Developing an agent-based simulation model to evaluate biosecurity inspection policies

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Abstract: Many countries, including Australia, seek to prevent new invasive species from establishing by implementing biosecurity controls at the border. We have developed a simulation model that can comprehensively explore multiple alternative management scenarios, to support evidenced-based border inspection policy changes. Our generalised framework allows us to integrate multiple pieces of biosecurity research and provides a flexible structure to create inspection policies and processes. Our model evaluates proposed inspection policies by estimating the resultant detected and leaked contamination, and the inspection effort required from government and industry. We will discuss the key features of our model and its potential benefits for enhancing biosecurity performance.

Our model uses estimates of contamination that are conditional on attributes of containers and cargo as a foundation to evaluate inspection policies. It requires a list of attributes (for example, the origin or whether it is destined for a metro or rural destinations), the probability of arrivals for each combination of attributes, and the probability of contamination for each combination of attributes. Using these probability distributions, we create simulated versions of containers and cargo, with known attributes and hidden contamination. We then simulate inspections and calculate the percentage of undiscovered contamination and inspection effort.

Our framework for modelling inspection policies represents the policy as a set of nodes and links between them. We use three classes of nodes: decision nodes, treatment nodes and inspection nodes. A decision node will split up the simulated containers and cargo and send them to different nodes, either randomly or based on their attributes. The treatment nodes represent activities such as fumigation or washing and these reduce the probability of contamination, but do not provide information about what was or wasn't contaminated. Finally, inspection nodes are used to identify contamination.

By simulating inspection policies, we can quantitively evaluate proposed policies before they are implemented. Key outputs from these simulations are the inspection effort required, how inspection effort and costs are split between government and industry, the amount of information gained through inspections and how much contamination is passing through undetected. These outputs are critical to make informed decisions and to set policies that are coherent and allocate effort in an effective way.

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