Hoarding rainwater could 'dramatically' expand range of dengue-fever mosquito

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Ecologists have developed a new model to predict the impact of climate change on the dengue fever-carrying mosquito *Aedes aegypti* in Australia - information that could help limit its spread.

According to the study, published in the new issue of the British Ecological Society's journal *Functional Ecology*, climate change and evolutionary change could act together to accelerate and expand the mosquito's range. But human behaviour - in the form of storing water to cope with climate change - is likely to have an even greater impact.

Lead author, Dr Michael Kearney of the University of Melbourne says: "The potential direct impact of climate on the distribution and abundance of *Ae. aegypti* is minor when compared to the potential effect of changed water-storage behaviour. In many Australian cities and towns, a major impact of climate change is reduced rainfall, resulting in a dramatic increase in domestic rainwater storage and other forms of water hoarding."

"Water tanks and other water storage vessels such as modified wheelie bins are potential breeding sites for this disease-bearing mosquito. Without due caution with water storage hygiene, this indirect effect of climate change via human adaptation could dramatically re-expand the mosquito's current range," he says.

Ae. aegypti probably arrived in Australia in the 19th century on ships carrying mosquito larvae-infested water barrels. During the late 19th

century, *Ae. aegypti* was widespread in urban Australia, stretching as far south as Sydney and Perth. By the late 1960s, *Ae. aegypti* was restricted to the northern half of Queensland (where it currently resides) thanks in part to removal of old galvanised tin rainwater tanks, installation of piped water, insecticides and new power lawnmowers that helped people keep their back yards tidy.

The study has major implications for public health interventions in Australia and other areas of the world affected by dengue and other mosquito-spread diseases. According to Dr Scott Ritchie, a mosquito control expert and contributing author: "The better we understand the underlying processes, the better we will be able to manage disease risk into the future. Our results highlight that dengue-vectoring mosquitoes can spread to areas where they are currently not found once suitable breeding sites, such as containers, become available. Our research can help target water hygiene education campaigns to areas most at risk of dengue mosquito establishment."

The predictions come from a new "bottom-up" model that takes into account the mosquito's biology and its physiological limitations, such as the ability of its eggs to tolerate drying out.

To construct the model, Kearney and his colleagues needed to predict the microclimates mosquitoes experience. "Like all mosquitoes, the dengue mosquito has an aquatic larval phase and it is very particular about breeding in artificial containers like water tanks, buckets and old tyres. So we developed a model of the temperature and depth of water in different containers as a function of climate. We modelled two extreme types of container - a large (3600 litre) water tank receiving rainwater from a roof catchment, and a small (20 litre) bucket only receiving rainwater from directly above. We considered each container type in high and low shade," Kearney says.

The authors also took evolution into account - the first time this has been done in such models. According to Professor Ary Hoffmann, a coauthor of the study: "Evolution happens all the time in nature and can be very rapid, taking only a few generations to influence the fitness of populations. Our results show that evolution can make a very large difference when predicting changes in species ranges under climate change."

Reference: Michael Kearney et al (2009). Integrating biophysical models and evolutionary theory to predict climatic impacts on species' ranges: the dengue mosquito Aedes aegypti in Australia, *Functional Ecology*, doi: 10.1111/j.1365-2435.2008.01538.x, is published online on 28 January 2009.

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