

DECISION SUPPORT SYSTEMS FOR URBAN AND REGIONAL PLANNING

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Summary

An overview of the demographic and technological issues behind urbanization, and of the socio-economic and environmental problems that result from urban development constitutes the first part of this article. Focusing on sustainable management of coastal areas, two main methodologies are discussed:

The use of geographic information systems as a planning and management tool for regional and urban development in coastal areas, and the additional tools that a customized decision support system linked to such a system can provide, once simulation, socio-economic and environmental models are integrated in the same framework.

1. Introduction

Overpopulation became an important global issue by mid 20th century. In developed countries population growth is slowing down and in some cases falling, but this is not the case in developing countries. Countries with "transitional" economies are undergoing demographic transition, which is mostly accomplished by the movement of people towards urban centers where fertility rates are lower. However, this migration to the cities is not in most cases accompanied by economic growth and in some cases, the influx of people to the urban centers is so high that the infrastructure capacities of the cities is surpassed. The World Resource Institute (WRI) reported estimates of the world's urban population in 1996, was 2.6 billion people: 1.752 (67%) billion in developing countries and 0.882 (33%) billion in Industrial countries.

Combined with the lack of economic opportunities, the living conditions decrease in the areas of the cities where lower income people tend to gather - ghetto effect. At the same time, the periphery of the cities becomes larger and larger, as the wealthier migrate to those areas - urban sprawl. This trend is creating additional migration flows within the cities: High and medium income people are moving away from the densely core areas of the cities and from the higher residential prices left in the center of the cities, and the cities centers are becoming more and more entirely business centers. These migratory flows, place additional pressures on the urban environment as the population density increases and the land resources diminish.

Cities are very inefficient "systems" since they require enormous quantities of food, water, energy and materials to operate, and they generate equal enormous amounts of waste and pollution. Urban environmental problems vary by city size, rate of growth, income level, institutional capabilities, and also depend on the regional geography and climate. Sustainable development is thus harder to achieve in larger cities where the financial resources needed to accomplish the necessary tasks are higher, and where very often several jurisdictions are involved, requiring extensive inter-agency coordination and responsibility sharing. Therefore, the evaluation of environmental and socio-economic costs of projects require large amounts of information to be quickly shared and analyzed by the various agencies within each jurisdiction, which are frequently subject to different regulations.

With this in mind, the importance of the need to design analysis tools to help decision makers and planners integrate all the necessary information and predict the effects that their decisions have on the overall sustainability of the area becomes clear. In coastal areas, this need is particularly urgent due to the high development pressures, and due to the scarcity of coastal land available for development. Decision Support Systems can be very useful in effectively representing the interactions and the possible synergetic effects of several variables involved in the resolution of coastal problems, hence they constitute a helpful tool for planning and decision-making on a regional basis.

2. Population Growth

In spite of the increasing awareness with regard to the issue of over population, the world population reached 5.9 billion people in 1998, and UN projections point to a

world population of 9.9 billion \pm 2 billion by the year 2050. These projections are dependent on the total fertility rates, and take in consideration the effects that economic growth and investment in female education have on the fertility rate of the poorest nations. The lower projection scenario requires a drop in the world total fertility rate to the population replacement level of 2.1 (currently the total world fertility rate is 2.8 children per woman: 3.1 in developing countries and 1.6 in developed countries). Current reports by the WRI, show that the annual world population growth rate has stabilized around 1.3% in the past years, and the trend shows signs of a slow decrease within the next decades, with an increase in the number of countries undergoing demographic transition.

2.1. Population Growth Rate

If demographic models are included in regional decision support systems, several factors have to be weighed in the growth models. Table 1 summarizes the factors that contribute to the growth rate of a population. Factors included are dependent on the scale and detail required by the models. For example, most urban models only use for their population projections: The natural growth rate of the population (birth rate - death rate) and the net migration rate which reflects the potential increase/decrease in population caused for example by changes in employment opportunities, quality of living, and so forth. However, when modeling a country, more detailed studies need to be done, including: population structure and the socio-economic factors that drive the population growth in the country.

2.2. Population Migration Patterns

Population migration patterns contribute to the decrease of the population growth rate of a nation, because they are in general associated with movements towards major urban centers where fertility rates are lower. The lower fertility rates are due to higher employment opportunities for men and women, higher costs of living, and lack of housing space. Several types of migration patterns of human populations can be identified based on the geographic location and on the degree of the country's development.

2.2.1. Migration Patterns due to Geographic Location

Coastal areas were always preferred locations for the development of the industrial and commercial centers, due to the easy access to transportation and "convenient" waste disposal. For these reasons, most urban centers are located in coastal areas, and very often are home to the majority of the country's population. For example, in the United States one third of the population lives in the coastal zone, and population growth rates in those areas is almost twice the remainder of the country.

Migration towards the coast is the most common pattern in coastal countries. However, coastal cities are faced with potential needs for population relocation due to the high occurrence and exposure to the impacts of natural hazards such as: hurricanes, ocean and riverine driven floods and storm surges, sea level rise, tsunamis and shoreline changes due to coastal erosion or land subsidence. The way each country deals with this

problem is highly dependent on the level of socio-economic and political organization of the country and on the available technology and resources it is able to allocate to counter act these natural forces. For example, in the United States the prevention and maintenance costs of shoreline protection of the growing coastal communities are estimated to be in the order of the hundreds of thousand of dollars per kilometer of shoreline. Countries such as the Netherlands prefer the land reclamation to the sea approach to allocate its growing population; Developing countries are faced (most of the time) with high loss of human lives, in coastal areas, due to the lack of means to allocate resources to prevent or mitigate the impacts of natural disasters.

Factors	Influence	Influence on Growth Rate
Population Structure Factors		
Age Structure and Fertility Rates	- The number of women of childbearing age in the population determines the potential fertility rate of that population. The younger the population, the higher the fertility rate	Increase Decrease
Death Rate	- Death rates increase due to aids, economic and political instability, poor living conditions and environmental contamination	Decrease
Birth Rate and Life Expectancy	- As health resources improve, infant mortality decreases (it reduce the need for an high number of children) and life expectancy for the elderly increases (increases the burden to the health system, and shared costs of the labor force).	Decrease
Socio-Economic Factors		
Regional level of development	- Developing countries, have higher population growth rates - Demographic transition	Increase Decrease
Shift from agricultural to industrial economy	- In an agricultural economy, children are regarded as extra labor, but in an urban economy, extra children represent less to the family	Decrease
Social System and Family Structure	- More children are seen as higher "old-age security" - The number of children is proportional to the social status - Birth control is not accepted for religion reasons	Increase
Woman Education	- Higher education of woman increase their employment opportunities, and the opportunity costs of raising children - Higher educated parents usually demand higher education for their children, which increases the costs of each child	Decrease
Urban Migration	- People in reproductive age are the majority of the migrants towards the urban areas, where fertility rates are lower	Decrease

International Migration	- Voluntary migration usually in search for better economic opportunities - Involuntary migration due to war or other political concerns	Decrease

Table 1. Factors that Influence Population Growth Rate.

2.2.2. Migration Patterns due to the Degree of Development of the Country

In developing countries migration from rural to urban areas and international migration to developed countries are the most common migration patterns. In both cases migration is driven by job opportunity, higher incomes, improvement of life quality, better access to education and health care.

These patterns create unemployment in the cities, as most cities cannot accommodate the high influx of low skilled workers. While cities grow, demands placed on its infrastructure require expansion of city services provided. The public service jobs created in response to urban grow are typically low salaried and do not overcome the prior poverty.

In developed countries, migration between urban centers is the most frequent. Urban growth in these countries is much slower, in part due to the lack of land, and to the population shifts, away from the concentrated urban centers to the vast sprawling metropolitan regions, or to small or intermediate cities.

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Biographical Sketch

Alexandra Carvalho has a "Licenciatura" from the University of Algarve, Faro, Portugal in Marine Biology and Fisheries, and she is currently finishing her Ph.D in Oceanography - Coastal Zone Management at Florida Institute of Technology, Melbourne, Florida, USA. She has worked as a research assistant at Guia Marine Laboratory. Lisbon, Portugal in the Project: Management of the Intertidal marine communities of the Natural Park of Sudoeste Alentejano and Costa Vicentina and for the past two years, she has been a Research Assistant at the Division of Marine and Environmental Systems in the project: Sebastian Inlet District's wave, tide and weather data monitoring. Her current research is on decision support systems for integrated coastal zone management, and she is designing and developing a PC-based decision support system for the barrier island in Brevard County, Florida, USA. Her research interests are GIS application to urban and regional planning and decision-making, integrated coastal zone management, and coastal processes.