System Dynamics Modeling of Community Sustainability in NetLogo

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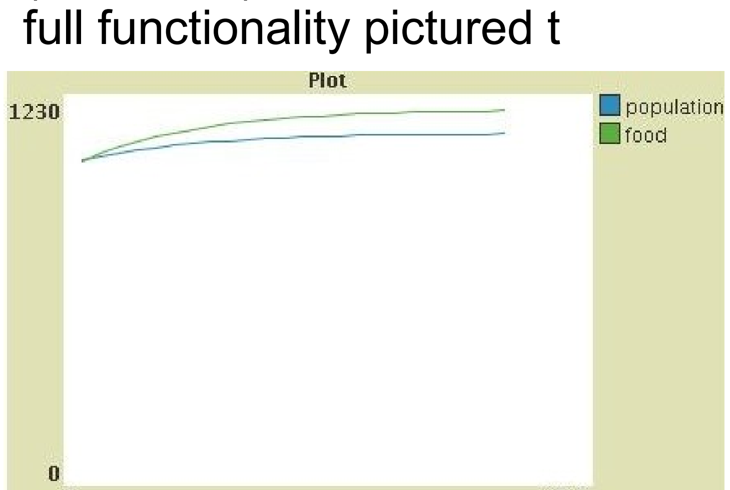
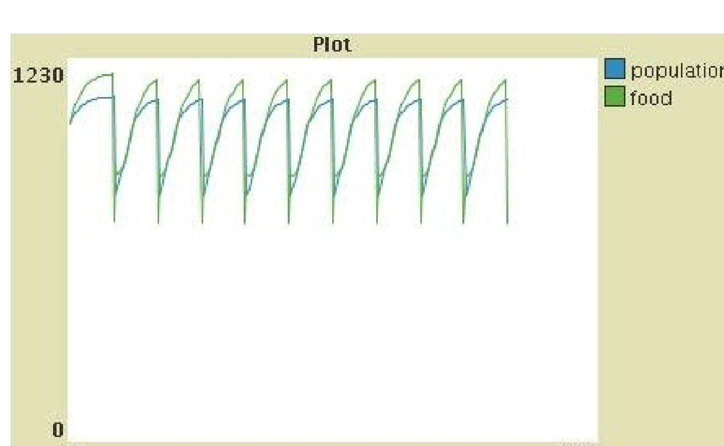
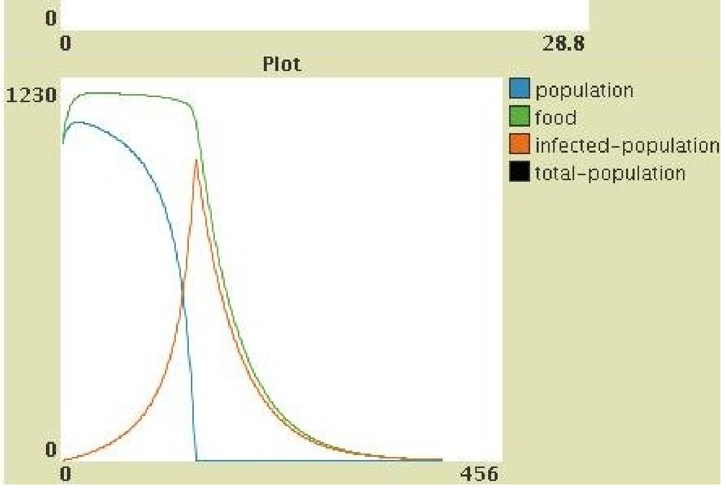
Abstract: The goal of this project is to apply system dynamics modeling to a basic instance of the contemporary issue of sustainability. System dynamics modeling is especially well-suited to the topic of sustainability; the flows and stocks involved with this sort of modeling are the keys needed to express the relationships between quantities and to observe their interactions. My project would model an arbitrary system, which would be a basic model representative of more realistic systems. The results of the model will be displayed to the user graphically. Optimally, the model should functions harmoniously over a sustained period of time rather than spiral wildly out of control, except in the case of AIDS and weather events, which are inherently unsustainable and are included more as an educational experiment than as a step towards a sustainable environment. It is important not to value sustainability over realism in the model.

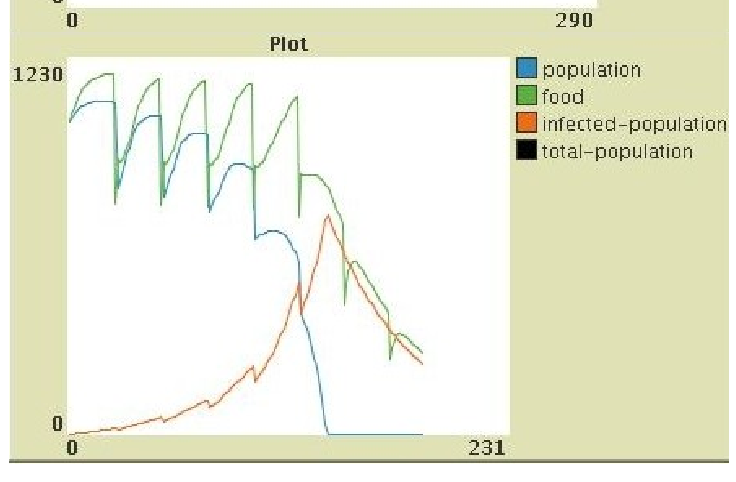
Development Procedures: The foundation for this model are the two stocks, food and population, and their respective flows: births, deaths, food grown, food destroyed. To make this oversimplification more realistic, the stocks were related by means of variables affecting one another's stocks; i.e. food determines food per capita affects starvation rate which affects death rate and thus the population. To add realistic unsmoothness to the model, an element of periodicity was required. This came in the form of periodic famines, the intensity and interval of which is user-determined. Limit were imposed on the model in the form of a definite quantity of land and population density.

Potential outcomes: population density (ceiling, and AIDS (extinction); famines cause oscillation. Weather events with full functionality pictured t

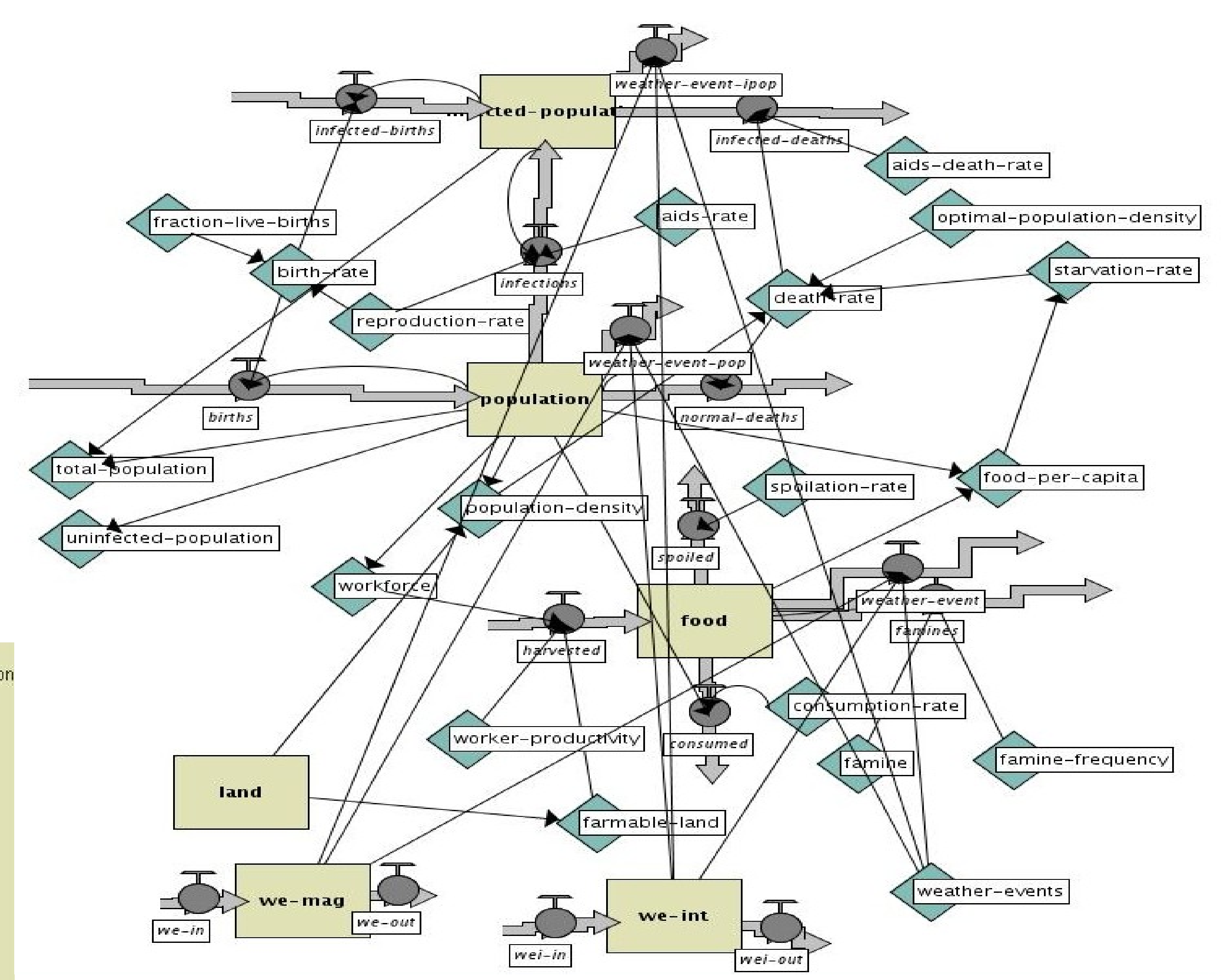


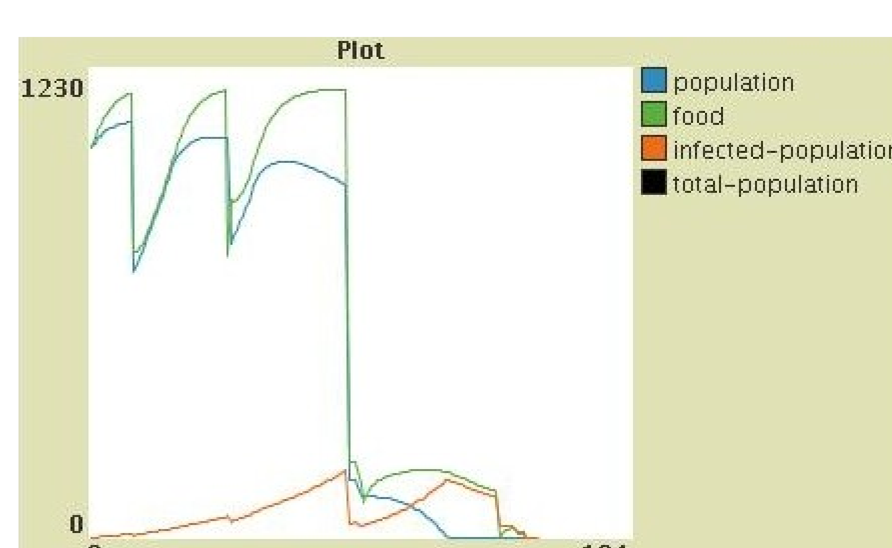






Introduction: The numbers on which the system is based, instead of being simply arbitrary, are based loosely on data for Kenya from the CIA World Factbook (https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html). The basis for the system is the relationship between food and population. For example, if there is insufficient food, people starve, which means that there are fewer workers to grow the food, etc. System dynamics are essential for predicting the long-term results of these continual interactions. The key facets of the model are regular spoiling, consuming, and growing of food and births and deaths amongst the population. There are various levels of complexity in these facets: the birth rate is constant; the food is only grown by a fraction of the population selected to represent a normal percentage of people able to work; and the death rate is variable, based on food available (i.e. if people cannot eat, they starve).My project will involve periodic perturbations in the form of famines, the intensity and interval of which may be defined by the user. There is a limited amount of land for the model; thus population density serves to provide a ceiling for the model. AIDS provides for the outflow of persons from population into infected-population, which has a higher death rate. The disease is linked to reproduction rate, and though it is unsustainable by nature, its very destructiveness provides certain insights into the nature of a sustainable model. Likewise, weather events provide randomness in interval and magnitude and have a very significant effect on the model.





Results and Conclusions:

As of now, the model is generally sustainable, as it is difficult for famines to destroy the population entirely, and population density prevents overshoot. Although it is sustainability, one must also examine the time period required for such an outcome to become apparent. The model, with the right parameters, may take a long time to achieve this sustainability; famines have a much more devastating effect on the short term. Ultimately, however, the model is infinitely sustainable while remaining within the parameters of system dynamics. Only AIDS and weather events, which were not intended to maintain sustainability, cause extinction.

The population-food model fulfills the intention of the project in that it is well-suited to system dynamics. The basic stocks and flows, if not the more complex variables, allow for an easy understanding of the interactions on the most basic level, and the testing methods lend themselves to good analysis of the model's sustainability. The random factors of weather events mean that the model outcome will never be exactly the same. The interactive elements of the program allow for user immersion and a better understanding of both system dynamics and sustainability.