A System Dynamics Approach to Regional Impact of the Construction of a Submerged Floating Tunnel.

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Abstract

This study aims to examine the regional impacts of the construction of a long submerged floating tunnel across the bay. This study has been motivated by the apparent scant data and research works on the likely regional consequences of such a large-scale project (Alex 1989 ; Thirumurthy 1987). The main concern is with the department of techniques to predict likely regional impacts. The main premise is that the construction of the submerged floating tunnel across the bay will result in changes may initially affect the immediate surroundings of the projects site but eventually they are likely to have widespread effect.

Ideally, these changes may be advantageous to some organisms but disadvantages to others. From this view- point, we propose an System Dynamics Model for the regional impacts. The actual simulation is examined using the example of the Volcanic Bay of Hokkaido in northern Japan.

1. Introduction

The regional impact programs originating from the construction of a submerged floating tunnel project are quite significant and require adequate consideration.

These problems can be best analyzed from System Dynamics Approach point of view. The seaside region is the habitat of many living organisms which from a regional community. Each organism interacts with its regional economics and with other organisms. The interaction with other organisms leads to complex and dependent relation.

Our model represents four sectors model including such as population sector, living environmental sector, industrial sector and investment sector (Forrestor 1974a, 1974b). The population sector includes the transfer of people from one age groups to the next age group to the upward time (Yamamura 1991) . The living environmental sector includes the basic services and supplementary services of living environment (Yamamura 1984) . The industrial sector includes the basic employment, fishery industry and tertiary industry arising from the construction of a submerge floating tunnel (Yamamura 1985) . The simulations was concentrated to the regional impact arising from the constructions of submerged floating tunnel.

2. Methodological Framework of the Study

The seaside region of the Volcanic Bay of Hokkaido in northern Japan is the habitat of many living organizations which form a regional community. Each organism interacts with its regional ecosystems and with other organisms. The comprehensive approach involves, interaction among the parameter controlling each component of the system in a dynamic state. Each component and its related parameters state are identifiable at every desired stage so as to give leverage for applying the policy options deemed fit to orient the model in the desired direction. The system is also designed to function with suitable sectorial modulators so as to avoid greater as oscillation within the model and also to be realistic with the practical situation (Yamamura 1986,1989) .

The Figure 1 illustrates the complex factors influencing the construction of a long submerged floating tunnel across the bay and their interaction and also the interaction among the sectors.

The population component

The population component includes the social factors and parameters. The total population is classified into four generations namely, CHLDZ (0-14 years), YADZ (15-24 years), ADZ (25-59 years) and OLDZ (60 years above).

The natural Increase involves BRADZ (birth rates) and the death rates namely, DRNCD (0-14 years), DRYAD (15-24 years), DRAPD (25-59) and DROD (60 above).

The natural transfer of population age from one age group to another is also included, namely, GCHDZ(from CHLDZ to YADZ), GYADZ (from YADZ to ADZ) and GADZ (from ADZ to OLDZ).

The social migration of population includes MCHLDZ(0-14 years), MYADZ(15-24 years), MADZ(25-59 years) and MOLDZ(60 years above). POPDZ, TOTALMPOP, TOTALMWRK and TOTALWWRK are represented total population, total male population, total male work population and total female work population respectively.

The investment component

The investment component included INBEXPEND (investment expenditure), OBLEXPEND (obligated expenditure), INFRAPRM (infrastructure investment expenditure), TINESPC (total investment expenditure), CGEXPEND (treasure disbursements), LCLGRANT (distribution of local allocation tax), LCLTAX (local tax) and LCLBOND (local bond).

The industrial Component

The industrial component includes AMOSALESZ (commercial sale), COMSOC (construction industry expenditure), JOOPCO (employment opportunity of construction industry), TOCON (workers of construction industry), YIELDFISH (fishery output), REGPRMO (development program), JOOPPRM (employment opportunity of development program), FISHWRK (workers of fishery) and NEWPRD (impact on fishery based on development program)

The living environmental component

The living environmental component is divided 13 group component such as health, against pollution, disaster prevention, transportation, consumption, employment, solidarity, culture, welfare, education, residential facility, recreation, and environmental conservation.

The main component includes, EDUFACZ (level of educational facility), NHBEDZ (level of hospital facility), AGPNFACZ (level of old aged facility), SEWERSYSZ (level of sewage facility), TRAFZ (level of road facility), PUBHSZ (level of public housing facility), AMSAZ (level of commercial sale), JOBZ (level of employment opportunities), COMFACZ(community facility), CULFACZ (cultural facility), PUMPFACZ (level of pump facility), RECZ (level of recreational facility) and ENVCONSZ (level of environmental conservation).

The Figure 2, 3, 4, 5 illustrates the population sector, the living environmental sector (1), the living environmental sector (2) and investment sector, and the population sector and industrial sector.

3. Simulation Analysis

The first simulation attempts to confirm the model based on the past population of Sahara town with most impacted by the long submerged floating tunnel across the bay.

Table 1 represents the fit results between the actual and estimated values.

The second simulation attempts to estimate of the impact population and fishery output of Sahara town by the construction investment and damage of fishery. We consider the four cases such as :

Case 1 : The allocation of construction investment of tunnel based on the population rates of each town and 10% of damage of fishery according to the construction investment.

Case 2 : The allocation of construction investment of tunnel based on the population rates of each town and 5% of damage of fishery according to the construction investment.

Case 3 : The double allocation of construction investment of tunnel of Sahara town based on the population rates of each town and 10% of damage of fishery according to the construction investment.

Case 4 : The double allocation of construction investment of tunnel of Sahara town based on the population rates of each town and 5% of damage of fishery according to the construction investment.

Figure 6 represents the population estimation of Sahara town of each case. Case 4 represents the stable value of population estimation and other cases represent the decreasing value.

Figure 7 represents the damage of fishery of Sahara town of each case. Case 2 and Case 4 represents small damage and high increase of fishery output. But, Case 1 and Case 3 represent big damage and the recovery of fishery output is small.

4. Conclusion

The simulation results of the present study thus establishes the imperative need to identify the most probable dynamic changes expected during a foreseeable future in order to frame appropriate regional policies to Sahara town development.

The double allocation of construction investment of tunnel of Sahara town based on the population rates of each town and 5% of damage of fishery according to the construction investment (Case 4) represent the most probable stable value. In the future research, it is necessary to study the ecological system dynamic model in the Volcanic Bay (Yamamura 1993) .

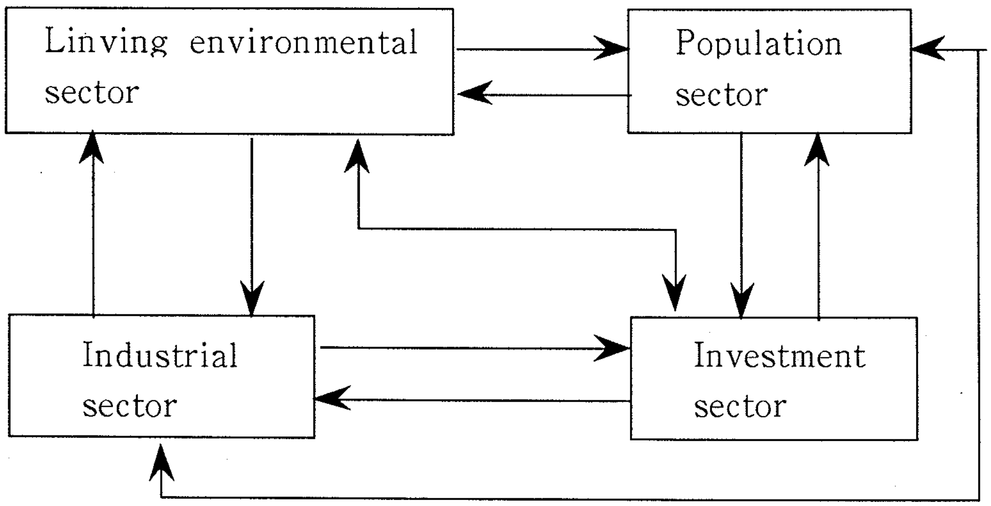

Figure 1. Basic Concept of Regional System Model

Table 1. The Fit Results Between Actual and Estimated Values

Year \ Total Popuration	Estimated values	Real values
1985	6,100	6,100
1986	6,045	6,192
1987	5,991	6,101
1988	5,937	6,018
1989	5,882	5,951
1990	5,829	5,856

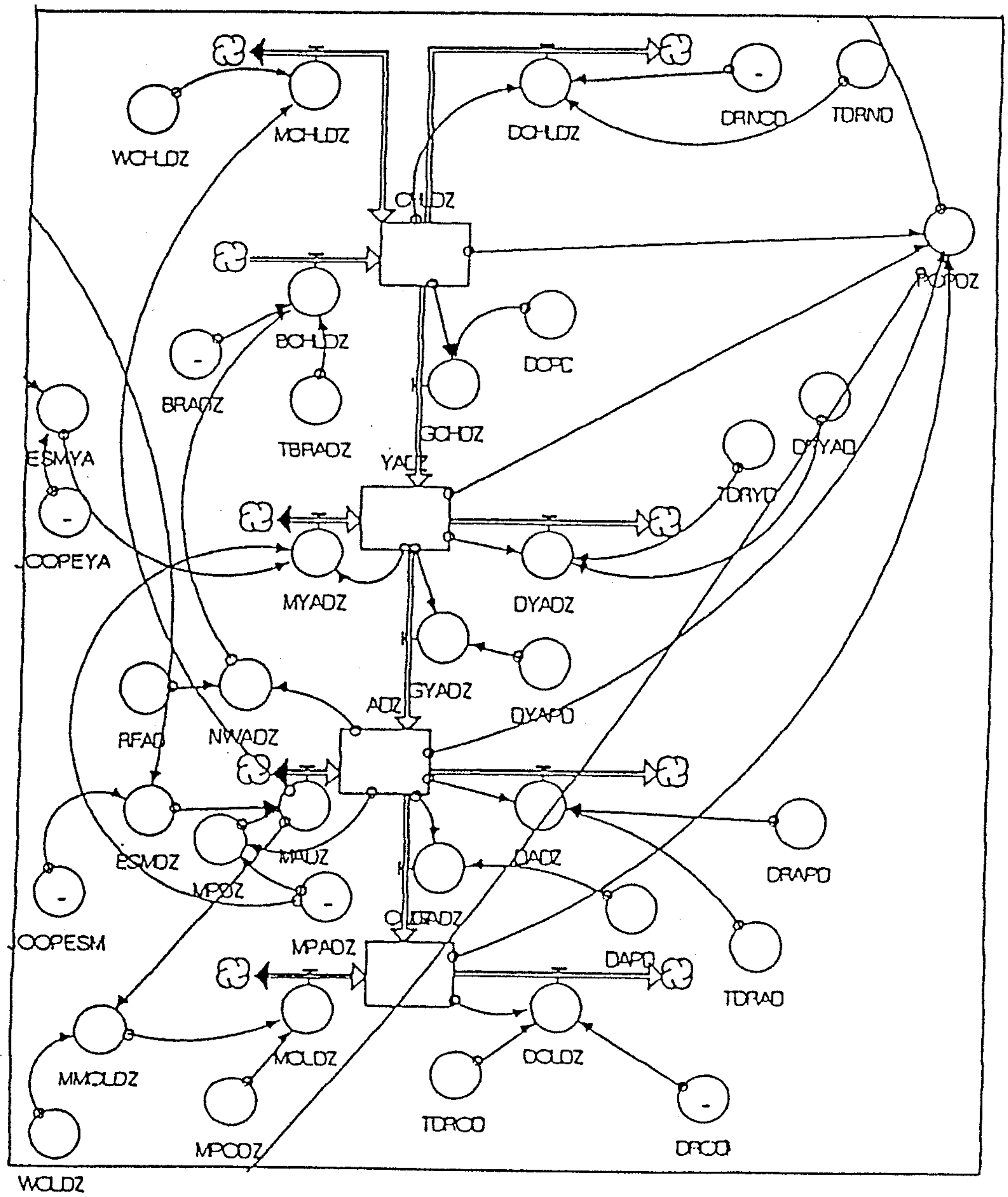

Figure 2. The Population Sector

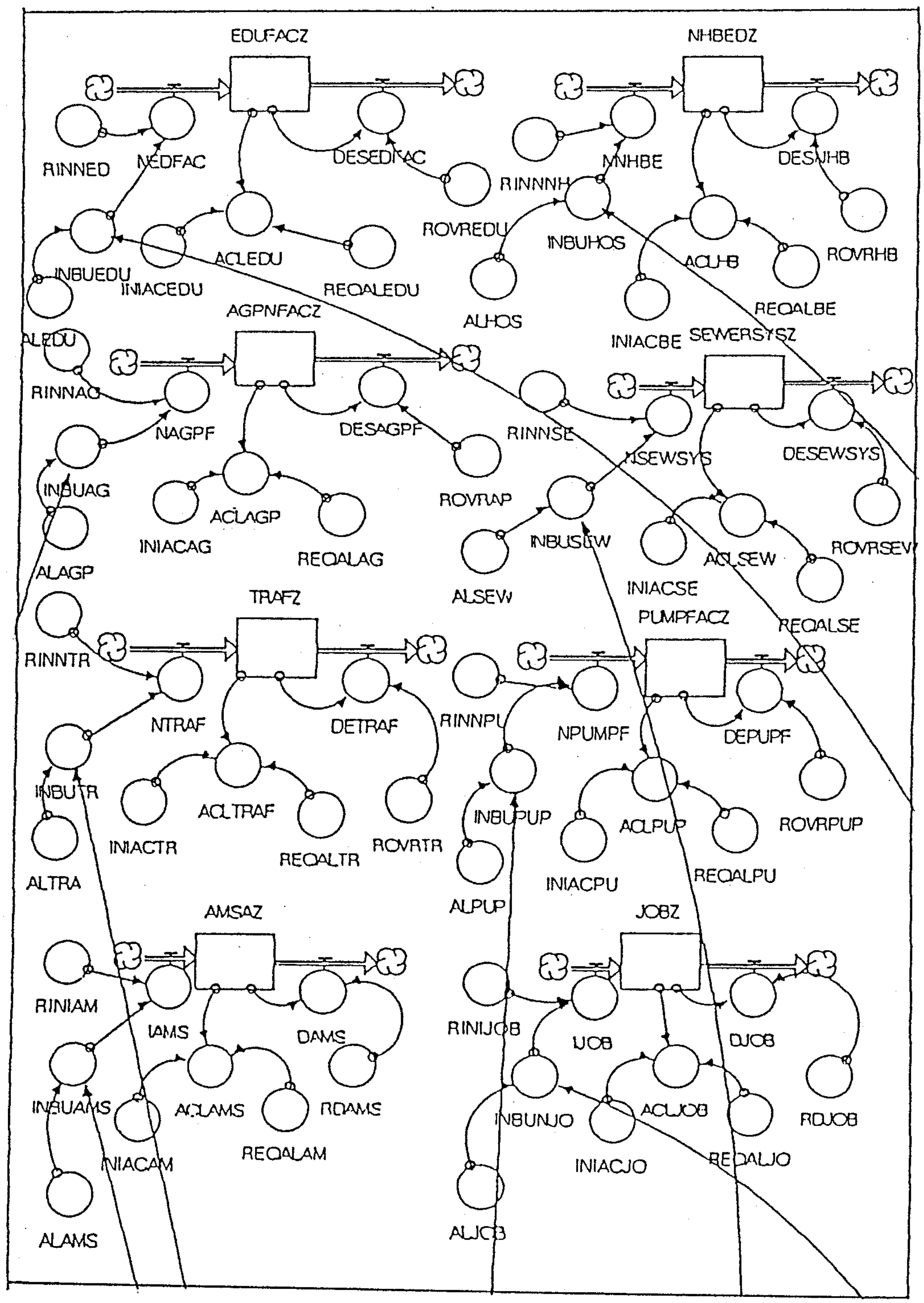

Figure 3. The Living Environmental Sector (1)

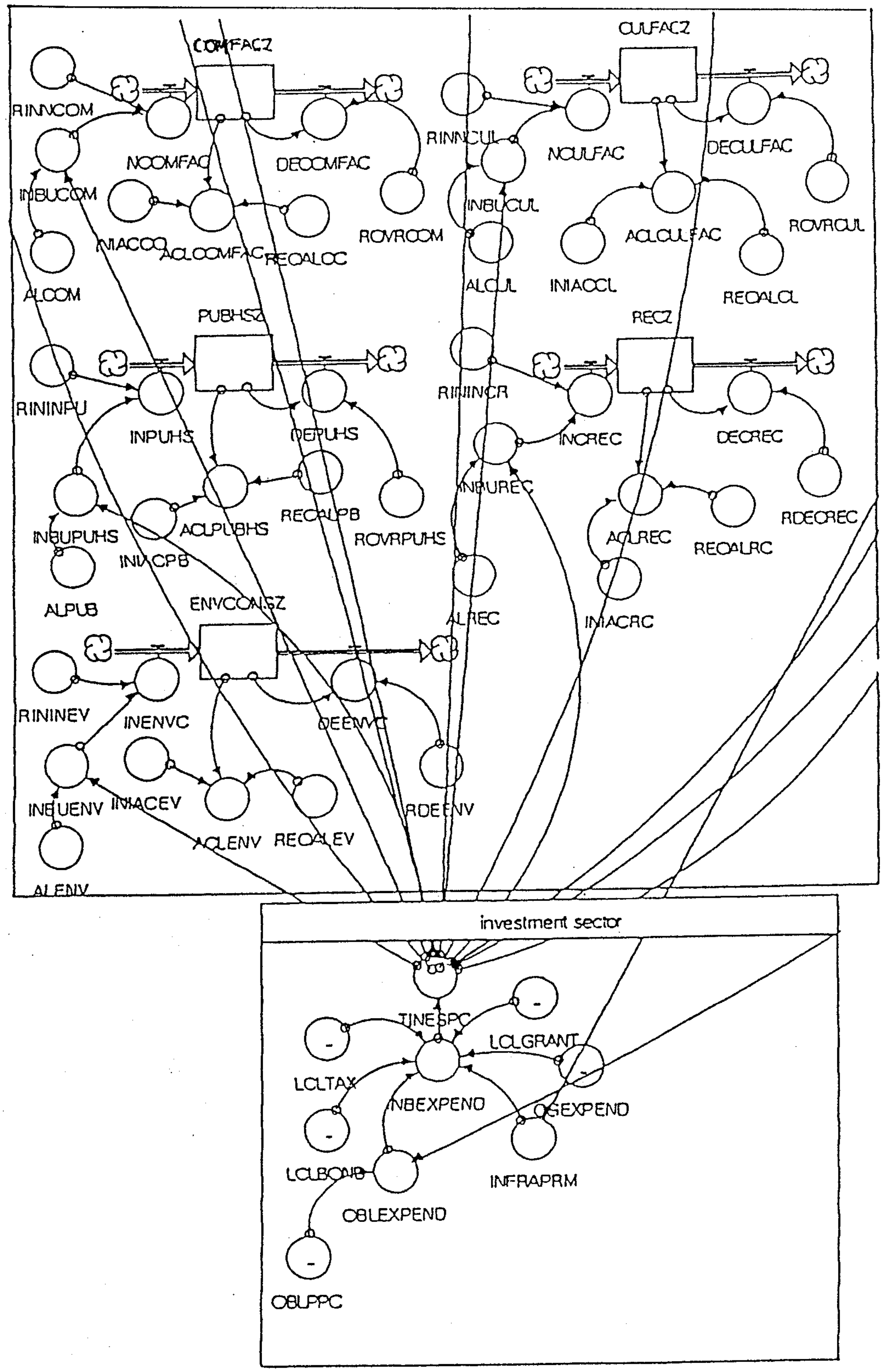

Figure 4. The Living Environmental Sector (2) and Investment Sector

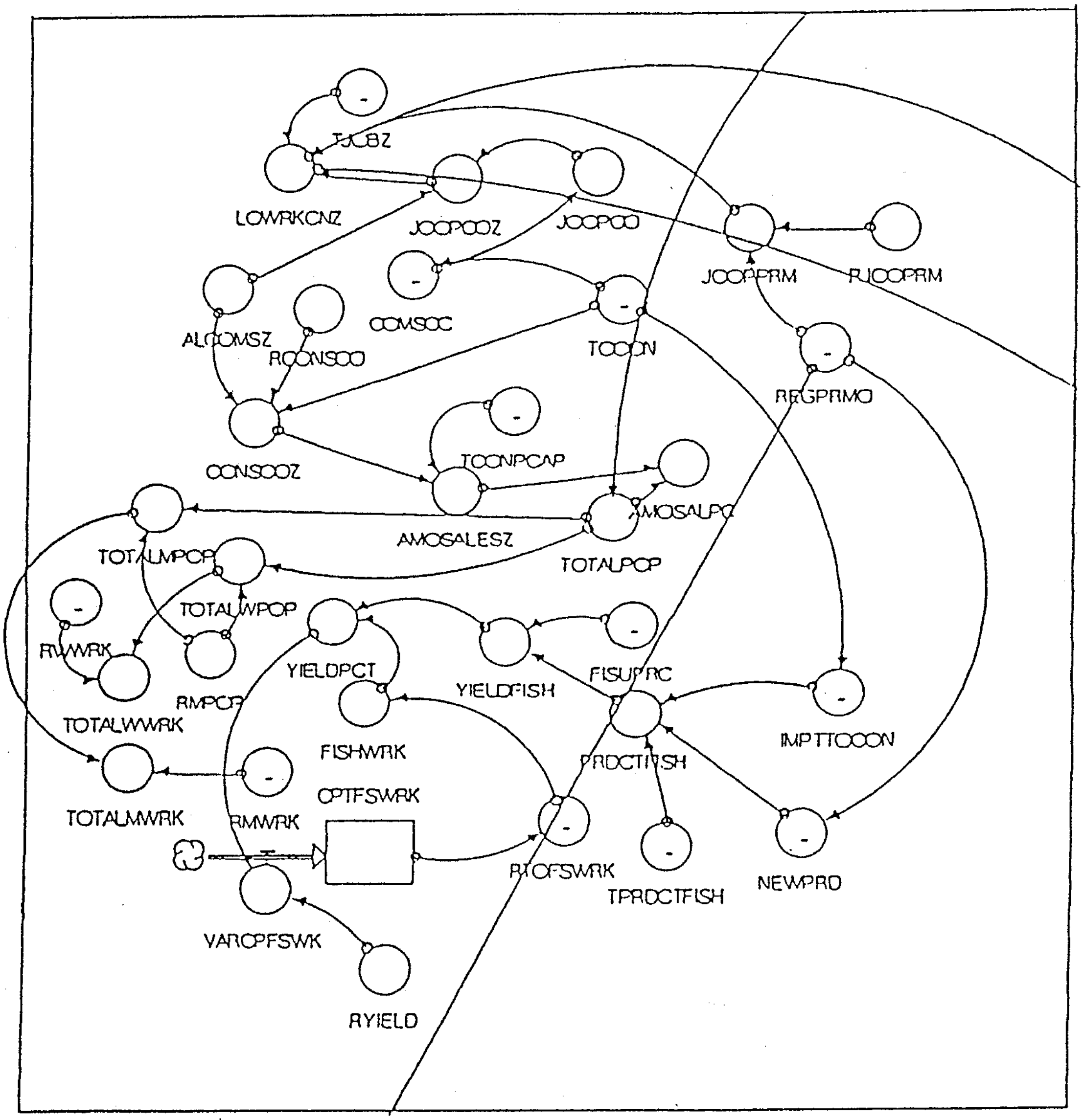

Figure 5. The Population Sector and Industrial Sector

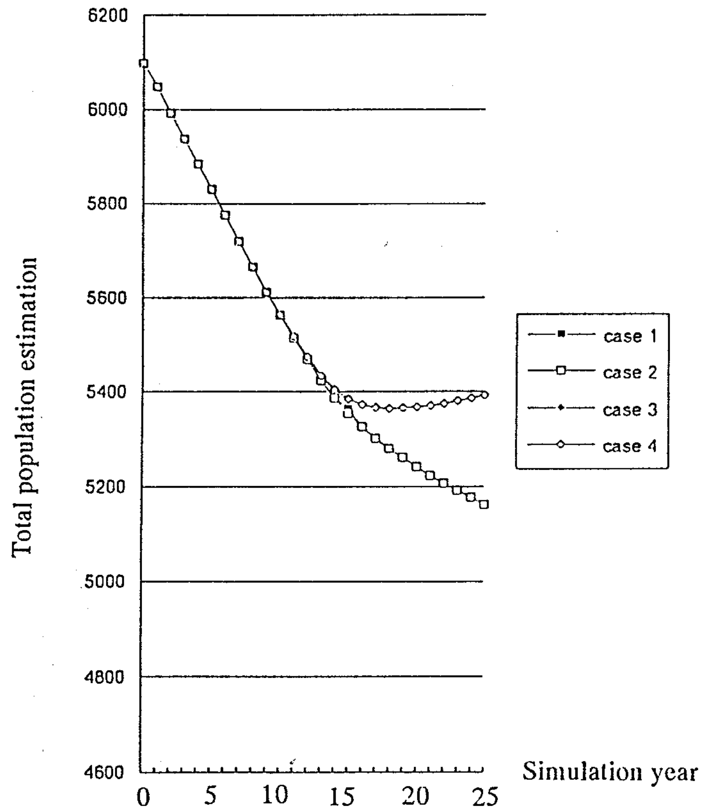

Figure 6. The Population Estimation of Sahara by Four Cases.

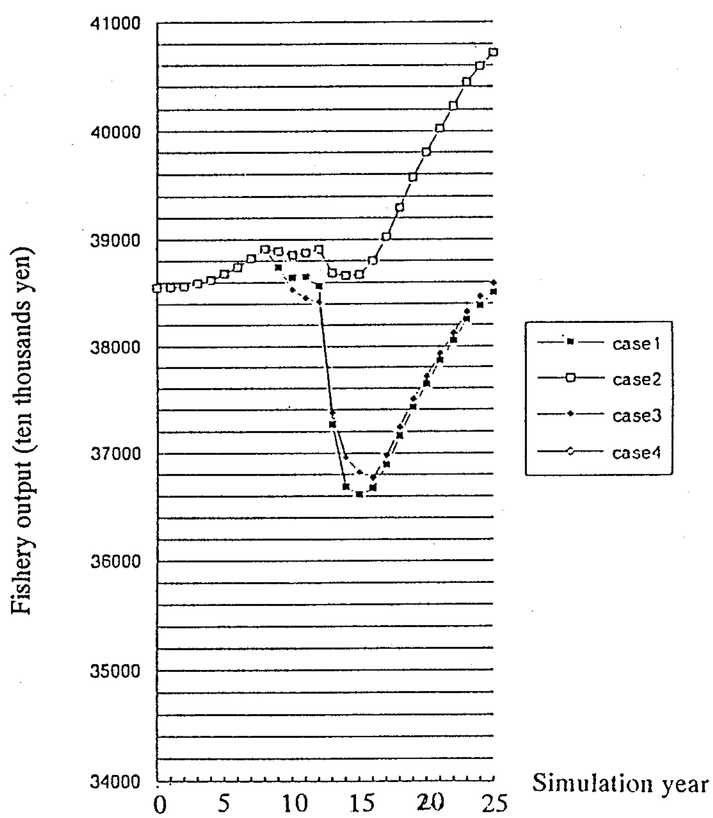

Figure 7. The Damage of Fishery of Sahara Town by Four Cases.

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