A MULTI - MODEL APPROACH TO DESCRIBE THE CHIKUNGUNYA EPIDEMIC IN ITALY DURING SUMMER 2007

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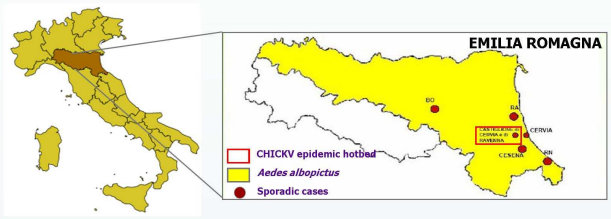
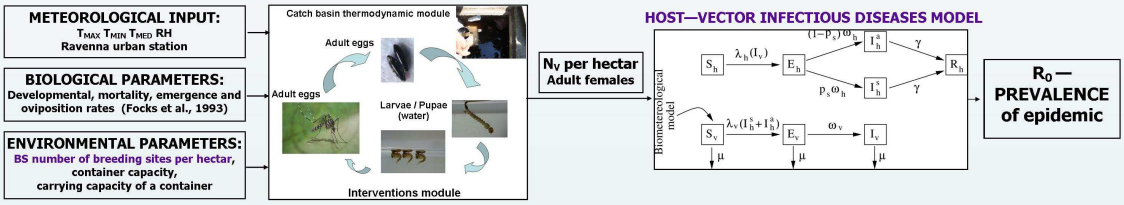
AIM OF THE STUDY: investigate the transmission potential of CHIKV in Italy, to provide insight into the possible impact of future outbreaks in temperate climate regions, and the effectiveness of the interventions performed during the outbreak for the epidemic control.

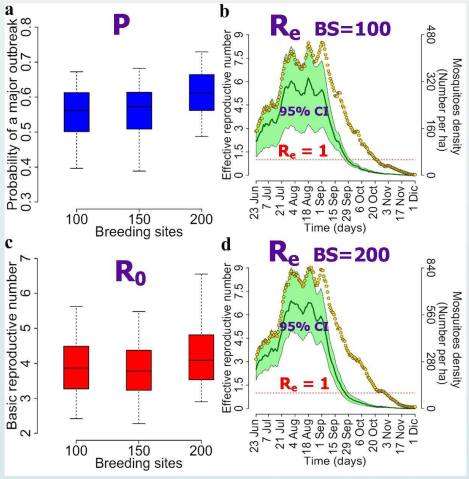
EPIDEMIC: Chikungunya virus (**CHIKV**), arthropod–borne virus transmitted to humans by *Aedes* mosquitoes (Reiter et al., 2006); **VECTOR**: ***Aedes albopictus*** ;
EPIDEMIC HOTBED: Castiglione di Cervia and Castiglione di Ravenna (Emilia Romagna region), 3968 inhabitants in a built–up area of about 70 ha
CONFIRMED CASES: **161 laboratory confirmed cases** (Rezza et al., 2007);
PREVALENCE: estimated **10.2%** (Moro et al., 2010), La Reunion Island '05 –'06 epidemic 38.2%(Gerardin et al., 2008) and in Mayotte, Indian Ocean, 37.2%(Sissoko et al., 2008);
INDEX CASE: foreigner arrived in Italy from India on June 21, recorded on June 23;
INTERVENTIONS: (Rezza et al., 2007) started at August 23. Breeding sites removal in the entire area, eggs removal (1 day), larvicides and adults removal (3 days).



BiTE
(Biometeorological Tiger mosquitoes Estimator)
adapted version of the model described in (Otero et al., 2006)



MODELLED POTENTIAL TRANSMISSION OF CHIKV



BITING RATE K = 0,22 day^{-1}
95% CI 0,15-0,32
fitted using notification data before the interventions and by assuming a number of breeding sites equal to 200 (0,25 day^{-1} reported in Fonteneille et al., 2007)

MAX RATIO OF MOSQUITOES TO HUMANS N_V/N_H = 10 - 15
obtained with the mean number Nv estimated through the biometeorological model over a 70 ha area
(20 reported in Fonteneille et al., 2007)

Table 1: Epidemiological and entomological parameters.

parameter	description	value
$1/\omega_h$	Latent period in humans	2–4 days [1,2,3,4]
$1/\gamma$	Infectious period in humans	2–7 days [1,2,5]
χ_h	Human susceptibility to infections	50%–80% [1]
p_s	Symptomatic ratio	82% [6]
p_n	Notification ratio	54% [6]
N_h	Human population	3,968 [7]
$1/\omega_v$	Latent period in mosquitoes	2–3 days [1,8]
χ_v	Mosquito susceptibility to infections	77.1% [9]
$1/\mu$	Lifespan of adult mosquitoes	4–10 days [1,10]
k	Mosquito biting rate	fitted

[1] Dumont et al. (2008); [2] Chhabra et al. (2008); [3] Boëlle et al. (2008); [4] Centers for Disease Control and Prevention (2008); [5] Parola et al. (2006); [6] Moro et al. (2010); [7] Rezza et al. (2007); [8] Dubrulle et al. (2009); [9] Vazeille et al. (2008); [10] Favier et al. (2005).

$$R_0 = R_0^{HV} R_0^{VH} = k^2 \frac{N_v}{N_h} \frac{\chi_h \chi_v}{\gamma\mu} \frac{\omega_v}{\omega_v + \mu}$$

R_0 = 4,3 95% CI 2,9-6,5
obtained with the mean number of Nv estimated through the biometeorological

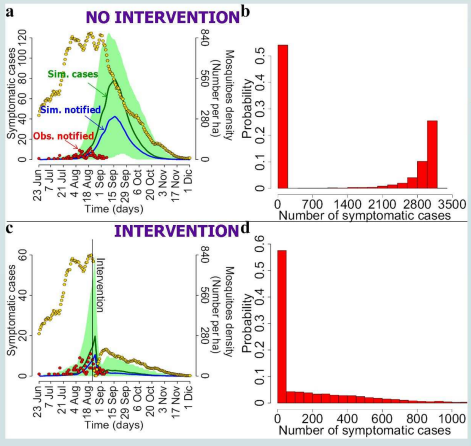
$$p = 1 - \frac{R_0^{VH} + 1}{R_0^{VH}(R_0^{HV} + 1)}$$

PROBABILITY OF MAJOR OUTBREAK
p = 0,61 95% CI 0,49-0,73
obtained with BS = 200 (almost constant with BS variation)

major outbreaks are possible only for large value of Nv/Nh !!!

MODEL VALIDATION

Cumulative attack rate = symptomatic cases / population at the end of epidemic
Prevalence = cum. attack rate / P_S symptomatic ratio
no intervention —> estimated cum. attack rate = 73%
intervention —> estimated cum. attack rate = 9% VS 8,4% (Moro et al., 2010)



192 sim. VS 161 obs. notified cases (Rezza et al., 2007)

DISCUSSION:

- **Transmission potential of CHIKV in Italy was similar to the one observed in tropical regions where Chikungunya fever is widespread confirming the high risk of vector borne diseases as a consequence of globalization and global warming .**
- **This analysis strongly support the efficacy of the disinfestation strategy performed during the Italian outbreak, which drastically contributed to reduce the cumulative attack rate (of about 88%).**

EFFECTIVENESS OF INTERVENTIONS

INTERVENTIONS (Rezza et al., 2007)	BS removal	Eggs removal	Larvicide	Adulticide
Reference scenario (estimated effects)	-40%	-40%	-90%	-95% for 3 days

Sensitivity analysis through the variation of each single intervention (modelled with BiTE biometeorological model), all togheter or separately:
A combined strategy can result in a drastic reduction of the epidemic impact !
Adulticides are the most effective single intervention since mosquitoes are in a decaying phase at the time of the intervention !