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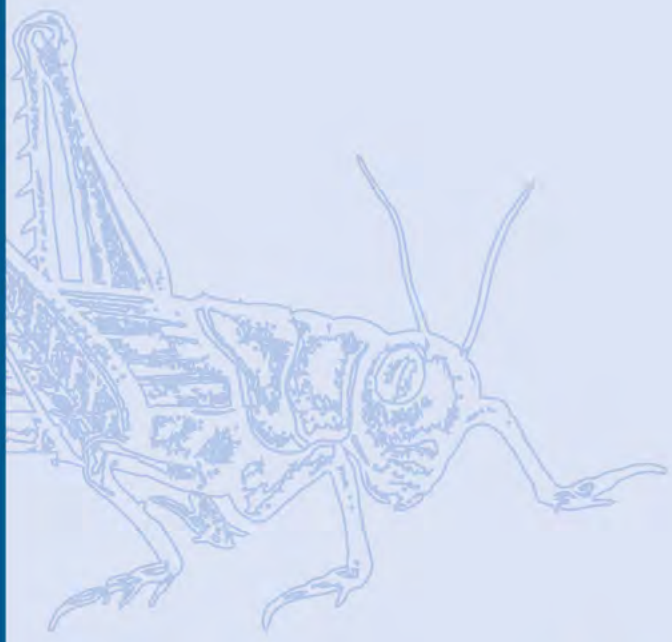


**CONGRESS SECRETARIAT**

Sciences Faculty, University Ibn Zohr
AGADIR | MOROCCO
orthoptera2019@uiz.ac.ma


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# SPATIAL UNCERTAINTY AND STRUCTURATION EFFECTS ON PREVENTIVE MANAGEMENT OF LOCUST PLAGUES: A MULTI-AGENT PERSPECTIVE

*Pierre-Emmanuel Gay*[1], *Michel Lecoq*[1], *Cyril Piou*[1]

[1] *CIRAD, CBGP, Montpellier, France; cyril.piou@cirad.fr*

*CBGP, CIRAD, INRA, IRD, Montpellier SupAgro, Univ Montpellier, Montpellier, France*

The spatial structure of locust outbreaks is a major item of planning and success of locust preventive management strategies. Indeed, preventive management relies on where and when survey teams have to be sent to explore and report the biotope situation and the potential locust population development in order to react in time to any upsurge. The spatial concentration of areas favourable to outbreak has been documented in many species. Other spatial limits are the areas where the preventive management fails to collect information, either because of insecurity or remoteness.

We explored these spatial specificities with the help of ALMMAS, a spatially explicit multi-agent system representing a typical preventive management system with 4 levels of agents: locusts moving randomly and causing intermittently outbreaks spatially localized, field teams conducting surveys and controlling locusts, a management centre hiring and funding the field teams, and a budget holder funding the management centre depending on its own perception of the risk. We simulated 1) some areas where field teams have a low access (only through a corridor), 2) some areas where field teams have no access at all and 3) some areas where the probability to observe initial outbreaks is concentrated in hotspots. We explored the effects of number and size of these areas on the proportion of plague times through series of 100-year simulations.

We observed that a strong effort of the budget holder to keep its funding through time might be annihilated with only 5% of a spatial territory with a restricted access. Logically, we obtained also that the largest the areas without access are, the worse the proportion of plague years is. But interestingly, if these inaccessible areas are divided in several small spots, the plagues are more numerous than with only one equivalent inaccessible area. This is explainable through a border-effect, i.e. more kilometres of frontiers to control when there are several inaccessible areas instead of one.

The concentration of outbreaks in hotspots also increased the probability to observe plagues. Here too, the spatial distribution of only one hotspot was easier to control for the field teams than of several hotspots of identical size. But particularly, an interesting finding was that with only one hotspot, the period of cyclic behaviour of the budget holder between awareness and the reduction of funding was longer than with several smaller hotspots.

These results highlight the need to consider the spatial specificity and accessibility of each locust species when planning the sustainability of anti-locust management systems. The cyclic outbreaks of some locust species, despite the significant budgets in order to establish a preventive management system, may be related to these spatial specificities. Further studies should also focus on the effects of concentrating the attention of surveys in outbreak hotspots.

***Key Words:*** multi-agent model, vicious circle, spatial heterogeneity, preventive management.