

Spatial uncertainty and structuration effects



on preventive management of locust plagues: a multi-agent perspective

Context

The spatial structure of locust outbreaks is a major item of planning and success of locust preventive management. 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 outbreaks 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.

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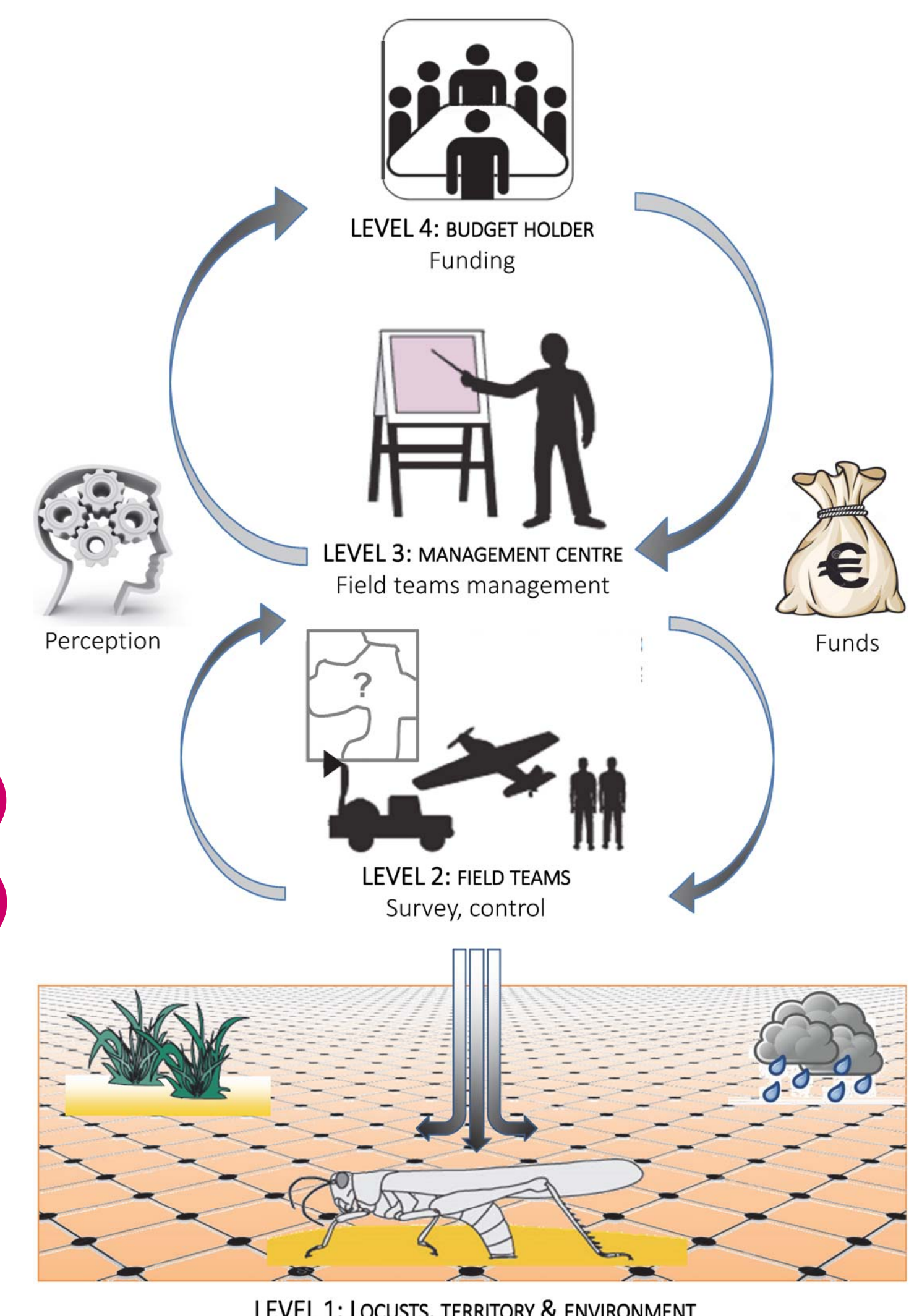
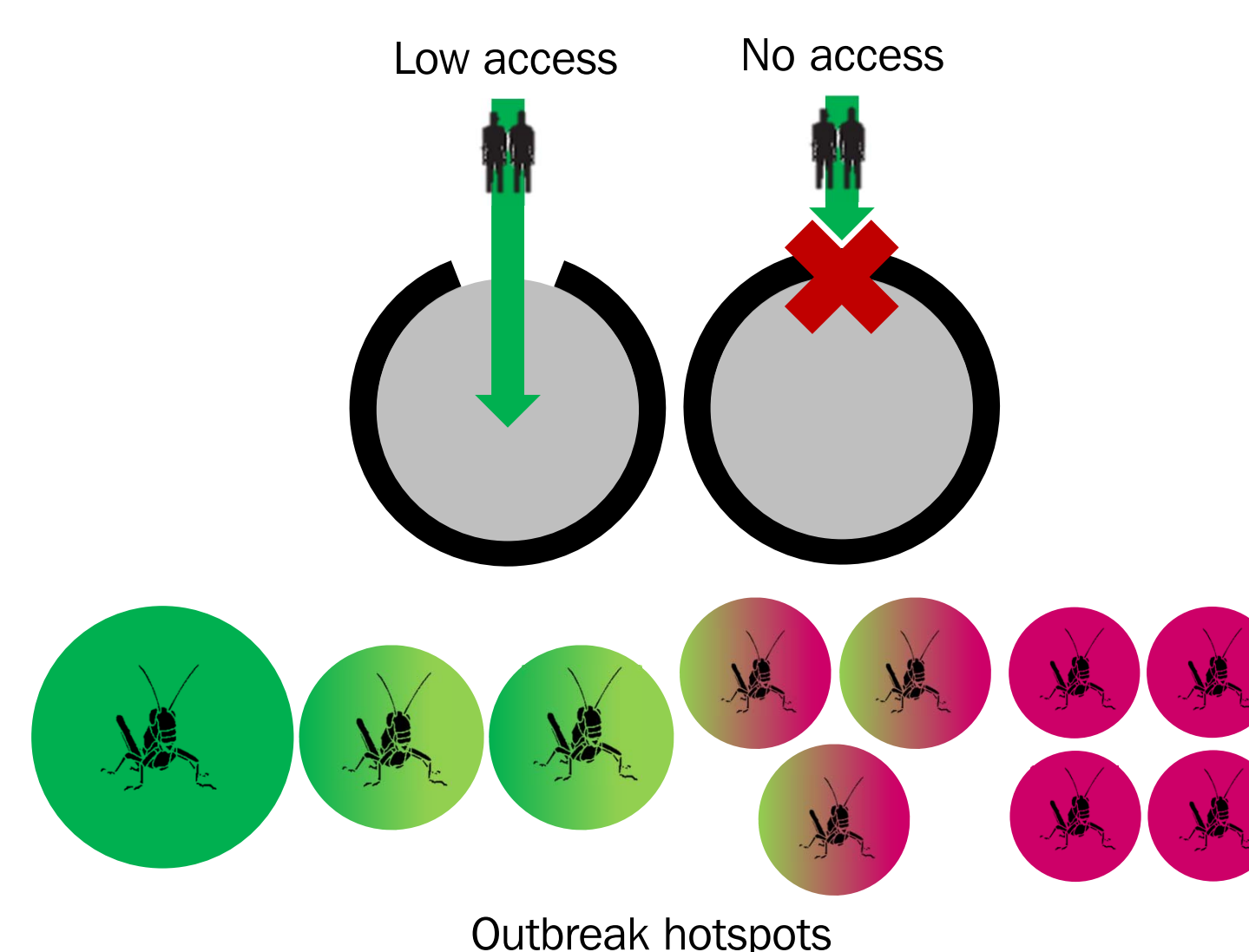
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Work plan

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



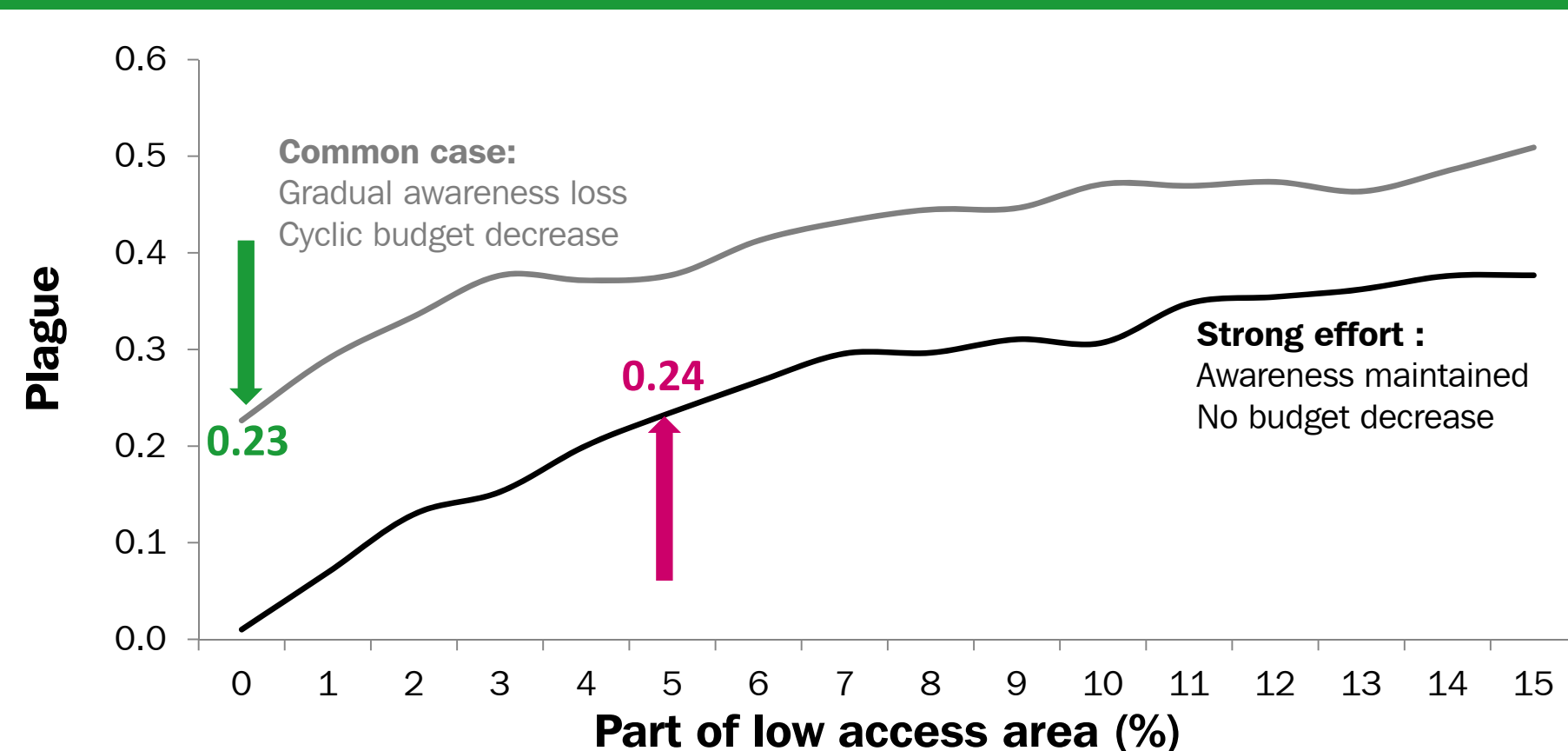
The four levels of the preventive management system.

Insights

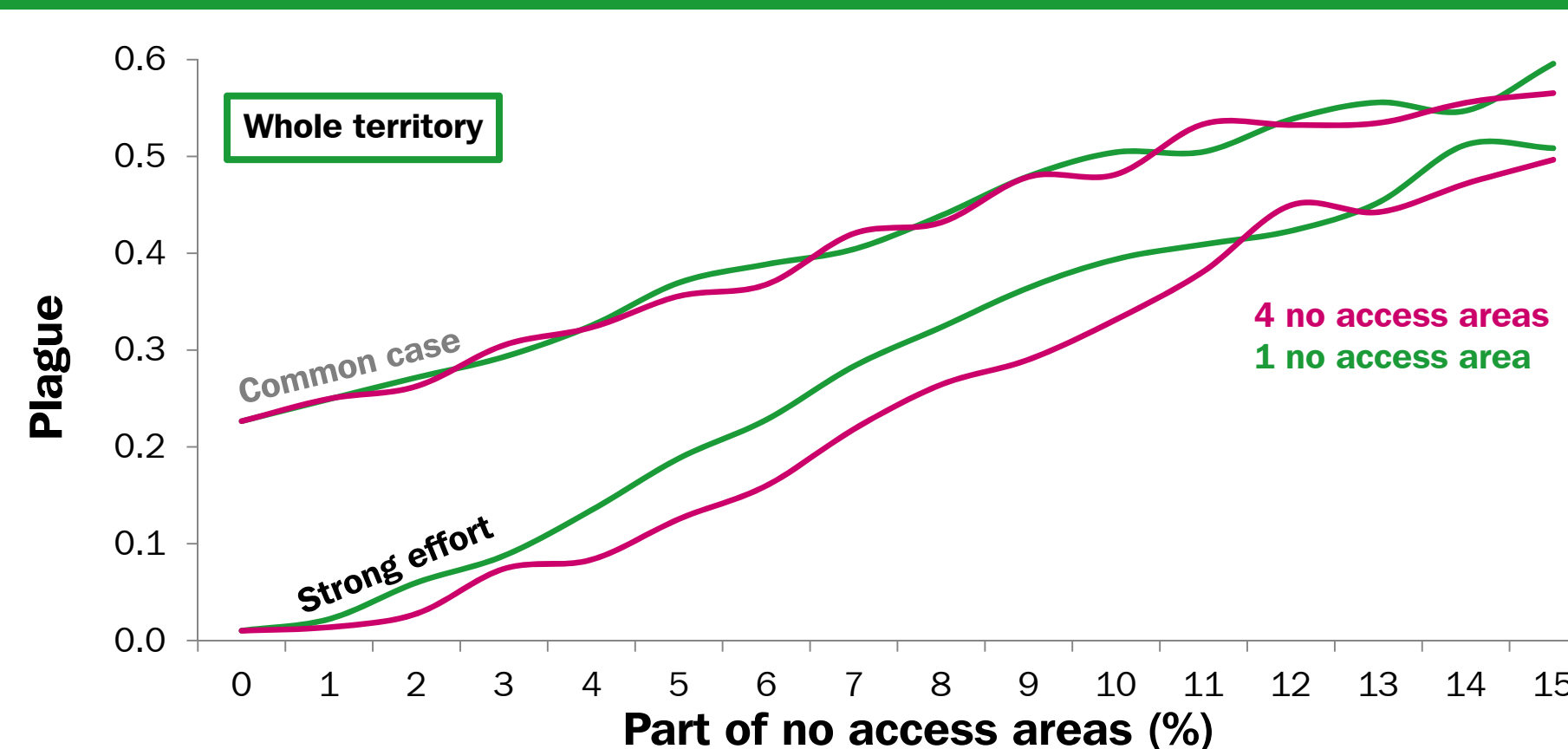
- 1) A strong effort of the budget holder to maintain its funding through time might be annihilated with only 5% of a spatial territory with a restricted access.
- 2) The largest the areas with no access are, the worse the proportion of plague years is.
- 3) When the no access area is divided in smaller areas, the plagues get more numerous.
- 4) One single and large outbreak hotspot is easier to control than several of a same overall size.
- 5) The period between the budget holder is aware and the moment when funds are reduced is longer with a single outbreak hotspot.

The plague is quantified with a ratio between the invasion time (locusts on more than 2% of the land surface) and the total duration of the simulation (100 years).

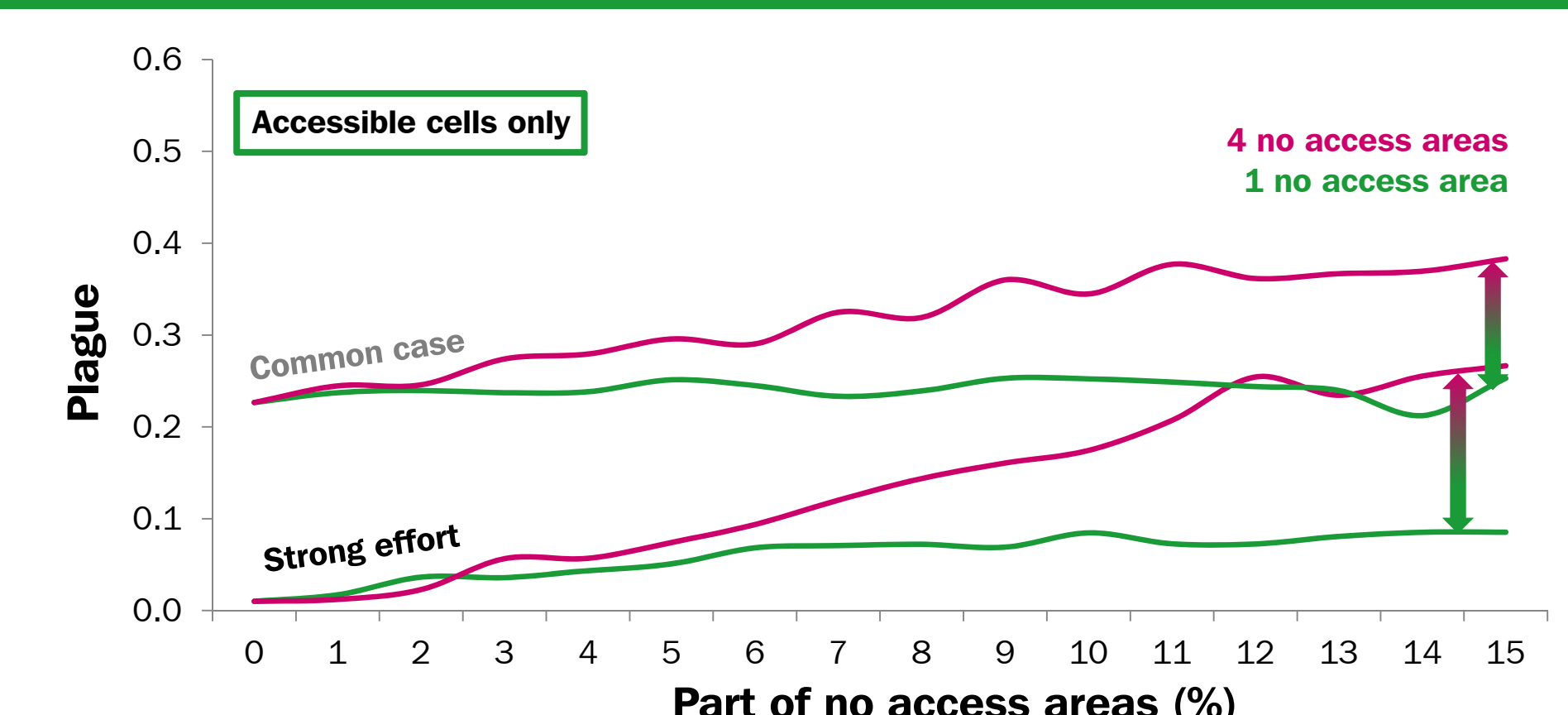
1 Access restriction ► effort annihilated, more plague



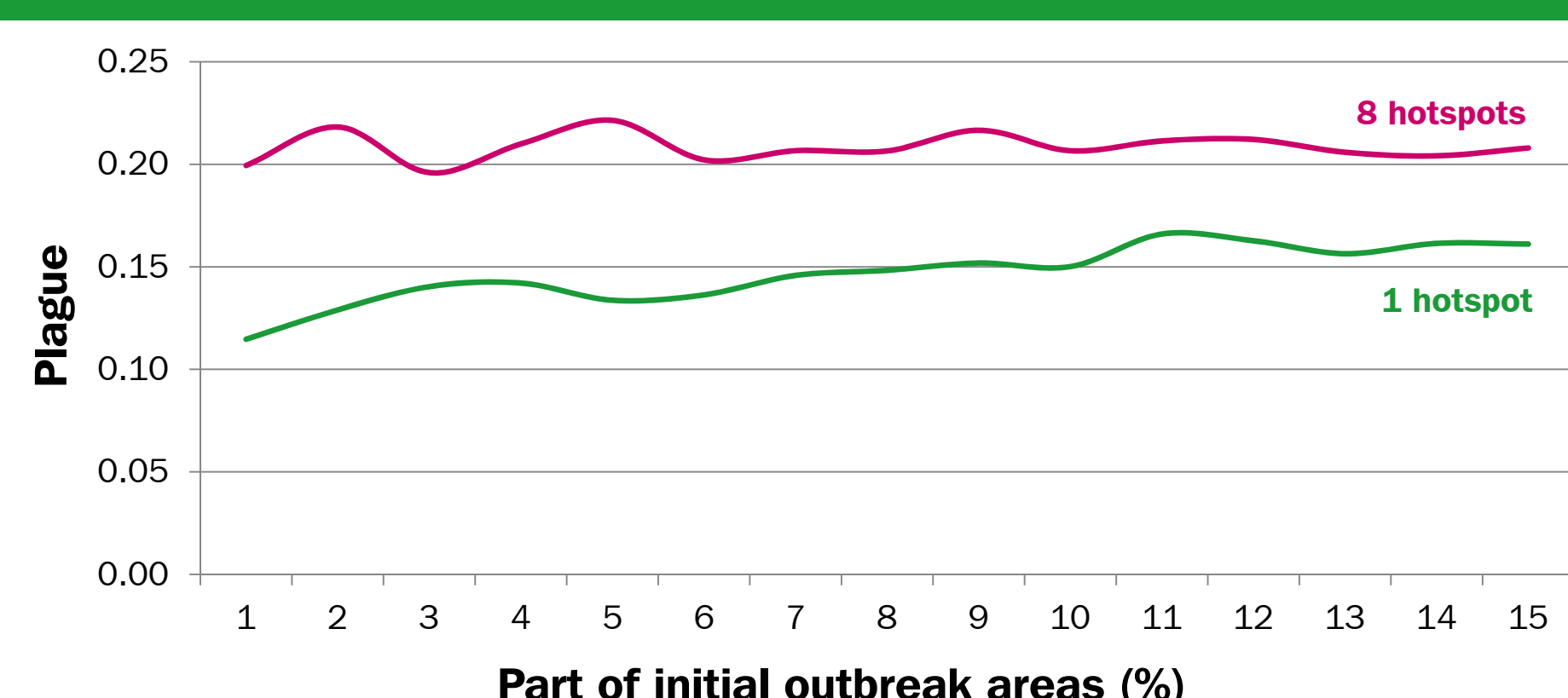
2 No access ► more plague



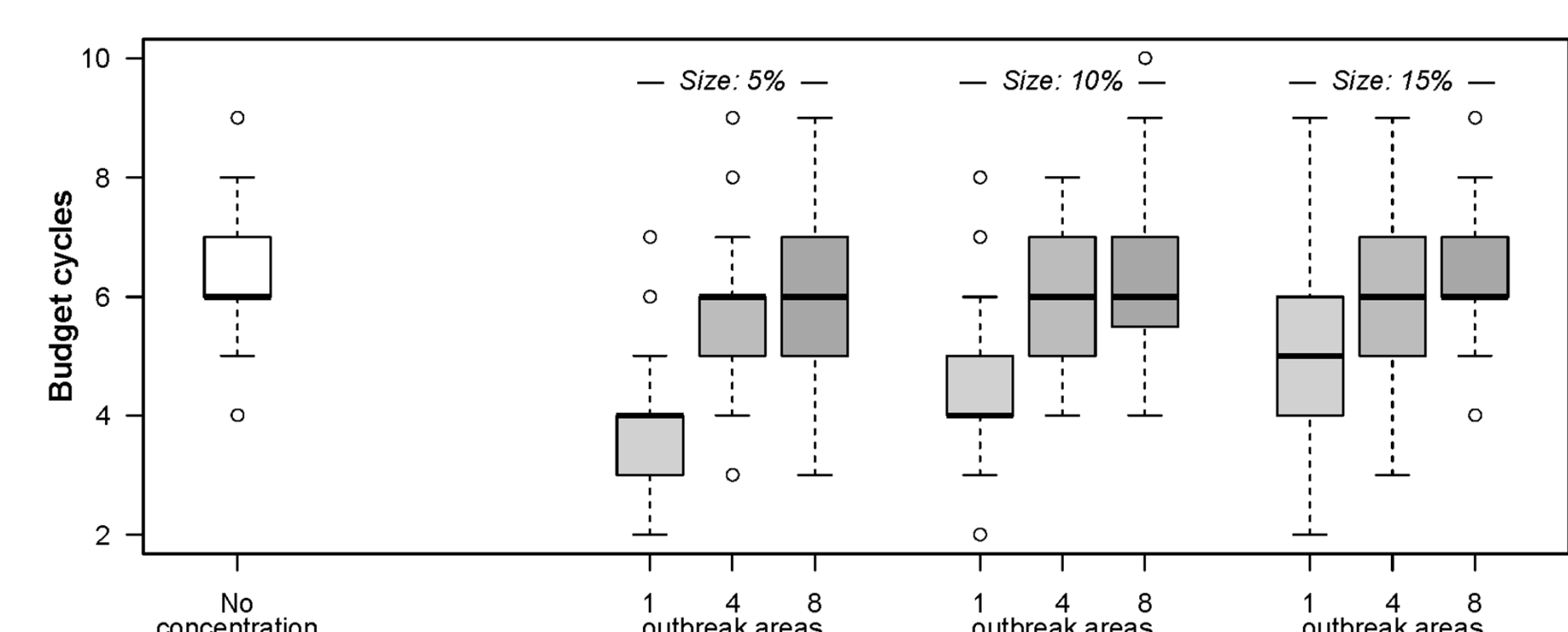
3 Scattering no access ► more plague



4 One single outbreak hotspot ► easier control, less plague



5 One single outbreak hotspot ► less budget cycles, longer awareness



The cyclic outbreaks of some locust species, despite the significant budgets in order to establish a preventive management system, may be related to spatial specificities. Further studies should also focus on the effects of concentrating the attention of surveys in outbreak hotspots.

Conclusion

These results highlight the need to consider spatial specificity and accessibility of each locust species when planning the sustainability of anti-locust management systems.