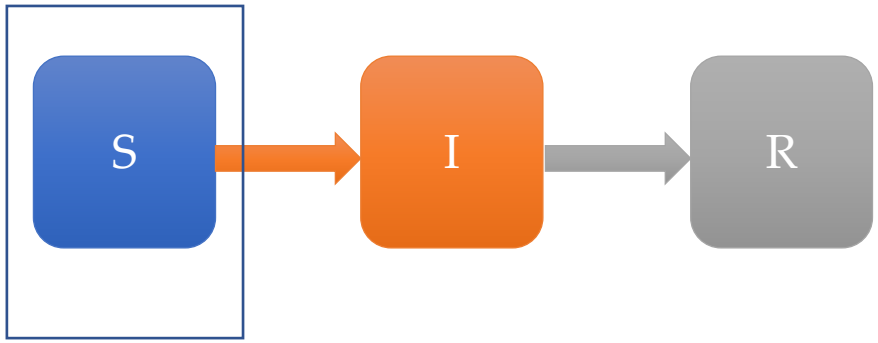
Modeling assumptions and limitations

MATHEMATICAL MODELING FOR INFECTIOUS DISEASE PLANNING IN AFRICA

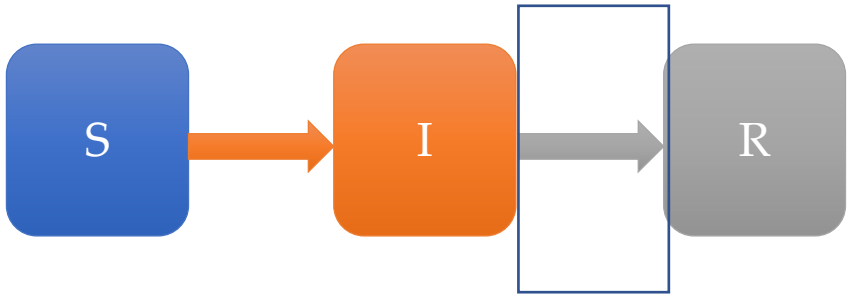
(30 minutes)

MODEL STRUCTURE ASSUMPTIONS

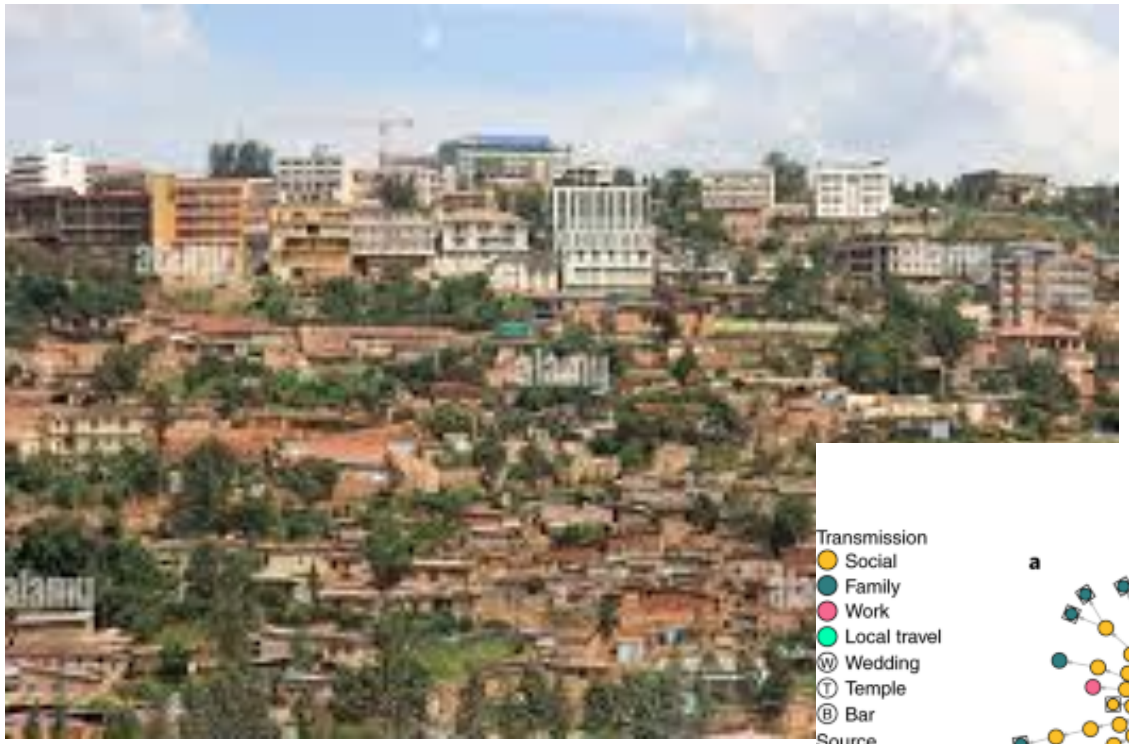
- Does anyone enter or leave the model?
- What are we assuming about population size?
- What are we assuming about virulence?
- What are we assuming about immunity?



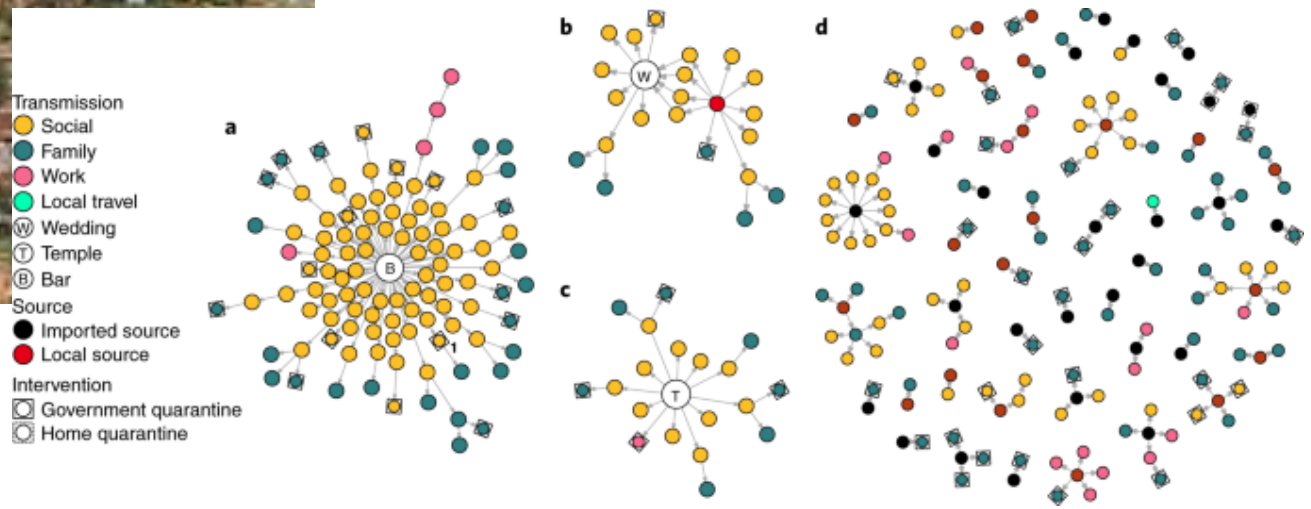
Compartments: Everyone in a compartment is assumed to be similar (ie. heterogeneity in the population is not significantly impacting the dynamics).



Rates: rates are averaged for the compartment. The rate is *inversely proportional to the average time spent in that compartment.* (e.g. the recovery rate is 1/avg duration of infection).



CONTACT RATES: assumption in the simplest models is that everyone has the same contact rate in the population. This is obviously not true…

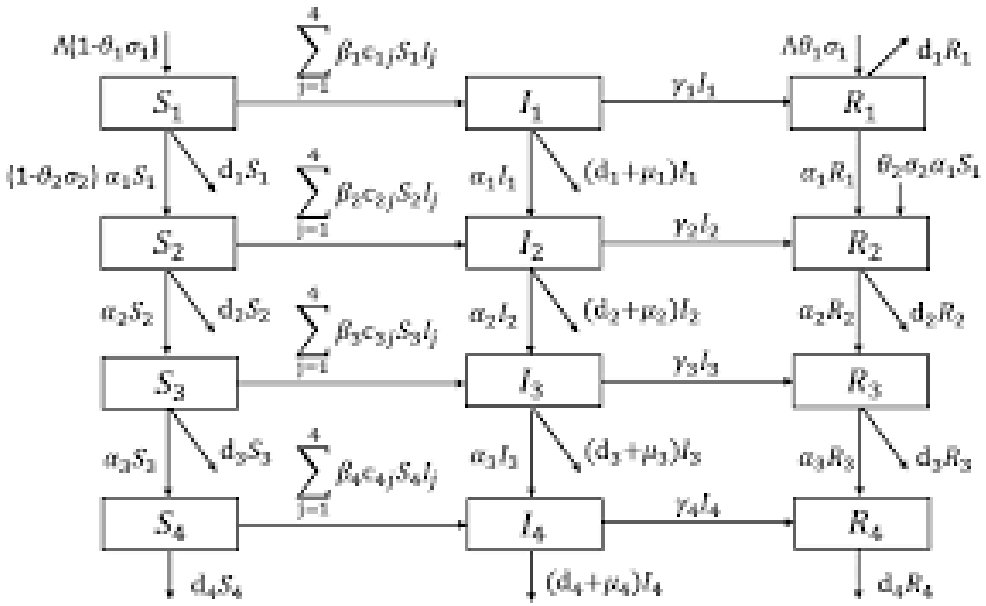


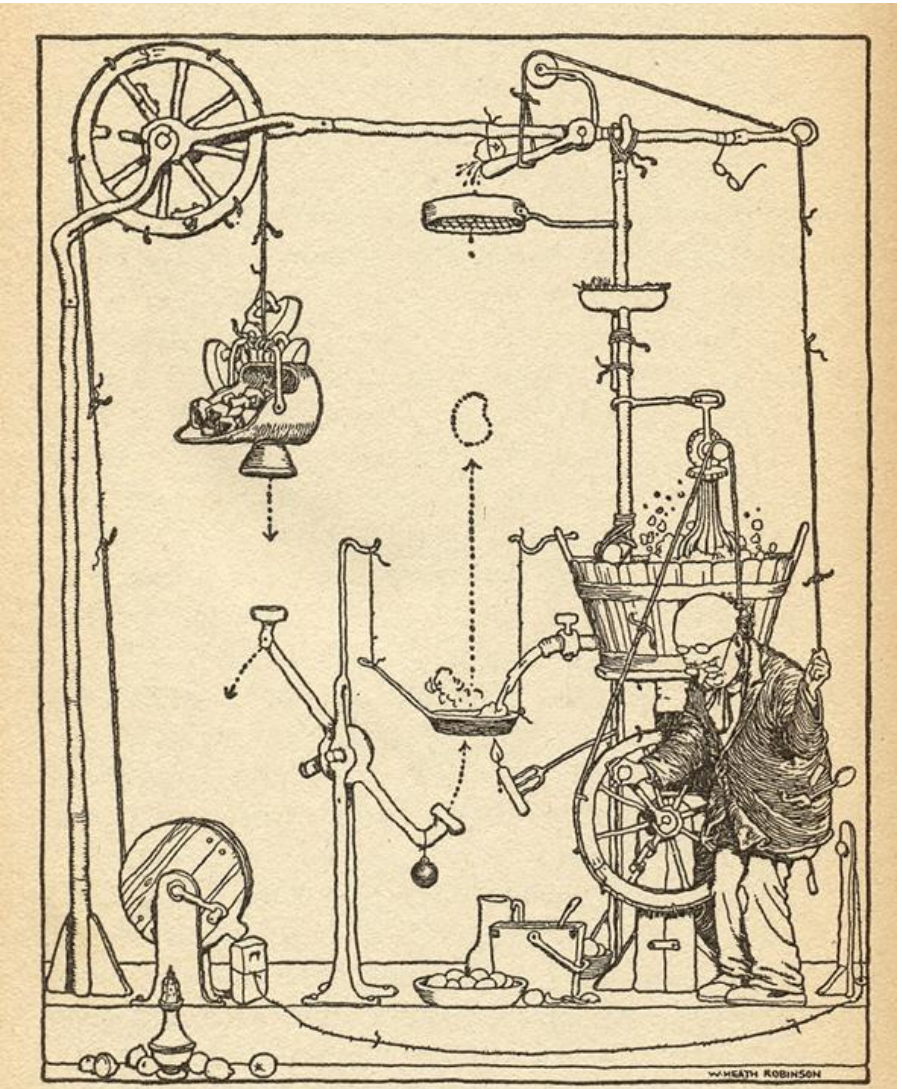
The African context

- Far less data, particularly on contact rates, especially in rural areas
- Often less studies and data for some (not all) diseases, so parameters from the literature must be used carefully
- Models developed by scientists in the global north are often applied haphazardly to LMICs without consulting local experts on parameters and model structure assumptions

Trade offs between realism and clarity

- Adding heterogeneity in the form of more rates or more compartments (e.g. age structure) adds complexity to your model





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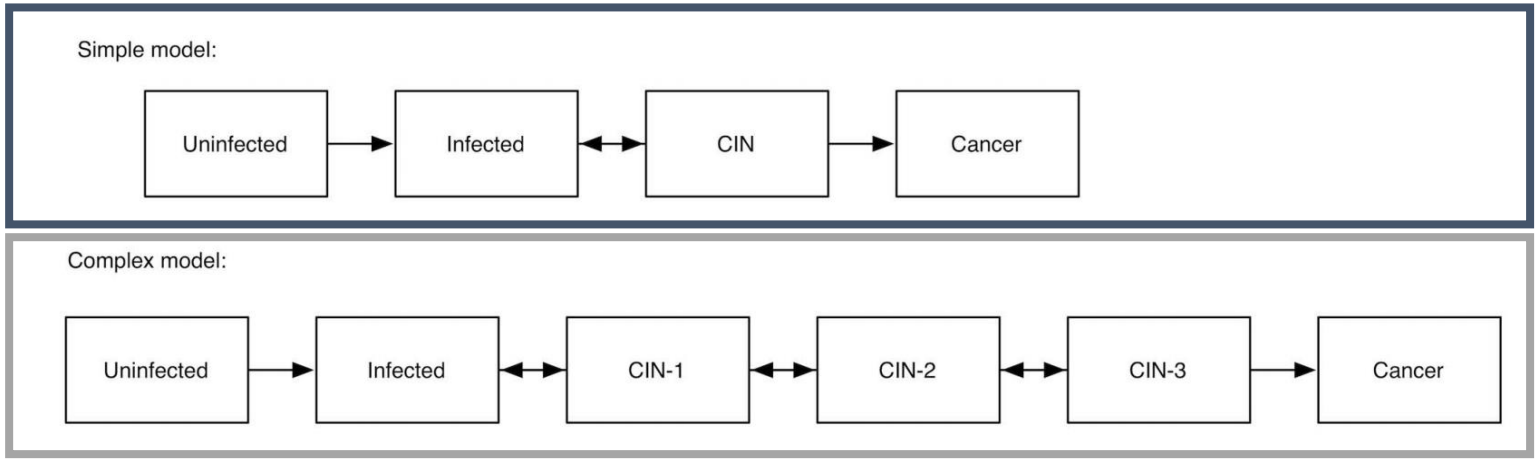
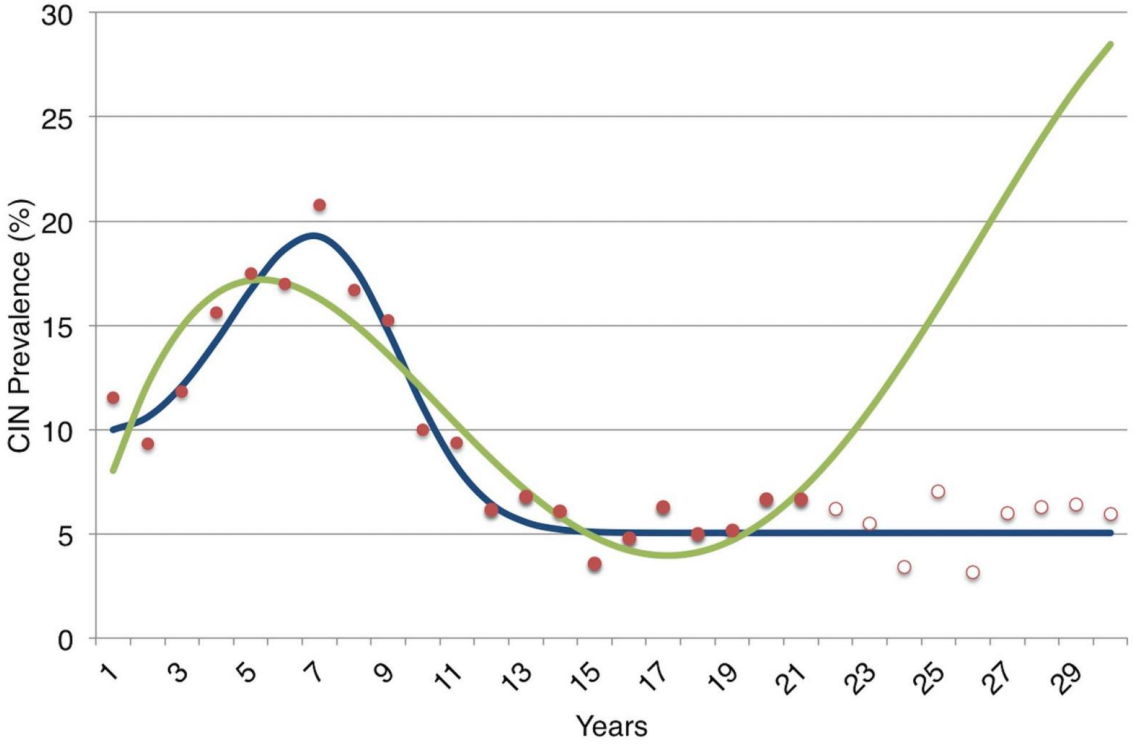
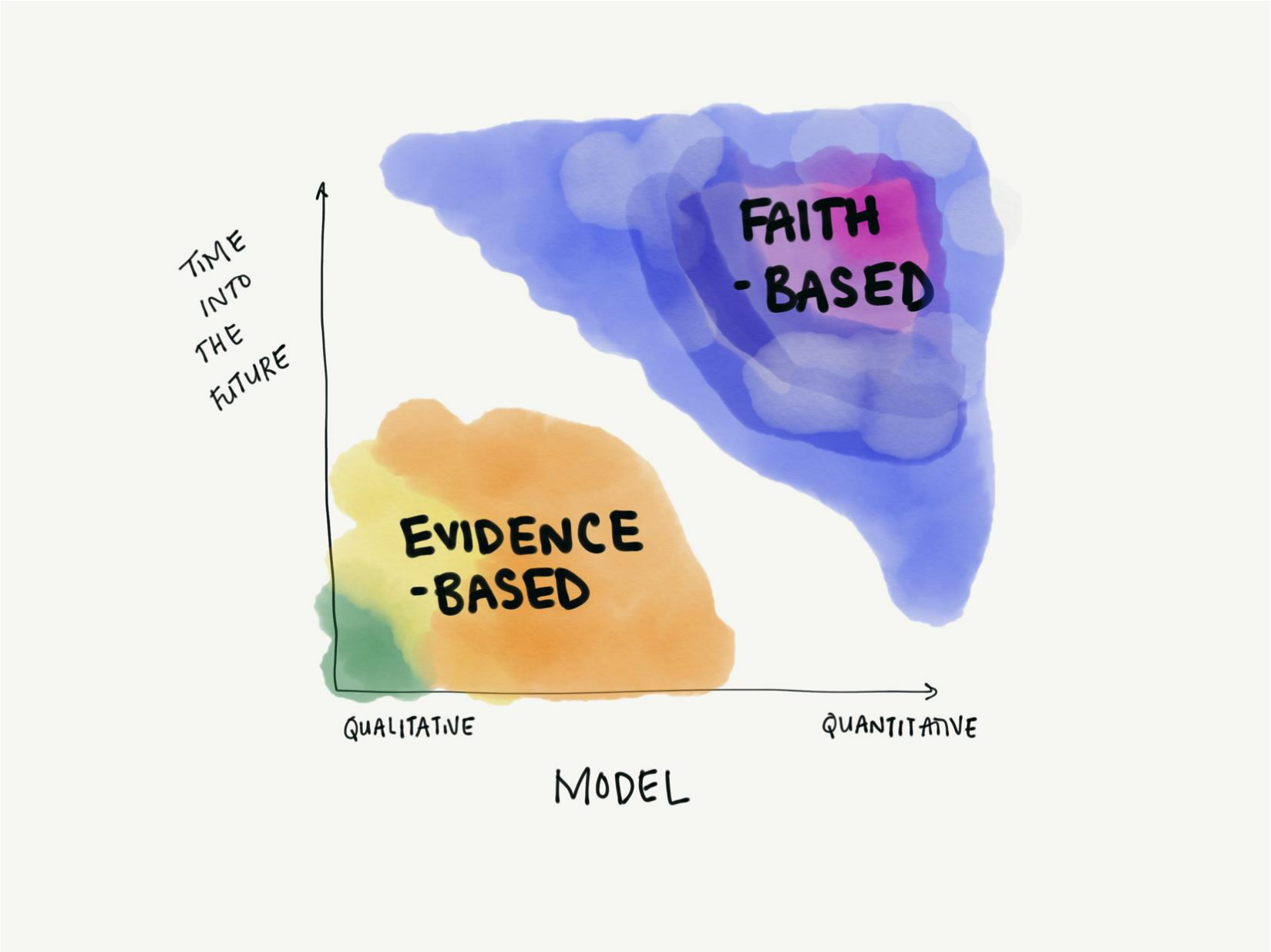




"The more complex model did not perform poorly simply by chance; it did so because there was insufficient prior knowledge to inform the parameter values describing the process through [the] states, hence the model was susceptible to fitting too tightly to the noisy prevalence data (overfitting)."

Basu & Andrews (2013) PLoS Med

*a personal opinion!



“Perhaps most common among abuses… are situations where mathematical models are constructed with an excruciating abundance of detail in some aspects, whilst other important facets of the problem are misty or a vital parameter is uncertain to within, at best, an order of magnitude.

It makes no sense to convey a beguiling sense of “reality” with irrelevant detail, when other equally important factors can only be guessed at.”

Robert May (2004) Science. *The Uses and Abuses of Mathematics in Biology.*