Ecological cities: Alexandria case study
A metabolic-based model for evaluating urban planning and development

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ABSTRACT

Like all ecosystems, the city is a system, having inputs of energy and materials. The main environmental problems (and economic costs) are related to the growth of these inputs and managing the increased outputs. By looking at the city as a whole and by analyzing the pathways along which energy and materials including pollutants move, it is possible to begin to conceive of management systems and technologies which allow for the reintegration of natural processes, increasing the efficiency of resource use, the recycling of wastes as valuable materials and the conservation of (and even production of) energy.

The goal of sustainability in a city can be defined as the reduction of the city's use of natural resources and production of wastes while simultaneously improving its livability, so that it can better fit within the capacities of the local, regional and global ecosystems.

In a model that is called the 'Extended Metabolism Model of the City'. Metabolism is a biological systems way of looking at the resource inputs and waste outputs of settlements. This approach has been developed by a few academics over the past 30 years, though it has rarely if ever been used in policy development for city planning.

In this model it is possible to specify the physical and biological basis of the city, as well as its human basis. The physical and biological processes of converting resources into useful products and wastes are like the human body's metabolic processes or that of an ecosystem. They are based on the laws of thermodynamics which show that anything which comes into a biological system must pass through and that the amount of waste is therefore dependent on the amount of resources required.

For physical expansion in land, Alexandria city experienced a long history of deterioration from the end of the Roman era until the French expedition's departure in the beginning of the 19`" century. Alexandria began to revive again from the first half of the 19`n century during Mohamed Ali era up to date. The city expanded in all available directions. Therefore, the side effects of urban growth commenced to develop in some parts such as informal housing on the cultivated land in the east and southeast of the city.

The research is an attempt to analyze and assess urban dynamics through an ecological urban metabolism approach. Thus it is concerned with developing an SD simulation model and decision support functionalities using STELLA software, which can evaluate urban planning development with focus on land management strategies based on the metabolic system of the city.

The modeling process is divided into three hierarchical tiers; the physical level, the SD modeling level, and the decision-making level. The physical level identifies past and current situations and potential problems. The SD modeling level simulates human impact on the environment and ecosystem based on physical level studies. Reaching the decision-making level, that performs certain scenario analysis following SD model formulation and validation.

The model identifies three critical management strategy variables, including land expansion, intensification and diversification. Several scenario analyses are conducted and presented in this study. Decision makers can also fine tune DSS variables and evaluate preferable

scenarios through simulations. Ecological management strategies for urban development can hopefully be developed and implemented in the near future.

Key words: *Ecosystems, metabolic process, urban metabolism, SD modeling, resources, physical expansion, land stock, urban growth, urban dynamics, land cover/use, ecological foot print, ecological principles, development scenarios, decision-making, Alexandria and sustainability.*