differential equations modified to compensate for the influence of temperature. Fecundity is modeled as a function of pupal size, which in turn is a function of the recent history of larval abundance, food, temperature and, fasting in the larval habitat. All survivals are tied to temperature, and, for adults and eggs, saturation deficit as well; larval survival is also a function of fasting and fat body reserves. Because microclimate is a key determinant of survival and development for all stages, CIMSiM also contains an extensive database of daily weather information.</p> <p>DENSiM (Focks et al., 1995) is essentially the corresponding account of the dynamics of a human population driven by country- and age-specific birth and death rates. An accounting of individual serologies is maintained, reflecting infection and birth to seropositive mothers. The entomological factors passed from CIMSiM are used to create the biting mosquito population. The survival and emergence values dictate the dynamic size of the vector population within DENSiM while the gonotrophic development and weight estimates influence the rate at which these females bite. Temperature and titer of virus in the human influence the extrinsic incubation period in the mosquito; titer is also seen as influencing the probability of transfer of virus from human to mosquito. The infection model accounts for the development of virus within individuals and its passage between the vector and human populations.</p>
Appropriate Use	The models can be used to 1) optimize dengue control strategies using multiple control measures; 2) develop transmission thresholds in terms of <i>Ae. aegypti pupae</i> per person as a function of temperature and herd immunity; and 3) evaluate the impact of climate change.
Scope	The models are site-specific and require local surveys and weather to parameterize them.
Key Output	Parameters estimated by DENSiM include demographic, entomologic, serologic, and infection information on a human age-class and/or time basis.
Key Input	A pupal/demographic survey is required to estimate the productivities of the various local water-holding containers. Daily weather is required — maximum/minimum temperature, rainfall, and saturation deficit.
Ease of Use	The front end of the models is Windows-based and easy to use. However, because the models are site-specific, there is a substantial upfront investment in parameterization.
Training Required	Usually, 3-4 days of training in the context of a grant where Dana A. Focks is either the PI or a collaborator with responsibilities for simulation analysis.
Training Available	Interested parties should contact Dana A. Focks.

CIMSiM and DENSiM (Dengue Simulation Model) (cont.)

Computer Requirements	IBM PC compatible computers are required. Memory 512 MB, processor speed useful, 1 GHz rough minimum.
Documentation	Documentation for the DOS versions is available from Dana A. Focks.
Applications	Use of the models has permitted the development of targeted source reduction/control strategies; WHO's TDR is now funding pilot evaluations in 10 countries. To project the impact of climate change on dengue prevalence in the Caribbean, Mexico, USA in Texas, and multiple locations in South and Central America, and Asia.
Contacts for Framework, Documentation, Technical Assistance	Dana A. Focks, Infectious Disease Analysis, P.O. Box 12852, Gainesville, FL 32604 USA; Tel: 352.375.3520; Fax: 352.372.1838; e-mail: DAFocks@ID-Analysis.com .
Cost	Depends on end user. Many dengue-endemic countries have copies.
References	<p>Burke, D., A. Carmichael, D. Focks et al. 2001. <i>Under the Weather: Exploring the Linkages Between Climate, Ecosystems, Infectious Disease, and Human Health</i>. National Research Council, National Academy Press, Washington, DC 146 pp.</p> <p>Focks, D.A. 2003a. A Review of Entomological Sampling Methods and Indicators for Dengue Vectors. Tropical Disease Research, World Health Organization. Geneva. in press and on WHO/TDR web site.</p> <p>Focks, D.A. 2003b. Epidemiology. In Dengue. S.B. Halstead (ed.). Tropical Medicine-Science and Practice Series. G. Pasvol and S. Hoffman S, series eds. Imperial College Press. In press.</p> <p>Focks, D.A., R.J. Brenner, D.D. Chadee, and J. Trosper. 1998. The use of spatial analysis in the control and risk assessment of vector-borne diseases. <i>Am Entomologist</i> 45:173-183.</p> <p>Focks, D.A., R.A. Brenner, E. Daniels, and J. Hayes. 2000. Transmission thresholds for dengue in terms of <i>Aedes aegypti</i> pupae per person with discussion of their utility in source reduction efforts. <i>Am J Trop Med Hyg.</i> 62:11-18.</p> <p>Focks, D.A., E. Daniels, D.H. Haile, and J.E. Keesling. 1995. A simulation model of the epidemiology of urban dengue fever: Literature analysis, model development, preliminary validation, and samples of simulation results. <i>Am J Trop Med Hyg.</i> 53:489-506.</p> <p>Focks, D.A., D.H. Haile, E. Daniels, and G.A. Mount. 1993a. Dynamic life table model of a container-inhabiting mosquito, <i>Aedes aegypti</i> (L.) (Diptera: Culicidae). Analysis of the literature and model development. <i>J Med Entomol.</i> 30:1003-1017.</p> <p>Focks, D.A., D.H. Haile, E. Daniels, and G.A. Mount. 1993b. Dynamic life table model of a container-inhabiting mosquito, <i>Aedes aegypti</i> (L.) (Diptera: Culicidae). Simulation Results and Validation. <i>J Med Entomol.</i> 30:1018-1028.</p> <p>Jetten, T.H. and D.A. Focks. 1997. Changes in the distribution of dengue transmission under climate warming scenarios. <i>Am J Trop Med Hyg.</i> 57:285-297.</p>