DEVELOPMENT MODELS OF THE PHILIPPINES

by

Ma. Sheilah A. Gaabucayan

Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
Master of Science
in
Transportation Engineering

APPROVED:

Donald R. Drew, Chairman

Richard D. Walker  Antonio A. Trani

December, 1992
Blacksburg, Virginia
DEVELOPMENT MODELS OF THE PHILIPPINES

by

Ma. Sheilah A. Gaabucayan

Dr. Donald R. Drew, Chairman

Civil Engineering

(ABSTRACT)

This purpose of this study is to construct computer models that can simulate national and regional development thus provide policy makers with a tool for policy experiments. This paper describes two models developed using the system dynamics methodology.

The Development Model of the Philippines (DMP) is a national model organized into seven sectors: (1) Industrial Sector, (2) Environmental Sector, (3) Infrastructure Sector, (4) Social Development, (5) Demographic Sector, (6) Agriculture Sector, and (7) Employment Sector. Six policy experiments were performed using DMP: (1) Government Support of Agriculture Policy, (2) Government Allocation to Social Services, (3) Industrial Development Policy, (4) Infrastructure, (5) Environmental Protection Policy, and (6) Zoning Policy.

The second model described in this study, called BUKID (from the filipino word for 'countryside'), is a multi-
sectoral regional development model embodying the dynamics of rural-urban dependency with emphasis on the impact of investment on rice and corn farmers. It is composed of the following sectors: (1) Agriculture, (2) Industrial, (3) Demographic, and (4) Transportation. Four policy strategies that may be evaluated using BUKID are described herein. These are: (1) Land Reform, (2) Feeder Road Construction, (3) Crop Production Policy, and (4) Promotion of Agro-based Industries.
ACKNOWLEDGEMENTS

This work would not have been accomplished without the grace of God who has richly blessed me with golden opportunities and wonderful mentors, family, and friends. To Him be all Glory and Praise.

Foremost, I would like to convey my deepest gratitude to Dr. Donald R. Drew, for his keen insights and invaluable comments, for challenging me out of my complacency, and for teaching me the value of time management and hard work. I would also like to extend my gratitude to Dr. Richard D. Walker and Dr. Antonio A. Trani, for serving in my committee and for taking time out of their hectic schedule to give valuable comments and suggestions for the improvement of my study.

To the Administration of Xavier University, the faculty and staff of the College of Engineering of XU, for encouraging me through the bleakest days.

To Dr. John Ballweg, for keeping a dream alive with his generosity and genuine concern for my academic advancement, despite the odds.

I would also like to thank Jo Anne Smith, for her commendable patience in answering all my trivial questions. To Nell Doss, for her friendship and support.
To Ms. Jimmie Johnson, for her support and consideration.

Special thanks to my friends Saripah and Salma, who gracefully put up with me and my eccentricities during the writing of this thesis.

I would also wish to convey my appreciation to the Filipino Student Association, for their support and understanding.

And finally, to Papa and Mama, Kent, Kay, and Kirk, Tatay and Nanay, and to countless aunts and uncles, as well as Paul, for their love and prayers, "Daghang Salamat".
DEDICATION

To Papa and Mama, in gratitude and love.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter/Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENT</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xiv</td>
</tr>
<tr>
<td>CHAPTER 1 - INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Background</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Needs and Priorities for Development</td>
<td>2</td>
</tr>
<tr>
<td>1.3 Objectives of the Study</td>
<td>4</td>
</tr>
<tr>
<td>CHAPTER 2 - PERTINENT INFORMATION ON STUDY AREAS</td>
<td>6</td>
</tr>
<tr>
<td>2.1 Republic of the Philippines</td>
<td>6</td>
</tr>
<tr>
<td>2.1.1 INDUSTRY</td>
<td>9</td>
</tr>
<tr>
<td>2.1.2 INFRASTRUCTURE SECTOR</td>
<td>13</td>
</tr>
<tr>
<td>2.1.3 DEMOGRAPHIC SECTOR</td>
<td>15</td>
</tr>
<tr>
<td>2.1.4 EMPLOYMENT SECTOR</td>
<td>18</td>
</tr>
<tr>
<td>2.1.5 AGRICULTURE SECTOR</td>
<td>19</td>
</tr>
<tr>
<td>2.2 Mindanao</td>
<td>22</td>
</tr>
<tr>
<td>CHAPTER 3 - SYSTEM DYNAMICS METHODOLOGY</td>
<td>26</td>
</tr>
<tr>
<td>3.1 Causal Diagramming</td>
<td>27</td>
</tr>
<tr>
<td>3.2 System Dynamics Modeling</td>
<td>30</td>
</tr>
<tr>
<td>3.3 DYNAMO Equations</td>
<td>30</td>
</tr>
</tbody>
</table>
6.1.5 Infrastructure Development Policy ......................... 180

6.1.6 Environmental Protection Policy ......................... 185

6.2 Regional Development Model (BUKID) ..... 195

CHAPTER 7 - SUMMARY AND CONCLUSIONS .................. 202

7.1 Summary ....................................................... 202

7.2 Model Usefulness and Limitations ................. 204

7.3 Conclusions and Recommendations ............. 205

REFERENCES .......................................................... 207

APPENDICES .......................................................... 210

Appendix A Development Model of the Philippines Program Equations 211

Appendix B BUKID Program Equations ...... 221
<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Map of the Philippines</td>
<td>25</td>
</tr>
<tr>
<td>3.1</td>
<td>System Dynamics Modeling Approach</td>
<td>28</td>
</tr>
<tr>
<td>4.1</td>
<td>Change-Resisting Loop</td>
<td>33</td>
</tr>
<tr>
<td>4.2</td>
<td>Population-Death Rate Loop</td>
<td>33</td>
</tr>
<tr>
<td>4.3</td>
<td>First-order Goal-seeking Loop</td>
<td>35</td>
</tr>
<tr>
<td>4.4</td>
<td>Road Density-Demand for Road-Road Construction Rate Loop</td>
<td>35</td>
</tr>
<tr>
<td>4.5</td>
<td>GNP-Industrial Capital-Agricultural Product Loop</td>
<td>37</td>
</tr>
<tr>
<td>4.6</td>
<td>Industrial Output-Pollution Capital-Output Ration Loop</td>
<td>39</td>
</tr>
<tr>
<td>4.7</td>
<td>Rice/Corn Farmers - ATTFR - Yield Per Hectare Loop</td>
<td>40</td>
</tr>
<tr>
<td>4.8</td>
<td>Positive Feedback Loop</td>
<td>41</td>
</tr>
<tr>
<td>4.9</td>
<td>Population - Birth Loop</td>
<td>42</td>
</tr>
<tr>
<td>4.10</td>
<td>Urban Population - Cultivated Area - Rural-Urban Migration Loop</td>
<td>43</td>
</tr>
<tr>
<td>5.1</td>
<td>Development Model of the Philippines</td>
<td>47</td>
</tr>
<tr>
<td>5.2</td>
<td>FIOIFM vs. (TICCI.K/TIFCI.K)/(TICN.K/TIFN.K)</td>
<td>52</td>
</tr>
<tr>
<td>5.3</td>
<td>CORM vs. POLR.K</td>
<td>52</td>
</tr>
<tr>
<td>5.4</td>
<td>POLATM vs. POLR.K</td>
<td>56</td>
</tr>
<tr>
<td>5.5</td>
<td>UFM.K vs. SDCPCR.K</td>
<td>56</td>
</tr>
<tr>
<td>5.6</td>
<td>ULEM.K vs. SDCPCR.K</td>
<td>67</td>
</tr>
<tr>
<td>5.7</td>
<td>PMM vs. POLR.K</td>
<td>67</td>
</tr>
<tr>
<td>5.8</td>
<td>Emigration Multiplier vs. Ratio of Per Capita Income</td>
<td>68</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>5.9</td>
<td>RFM vs. SDCPCR</td>
<td>68</td>
</tr>
<tr>
<td>5.10</td>
<td>RLEM vs. SDCPCR</td>
<td>68</td>
</tr>
<tr>
<td>5.11</td>
<td>RUMM vs. REA</td>
<td>71</td>
</tr>
<tr>
<td>5.12</td>
<td>Agriculture Diversity Index vs. Time</td>
<td>76</td>
</tr>
<tr>
<td>5.13</td>
<td>Multiple Cropping Index Multiplier vs. Time</td>
<td>76</td>
</tr>
<tr>
<td>5.14</td>
<td>Agricultural Diversity Index vs. FGNPA Ratio</td>
<td>78</td>
</tr>
<tr>
<td>5.15</td>
<td>LPCM vs. UIL Ratio</td>
<td>78</td>
</tr>
<tr>
<td>5.16</td>
<td>LPPM vs. UIL Ratio</td>
<td>82</td>
</tr>
<tr>
<td>5.17</td>
<td>Impact of Industrial Investment on Industrial Employment</td>
<td>82</td>
</tr>
<tr>
<td>5.18</td>
<td>SDCLRM vs. SDCCI.K/SDCN</td>
<td>87</td>
</tr>
<tr>
<td>5.19</td>
<td>BUKID Causal Diagram</td>
<td>89</td>
</tr>
<tr>
<td>5.20</td>
<td>Impact of Unemployment on Rural-Urban Migration</td>
<td>95</td>
</tr>
<tr>
<td>5.21</td>
<td>FLM vs. FTNIR</td>
<td>95</td>
</tr>
<tr>
<td>5.22</td>
<td>Rural Housing Construction Multiplier vs. Demand for Rural Houses</td>
<td>99</td>
</tr>
<tr>
<td>5.23</td>
<td>Impact of Profitability on Land Conversion Rate</td>
<td>99</td>
</tr>
<tr>
<td>5.24</td>
<td>FMM vs. AMU</td>
<td>105</td>
</tr>
<tr>
<td>5.25</td>
<td>Impact of AWPH on Farmer Availability Multiplier</td>
<td>105</td>
</tr>
<tr>
<td>5.26</td>
<td>Fertilizer Use Multiplier vs. Fertilizer Application Level</td>
<td>109</td>
</tr>
<tr>
<td>5.27</td>
<td>Capital Availability-Fertilizer Application Multiplier vs. Capital Available Ratio</td>
<td>109</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>5.28</td>
<td>CAMTAB vs. DPRAB</td>
<td>114</td>
</tr>
<tr>
<td>5.29</td>
<td>RAM vs. Average Road Density</td>
<td>114</td>
</tr>
<tr>
<td>5.30</td>
<td>MAAB vs. Average Road Density</td>
<td>120</td>
</tr>
<tr>
<td>5.31</td>
<td>AGSAVF vs. Per Capita Income</td>
<td>120</td>
</tr>
<tr>
<td>5.32</td>
<td>RRLAM vs. RDLFO</td>
<td>134</td>
</tr>
<tr>
<td>5.33</td>
<td>Road Maintenance Multiplier vs. Maintenance Fund per Kilometer</td>
<td>134</td>
</tr>
<tr>
<td>5.34</td>
<td>Impact of Truck Trips Daily on Road Deterioration</td>
<td>137</td>
</tr>
<tr>
<td>5.35</td>
<td>Demand for Road Multiplier vs. Actual Desired Road Density Ratio</td>
<td>137</td>
</tr>
<tr>
<td>5.36</td>
<td>ARTCM vs. Actual-to-Desired Road Density Ratio</td>
<td>139</td>
</tr>
<tr>
<td>5.37</td>
<td>TDRM vs. ETARR</td>
<td>139</td>
</tr>
<tr>
<td>5.38</td>
<td>Effective Road Deterioration Multiplier vs. Effective-to-Actual Road Ratio</td>
<td>144</td>
</tr>
<tr>
<td>5.39</td>
<td>Urban Housing Demand Multiplier vs. Urban Houses-to-Household Ratio</td>
<td>144</td>
</tr>
<tr>
<td>5.40</td>
<td>Urban Land Availability Multiplier vs. Urban Land Fraction Occupied</td>
<td>149</td>
</tr>
<tr>
<td>5.41</td>
<td>ULFAM vs. ULFTJR</td>
<td>149</td>
</tr>
<tr>
<td>6.1</td>
<td>Computer Simulation of GNP (Base Run)</td>
<td>159</td>
</tr>
<tr>
<td>6.2</td>
<td>Computer Simulation of Population</td>
<td>160</td>
</tr>
<tr>
<td>6.3</td>
<td>Computer Simulation FPU and PCCPR (Base Run)</td>
<td>162</td>
</tr>
<tr>
<td>6.4</td>
<td>Computer Simulation of AFS (Base Run)</td>
<td>163</td>
</tr>
<tr>
<td>6.5</td>
<td>Computer Simulation of UNEMNA (Base Run)</td>
<td>164</td>
</tr>
<tr>
<td>6.6</td>
<td>Computer Simulation of GNP Agriculture Development Policy</td>
<td>166</td>
</tr>
<tr>
<td>Figure</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>6.7</td>
<td>Computer Simulation of AFS</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td>Agriculture Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.8</td>
<td>Computer Simulation of UNEMNA</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td>Agriculture Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.9</td>
<td>Computer Simulation of GNP</td>
<td>172</td>
</tr>
<tr>
<td></td>
<td>Social Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.10</td>
<td>Computer Simulation of UNEMNA</td>
<td>173</td>
</tr>
<tr>
<td></td>
<td>Social Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.11</td>
<td>Computer Simulation of AFS</td>
<td>176</td>
</tr>
<tr>
<td></td>
<td>Social Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.12</td>
<td>Computer Simulation of GNP</td>
<td>177</td>
</tr>
<tr>
<td></td>
<td>Industrial Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.13</td>
<td>Computer Simulation of Population</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>Infrastructure Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.14</td>
<td>Computer Simulation of UNEMNA</td>
<td>184</td>
</tr>
<tr>
<td></td>
<td>Infrastructure Development Policy</td>
<td></td>
</tr>
<tr>
<td>6.15</td>
<td>Computer Simulation of Population</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td>Environmental Protection Policy</td>
<td></td>
</tr>
<tr>
<td>6.16</td>
<td>Computer Simulation of UNEMNA</td>
<td>187</td>
</tr>
<tr>
<td></td>
<td>Environmental Protection Policy</td>
<td></td>
</tr>
<tr>
<td>6.17</td>
<td>Computer Simulation of AFS</td>
<td>188</td>
</tr>
<tr>
<td></td>
<td>Environmental Protection Policy</td>
<td></td>
</tr>
<tr>
<td>6.18</td>
<td>Computer Simulation of GNP</td>
<td>193</td>
</tr>
<tr>
<td></td>
<td>Zoning Policy</td>
<td></td>
</tr>
<tr>
<td>6.19</td>
<td>Computer Simulation of UNEMNA</td>
<td>194</td>
</tr>
<tr>
<td></td>
<td>Zoning Policy</td>
<td></td>
</tr>
<tr>
<td>6.20</td>
<td>Population Forecast (BUKID)</td>
<td>197</td>
</tr>
<tr>
<td>6.21</td>
<td>Average Value of Agricultural Products</td>
<td>197</td>
</tr>
<tr>
<td>6.22</td>
<td>Potential Land for Transfer</td>
<td>198</td>
</tr>
<tr>
<td>6.23</td>
<td>Rural Road Length</td>
<td>198</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Philippine GNP Per Capita (Constant 1985 Prices)</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Composition of Manufacturing Value-added (Percent Share at Current Prices)</td>
<td>11</td>
</tr>
<tr>
<td>2.3</td>
<td>Government Spending in Infrastructure (in Million Pesos)</td>
<td>13</td>
</tr>
<tr>
<td>2.4</td>
<td>Dwellings with Adequate Source of Water</td>
<td>17</td>
</tr>
<tr>
<td>2.5</td>
<td>Health Indicators</td>
<td>17</td>
</tr>
<tr>
<td>3.1</td>
<td>Summary of DYNAMO Postscript Convention</td>
<td>31</td>
</tr>
<tr>
<td>5.1</td>
<td>International Standard Industrial Classification</td>
<td>48</td>
</tr>
<tr>
<td>5.2</td>
<td>DMP Development Indicators</td>
<td>49</td>
</tr>
<tr>
<td>5.3</td>
<td>BUKID Development Indicators</td>
<td>91</td>
</tr>
<tr>
<td>6.1</td>
<td>Results of Basic Model Simulation</td>
<td>161</td>
</tr>
<tr>
<td>6.2</td>
<td>Comparison of Agriculture Development Policy Results and Basic Run</td>
<td>168</td>
</tr>
<tr>
<td>6.3</td>
<td>Simulation Results of Social Development Policy and Basic Run</td>
<td>175</td>
</tr>
<tr>
<td>6.4</td>
<td>Simulation Results of Industrial Development Policy and Basic Run</td>
<td>179</td>
</tr>
<tr>
<td>6.5</td>
<td>Simulation Results of Infrastructure Development Policy and Basic Model</td>
<td>182</td>
</tr>
<tr>
<td>6.6</td>
<td>Simulation Results of Environmental Policy and Basic Model</td>
<td>190</td>
</tr>
<tr>
<td>6.7</td>
<td>Simulation Results of Zoning Policy and Basic Model</td>
<td>192</td>
</tr>
<tr>
<td>6.8</td>
<td>Simulation Results of BUKID (Basic Run)</td>
<td>196</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

1.1 BACKGROUND

The Philippines is a nation composed of more than 7,000 islands covering a total land area of 300,000 square kilometers and its population reached 61.50 million in 1990. Although rich in natural resources, it suffers from economic depression and technical retardation. In February 1986, it started a revolution without precedent. Men, women and children linked arms and disarmed the Marcos forces. Ferdinand E. Marcos, the Philippine President for 20 years, fled the country and Corazon C. Aquino, the widow of the assassinated opposition leader Benigno S. Aquino, was sworn into office. What should have been the start of a 'new' era of Philippine Development has turned out to be just another page in the country's history. The spirit of the revolution has not lived long enough to propel the Philippines back to economic viability and progress. To date, the economy is growing at a measly annual rate of 0.5 percent and 3 out of 5 of the 64 million Filipinos live in poverty. Nearly one-third of the labor force is unemployed. Health care is minimal and housing units for people who are homeless are scarce. Agrarian reform, which was the basic platform of the
Aquino Administration, has not been a potent reality in the search for economic upliftment. Hampered by political squabbling and budgetary constraints, implementation of Agrarian Reform has been sorely delayed. Except for the restoration of democracy, the Philippines is still in the economic quagmire it has been 10 years ago.

1.2 NEEDS AND PRIORITIES FOR DEVELOPMENT

Between 1965-1985 the Philippines consistently registered the lowest Gross Domestic Product (GDP) among the Southeast Asian nations reaching an all-time low of -0.5% during 1980-1985. High incidence of poverty (particularly in the rural areas) and severe unemployment and underemployment dogged the country. Moreover, the meager economic growth sustained by the Philippines failed to bring about a more equitable distribution of income. Agricultural incomes were and still are substantially lower than non-agricultural workers. The highly skewed income distribution is biased against rural households, particularly against small farmers and landless agricultural workers (5). A greater number of families at the bottom 30% of the income distribution are those engaged in agriculture (17).

The challenge for the Philippines is not just to recover from the recent years' economic depression but also to move the economy to a new development track that
promises both economic growth and equity (5). Based on a study by Adelman and Morris, equitable growth may be achieved by reorienting development strategies towards human-resource development patterns (1). The stress of such a development strategy is on export-oriented growth based on labour-and-skill-intensive exports. But in the light of the adverse conditions in the current international economic environment, foreign trade cannot anymore serve as the major source of economic growth and the country must look into itself for alternative development strategies. Given the dominance of agriculture and the rural sector in the Philippine economy, Filipino social scientists have urged a development plan with agriculture and the rural sector assuming pivotal roles (5).

Because employment creation is crucial to the country's economic growth and social equity, labor-intensive manufacturing industries cannot be completely taken out of the picture as a viable aid in promoting development. Despite the Philippines' vast natural resource and abundant, literate and cheap labor, the pace of industrialization in the nation has been fairly moderate by any standard. It took 24 years (1950-1974) to raise the share of mining and manufacturing industries in total net domestic product from 14 percent to 23 percent (7). Efforts to revive and sustain the growth in modern smallscale
industries and to prevent employment in the traditional cottage sector from declining further will be needed (7).

Programs to expand production and employment in agriculture and industry must also be complemented by increased investment in infrastructure and manpower training (7).

In summary, the development strategy of the Philippines is focused on: rural development, with emphasis on food production; accelerated industrialization; and substantial expansion of public sector infrastructure investment. Yet accompanying the need for economic growth is the concern for long-term social issues to ensure a better quality of life, especially for the rural and urban poor.

1.3 OBJECTIVES OF THE STUDY

Faced with a multi-pronged problem such as national development, policy makers must bring together a variety of mental models, translate them into a common language, and determine simultaneously all their important implications. It is of paramount importance that coherent dynamic tool be used as a means of communication among experts. This paper describes two computer models developed using the system dynamics methodology which attempt to put together the various forces that affect the Philippine economy. These
models are based on studies made in the Bicol Region of the Philippines (9). The purpose of this research is to construct computer models that can simulate national and regional development thus provide policymakers with a tool for policy experiments without the expense of actually implementing such policy. It is not the intent of this study to provide a static plan nor a blueprint for the development of the Philippines. It is also beyond the scope of this study to interpret the repercussions of the forecasted results.

The Development Model of the Philippines (DMP) is a national model organized into seven sectors: (1) Industrial Sector, (2) Environmental Sector, (3) Infrastructure Sector, (4) Social Development Sector, (5) Demographic Sector, (6) Agriculture Sector, and (7) Employment Sector.

BUKID (adapted from the Filipino word for countryside) is a multi-sectoral regional development model embodying rural-urban dependency. It is composed of the agricultural, industrial, demographic and transportation sectors.
CHAPTER 2
PERTINENT INFORMATION ON STUDY AREAS

2.1. REPUBLIC OF THE PHILIPPINES

The Philippines is one of the largest archipelagos in the world comprising of approximately 7,100 islands covering an area of 300,000 square kilometers. Of the total land area, 45 percent is classified as forest and 40 percent is under agricultural cultivation. Only 154 of these islands have an area of 13 square kilometers or more. The two largest islands are Luzon (104,668 square kilometers) and Mindanao (94,631 square kilometers). In 1975, the nation was divided into eleven geographical regions, namely: Ilocos, Cagayan Valley, Central Luzon, Southern Tagalog (including Manila), Bicol, Western Visayas, Central Visayas, Eastern Visayas, Western Mindanao, Northern Mindanao, and Southern Mindanao. Variation in vastness of natural resources and past concentration of both public and private investments has yielded considerable discrepancies in income levels between regions. A case in point: in 1971, the median income in Metro Manila was three times than that in Central Visayas who has quadruple the population of Manila. Moreover, equitable distribution of wealth is just a word in the dictionary for the Philippines. Five percent of the nation's population receive 88% of the total income compared to the 65% which share 5.5% of the income.
In February 1986, the nation started a revolution without precedent. Men, women, and children linked arms and disarmed the Marcos forces. Ferdinand E. Marcos, the Philippine country's president for 20 years, fled the country and Corazon C. Aquino, the widow of the slain opposition leader Benigno S. Aquino, was sworn into office. After serving the country for 4 years, Mrs. Aquino has stepped down from power leaving behind her a legacy of the restoration of democracy. In August of this year, the Philippines held its presidential and congressional elections. Fidel Ramos, the former chief of staff became head of state, with Eric Estrada, a movie star, as vice-president.

The development of Philippine economy is retarded by political upheavals which constantly beset the country. Agriculture, which is the country's most important sector, has been relegated to the background and its development has been slowed down because of an extremely ambitious investment program implemented by the Marcos Regime in the early 1980s which sought to provide the Philippines with a capital intensive base. The realization that such a development plan was catastrophic for a nation whose low-cost skilled labor force is one of its chief endowments came belatedly. A revised development plan was drawn up in the late 1984. In this plan, more emphasis was given to the development of agricultural and agribusiness. Unfortunately,
the original targets of the 1983-87 plan was negated by the assassination of Opposition Leader Benigno S. Aquino and the consequent events.

Troubled by the political instability of the Philippines, capital was withdrawn from the industries and other pertinent economic endeavors precipitating a crisis in the balance of payments. In October 1983 the Philippine peso had devalued by 21.4%. A sharp decline was experienced by the economy for the next two years. As of March 1986 more than 66% of the Filipinos were living below poverty line. Moreover, 15% were unemployed and 45% underemployed.

Gross National Product (GNP), which traditionally measures a nation's wealth, fell short of the target 7.6% and continued to decline recording a growth rate of 1.9%. Consequently, GNP per capita also declined (Table 2.1). The current development programme for 1987-92 estimates that it will achieve 1983 levels by 1991.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12,887</td>
<td>9,886</td>
<td>10,933</td>
<td>10,929</td>
<td>12,212</td>
</tr>
<tr>
<td>% Inc.</td>
<td>-1.4</td>
<td>-9.3</td>
<td>-6.4</td>
<td>-0.6</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Source: EIU Country Profile 1989-90 (Philippines)
2.1.1 INDUSTRY

The Philippines has the human and material resources for a sustained economic growth in industry yet it has only incurred a moderate pace of industrialization. With an industrial growth rate of 7.7%, the country took 24 years to increase the share of mining and manufacturing from 14 percent to 24 percent.

This sluggish growth rate may be attributed to several factors: (1) the competition for market posed by other Asian nations, (2) the disproportionate number of foreign markets serviced compared to the bulk of external trade, (3) the inefficiency of Philippine transportation and infrastructure facilities, and (4) the accrual of bulk of the nation's gain in foreign investment in the country of origin (7).

The manufacturing sector developed rapidly during the 1950s and 1960s essentially for import substitution and was helped on by the protection of an overvalued currency. This sector remained biased towards the production of consumer goods, which relied heavily on imported component, despite the development of the intermediate goods manufacturing sector. Moreover, it was targeted more on the domestic market regardless of the fact that a labor intensive export manufacturing sector had been evolving, particularly electronics and garments. It was not until the export processing zones were established in the early 1970s that
more attention was given to the investment in export-oriented endeavors. This development was also stimulated by floating the currency and giving special tax incentives and duty exemptions to interested companies. To date, there are more than 50 firms operating in the zones, providing employment to approximately 24,000 (11).

In 1981, the government launched a program designed to remedy the possible repercussions of the second oil shock and the decline of the export market. It sought to develop the nation's intermediate and heavy industrial base through 11 industrial projects. By 1985 four of the 11 proposed projects -- the copper smelter, the cocochemical complex, the phosphatic fertilizer plant, and the low range component of diesel engine manufacture -- were completed and put into operation. The rest were either under review, under construction as of this writing, or shelved indefinitely as casualties of the 1984-85 austerity programme. Philippine manufacturing had to change its course when it came under the weight of the payment crisis. More emphasis has been placed on agribusiness and on labor intensive and small scale projects. The Aquino administration supported this new direction in Philippine manufacturing by implementing industrial policies favoring the development of small scale manufacturing, scattered throughout the nation, and more in keeping with the Philippines' natural resource. Table 2.2 shows the composition of manufacturing based on value added.
| Table 2.2 Composition of Manufacturing value added  
<table>
<thead>
<tr>
<th>(Percent share at current prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer goods of which:</td>
</tr>
<tr>
<td>food</td>
</tr>
<tr>
<td>beverages &amp; tobacco</td>
</tr>
<tr>
<td>textiles, clothing &amp; leather</td>
</tr>
<tr>
<td>printing &amp; publishing</td>
</tr>
<tr>
<td>Intermediate goods of which:</td>
</tr>
<tr>
<td>paper products</td>
</tr>
<tr>
<td>wood &amp; cork</td>
</tr>
<tr>
<td>chemicals</td>
</tr>
<tr>
<td>petroleum &amp; coal</td>
</tr>
<tr>
<td>non-metallic minerals</td>
</tr>
<tr>
<td>Durable &amp; capital goods of which:</td>
</tr>
<tr>
<td>basic metals &amp; metal products</td>
</tr>
<tr>
<td>machinery (incl elec.)</td>
</tr>
<tr>
<td>transport equipment</td>
</tr>
<tr>
<td>Total incl others</td>
</tr>
<tr>
<td>Value added (gross)</td>
</tr>
<tr>
<td>P Mn current prices</td>
</tr>
</tbody>
</table>

Source: EIU Country Profile 1989-90 (Philippines)

As the table above indicates, consumer goods contributed more than half of manufacturing value added over the first few years. The share of chemical and rubber, which used to be two of the fastest growing industries in the early 1960s, has declined. Within the machinery sector, the export oriented electronics assembly industry is rapidly growing as reflected by its increasing share.

Mining in the Philippines is primarily participated in by the private sector. The only stipulation of the
Philippine government is that copper should be supplied to the national smelter, Pasar. Abundant reserves of mineral can be found in the country. In 1984 mineral reserves stood at 4312 million tons of copper ore, 1553 million tons of nickel ore, 2014 million tons of gold ore, 1280 million tons of iron ore, and 87 million tons of chromite. It has been speculated that some of the richest deposits still remain untouched.

Concomitant with the government's expansionary capital spending program which sought to broaden the capital intensive industrial base, the construction sector grew rapidly in the 1970s averaging about 15% annually. Unfortunately, the sharp budget cuts and weak demand from the private sector caused output to fall by over 25% in both 1985 and 1986. Output bounced back up by 15.9% in 1987 due to the government's special programme which sought to repair infrastructure and to construct roads, irrigation networks, schools and hospitals in the rural areas. In 1988, growth continued to improve at 11.8%. Table 2.3 shows the trend of government spending in the construction industry. The main drawback in the government investment in infrastructure in the early 1970s was that it overlooked the severe shortage of housing for impoverished urban population. Thus despite the increase in infrastructure investment the problem of inadequate housing still remained.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>10,566</td>
<td>10,256</td>
<td>----</td>
<td>----</td>
<td>18,785</td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>power gen.</td>
<td>5,319</td>
<td>4,493</td>
<td>----</td>
<td>----</td>
<td>11,946</td>
</tr>
<tr>
<td>roads</td>
<td>1,705</td>
<td>1,398</td>
<td>----</td>
<td>----</td>
<td>3,176</td>
</tr>
<tr>
<td>irrigation</td>
<td>1,655</td>
<td>1,591</td>
<td>----</td>
<td>----</td>
<td>2,868</td>
</tr>
<tr>
<td>social infra.</td>
<td>214</td>
<td>484</td>
<td>----</td>
<td>----</td>
<td>552</td>
</tr>
</tbody>
</table>

Source: EIU Country Profile 1989-90 (Philippines)

2.1.2 INFRASTRUCTURE SECTOR

In the Development Model of the Philippines (DMP) the Infrastructure Sector is modeled to include the following components: highways, railways, ports, airports, power and energy, water supply and distribution, telecommunication and sewage treatment.

In the Philippines, road transport is very important as it carries 60% of the freight and 80% of the passengers. In 1986 the total length of roadway was 162325 kilometers, 21299 kilometers of which were paved. The number of motor vehicles registered during the same year totaled 1,185,832 of which 338,687 were private cars. The railway system is composed of a 740-km single line track plying the Bicol-Manila-La Union route transporting 9.1 million passengers and 64,000 tons of freight as of 1986 and the new light railway transit servicing Manila. The Philippine shipping
fleet consists of 20,366 registered which includes 8,148 fishing vessels. The Philippine ports handled 33.7 tons of international seaborne cargo. Almost 50% of this total tonnage was handled by Manila. In 1985 the second phase of an international container in Manila was commenced. Another container port was also constructed and completed in Cebu City in 1986. A total of 87 airports service the nation including two international airports, one in Manila and the other in Cebu City (Visayas), yet air transport is still centered in Manila. In 1986, a total of 1,109 million ton-km and 8,901 million passenger-km were accrued by Philippine Airlines (PAL).

In 1978 the government entered into a contract to construct a nuclear plant in Bataan with the intent of increasing the electrical capacity of the nation. It was projected to generate 620 megawatts and was targeted to start its operation by 1985. It was further planned that two other nuclear plants would be constructed after the Bataan Nuclear Plant. Unfortunately none of the nuclear plants were ever put into operation. The Aquino administration decided not to put the Bataan for safety considerations. It was found that the nuclear plant is situated near a seismic fault line. The other projects were shelved because of the necessary cutback in foreign borrowings. In 1986 power generating capacity was 5,788 megawatts, 37% of which was
provided by hydroelectric plant and another 37% oil fired. Geothermal capacity is at 894 megawatts. The government's medium term development plan projects that an expansion of 12% will be had in coal fired capacity and a substantial increase in geothermal energy.

Between 1956 to 1970 the proportion of dwelling units with adequate water supply increased by 8%. But a decline in the absolute number of dwelling units without adequate water was recorded during the same period (Table 2.4). Moreover, lower income urban families had limited access to adequate and potable water. In 1975 the government initiated the construction of the Manila Water Supply Project designed to meet the needs of the populace. The first phase was aimed at increasing the total water supply in the Metropolitan Manila area by 120 mgd. The government also embarked on a similar project for the provinces. In 1973 the Local Water Utilities Administration was created to provide standards and regulations for the design, construction, operation, and fiscal practices of local utilities as well as provide technical assistance and training.

2.1.3 DEMOGRAPHIC SECTOR

A slowdown in the rate of population growth has been noted in the Philippines. The population grew from 36.68
million in 1970 to 48.10 million in 1980 registering a growth rate of 2.7% compared to the 3% growth in the previous decade.

In 1986, the crude birth rate decreased from 46 per thousand to 42 per thousand in 1960. This could be attributed to the implementation of a comprehensive family planning program. The problem of high fertility rate is more acute in the rural area. In 1970 rural fertility was 6.7 compared to 4.1 registered by the urban sector. This could be attributed to the fact the women in the urban areas marry later and once married have fewer children. Mortality has also improved due to public health measures, meager though it may be. In 1985 life expectancy was 64 compared to 53 in 1960. Infant mortality decreased from 106 per thousand to 54 per thousand in 1987. Likewise, child mortality declined from 14 per thousand in 1960 to 5 per thousand in 1987. It must be noted though that these figures represent a declining since 1984 when both rates were 49 and 4, respectively. This deterioration is considered by most economists as the result of the economic crisis of 1983-1985.

Availability of health care in the Philippines as measured by the ratio of physicians and nurses to population served has been on the decline for some time now (Table 2.5). This could be attributed to the fact that most
Table 2.4. Dwellings with Adequate Source of Water

<table>
<thead>
<tr>
<th>Year</th>
<th>Thousands</th>
<th>Percent</th>
<th>Thousands</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>1,631</td>
<td>42.8</td>
<td>2,181</td>
<td>57.2</td>
</tr>
<tr>
<td>1967</td>
<td>2,688</td>
<td>51.3</td>
<td>2,439</td>
<td>48.7</td>
</tr>
<tr>
<td>1970</td>
<td>3,112</td>
<td>50.7</td>
<td>3,027</td>
<td>49.3</td>
</tr>
</tbody>
</table>


Table 2.5. Health Indicators

<table>
<thead>
<tr>
<th>Population per physician</th>
<th>Population per nursing person</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,850</td>
<td>1,130 2,640</td>
</tr>
</tbody>
</table>

Source: EIU Country Profile 1989-90 (Philippines)

qualified medical personnel seek employment outside of the country.

Forty-two percent of the population was under 15 years old in 1980 and literacy rate was 88% for those over 15 years of age. In 1986 96% of children were enrolled in elementary and 54% were in the secondary schools; 16% of those between 7 and 24 years were enrolled in college.

In the recent years, two trends of the movement of
Philippine population is noticeable; (1) the decrease of the fraction of the urban population from 70% in 1960 to 59% in 1986 and (2) the migration of people to Mindanao despite the threat of political unrest in the area.

2.1.4 EMPLOYMENT SECTOR

With a population that increases rapidly, the size of the labor force in Philippine society is also constantly on a rise. In 1988 labor force was 23.05 Million, 47% of which were involved in agriculture, forestry, and fishing. Unemployment and underemployment are serious problems facing the nation. The economic crisis of 1983-85 compounded the unemployment situation by drastically reducing both the supply of imported inputs in industry and the domestic demand for its output, thereby causing jobs. In October 1988 unemployment had reached 8.7% nationwide, with double this figure in metropolitan Manila, where bulk of the manufacturing industries are. A program has been drawn by the government to decrease unemployment to 5% and underemployment to 25% by 1992. Real wages have been on a decline since 1960s. This denotes that an increasing number of people are seeking work and the inefficiency of the trade union movement. By 1987 real minimum wage was down by 12-17% based on the 1983 levels. The P10/P11 pesos (roughly 50 cents) increase imposed in 1987 did not fully cover the deficiency as it was offset by the 1988 inflation rate of
over 8%.

In the recent years, a rise in emigration has occurred helping stem the tide of an overwhelming unemployment rate. The number of emigrants rose from 14,500 in 1975 to 48,867 in 1981, putting the total number of emigrants and contract workers at approximately 2 million by 1984. Placements in 1987 was estimated to be some 433,300 with the Middle East accounting for 71%. Bulk of the contracts are for production and other related workers. But the proportion of service workers have increased to about 28% in the recent years reflecting the growth in regional demand.

2.1.5 AGRICULTURE SECTOR

Agriculture is considered as the most important sector in Philippine society. Although manufacturing equals agriculture’s contribution to the Gross Domestic Product (GDP), the latter still retains its superior significance in terms of employment and net contribution to export earnings. Agriculture has continually sustained the economy even when manufacturing was on a decline. Climate in the Philippines is very conducive to agricultural cultivation. The average annual rainfall is around 120 inches. Occurrence of typhoons and local tropical thunderstorms causes variation in rainfall patterns regionally. Only Southern Mindanao is
nearly typhoon free, and the sugar areas of Negros and Panay are relatively unaffected.

Crop area has increased from 9.4 million hectares in 1971 to 12.25 million hectares in 1979. This is attributed largely to the clearing of the virgin forests, particularly in Mindanao. Because of the growth in population, the average farm size has shrunk from 3.5 hectares in 1960 to 2.6 hectares in 1980. Area under irrigation has increased from 488,500 hectares in 1964 to 1,49 million hectares in 1987 (which represents 40% of the total area to be irrigated). This increase is largely due to the extensive programme of capital investment aided by multilateral agencies undertaken in 1987.

A Land Reform Programme, first implemented by the Marcos Regime in 1973, is being pursued by the Philippine government. Its thrust is to emancipate the farmer from share tenancies and empower the rural sector. When the Aquino administration came into power in February 1986, 600,000 hectares (more than half of the area covered by the 1973 Program) remained to be distributed. Whereas the 1973 Agrarian Reform Program only covered rice and maize land over 7 hectares, the Aquino administration introduced a more comprehensive programme covering all agricultural lands. In June 1988 Congress approved a bill providing for the redistribution of all land above a holding of 5 hectares per
landowner plus 3 hectares for each direct heir. The entire programme is projected to be completed in 10 years.

During the 70s producer prices were largely controlled by the government. Marketing of coconut and sugar was controlled by cronies of then President Marcos. It has been estimated that the country incurred a loss of at least P11.6 Billion between 1974-83 due to this monopoly. Moreover, farmers contend that the coconut monopoly cheated them out of about 9% to 15% of their rightful incomes. The Aquino administration has abolished these monopolies.

The principal food crops in Philippine agriculture are rice and maize. The country became self-sufficient in rice in the late 1960s due to the implementation of the 'Green Revolution'. But in 1971 demand overtook supply making it necessary for the country to import rice to avoid exorbitant increase in domestic prices. To remedy this, a rice development program called Masagana 99, was implemented in 1973. Output was improved in the subsequent years and no import was necessary after 1977, although small purchases had to be made in 1988-89. The nation has been self-sufficient in maize since the late 1970s. Other principal crops are as follows:

Coconut - most important export crop. The Philippines account for more than half of the world production.
Sugar – also an export crop but the decline in world sugar prices has precipitated a decrease in output and a switch to other crops.

Bananas – taken the place of abaca as a foreign exchange earner.

Abaca (Manila Hemp) – output declined heavily after World War II and the constant attack of disease and overstripping.

Pineapples – the second ranked export crop. It is largely grown in Mindanao (about 80,000 hectares are used for pineapple cultivation) and its production is largely dominated by multinational companies which export pineapples in canned form.

Coffee – cultivated mainly in Mindanao and Southern Tagalog (Mindanao). In 1986 production was at 136,500 tons with the volume of exports rising by approximately an eighth a year.

The country has ample supply of pork and poultry but has to import beef and dairy products. A credit program launched in 1987 helped improve the dairy industry but it still cannot meet domestic demand.

2.2 MINDANAO

Located in the southern portion of the Philippines, Mindanao is a major contributor to the national economy.
Based on 1986 data, Mindanao contributed 23 per cent of the volume of palay produced (rice), 65 per cent of the national corn production, 54 per cent of volume of coconut produced, 70 per cent of banana volume, and 94 per cent of the total pineapple production. It also contributed 61 per cent of the volume of timber products. Between 1975 and 1984 the average annual growth rate of Mindanao's Gross Domestic Product (GDP) was about 5 per cent compared to the national growth of 4.2%. Western and Northern Mindanao registered a growth rate of 7.6 per cent and 5.6 per cent, respectively, for the same period.

In 1984 Mindanao had 23 per cent of the nation's population, the result of the flocking of people to Mindanao where land for cultivation was ample. Between 1975 and 1984 population grew by an average of 4 per cent, except in Central Mindanao whose population only grew by 1.9 per cent during the same period. In comparison, the national population growth was posted at 2.8 per cent.

Impasug-ong, the locality used for the calibration of the regional model BUKID, is located in Northern Mindanao. It is surrounded by three major cities, namely: (1) Cagayan de Oro City, (2) Davao City, and (3) Butuan City. It has been a site for pilot projects in agriculture. Population is estimated to be equal to 22629, with a total of 4000

23
households. According to the data of the Department of Agriculture 3200 people are involved in rice and corn cultivation. It has a total land area of 115175 hectares.
FIGURE 2.1. MAP OF THE PHILIPPINES
CHAPTER 3
SYSTEM DYNAMICS METHODOLOGY

To guide national development effectively, policy makers must bring together a variety of mental models, translate them into a common language, and determine simultaneously all their important implications. Therefore, formal models--those whose assumptions are stated explicitly--are required. Formal models are best expressed in mathematical equations for three reasons: (1) mathematics is precise and interdisciplinary, (2) equations can be manipulated in response to changing inputs, and (3) the mathematical notation permits processing by a computer.

The system dynamics methodology developed by Professor Jay Forrester of M.I.T. seeks to use quantitative means to investigate the behavior of dynamic socio-technical and to show how structure, policies, decisions and delays interact to influence growth and stability. Systems under investigation from the perspective of system dynamics are considered dynamic, non-linear, and closed. It is the assertion of the proponents of the system dynamics methodology that all human systems are built on feedback loops.

In the system dynamics methodology three alternative forms of the model of a system are used: verbal, visual, and
mathematical. The modeling procedure is sequential and iterative. It starts with the verbal description of the major elements necessary to represent the relevant aspects of the system. Next is the postulation of the model's structure and conceptualization of causal relationships between model parameters in a form of a causal diagram. From the causal diagram, the system equations may be written. To complete the mathematical model, the model's parameters must be estimated. This includes placing numerical values on constants and the quantification of causal assumptions. Experimentation using simulation helps evaluate the accuracy of the model. At each step the model is exposed to criticism, revised, exposed again and so on in an iterative process that continues as long as it proves useful (12). Figure 3.1 shows these stages in modeling from the system dynamics perspective (18).

3.1 CAUSAL DIAGRAMMING

After defining the problem and the environment affecting the problem, the subsequent step in modeling using the system dynamics methodology is to represent the causal relationships between these factors using a causal diagram.
A causal diagram is made up of causal links between parameters which indicate the "direction" of each relationship. These causal links in turn form feedback loops. In developing a causal diagram, each link is represented by an arrow and an algebraic sign, whether plus (+) or minus (−). These signs indicate the effect of the independent variable (usually found at the tail of the arrow) on the dependent variable (one at the head of the arrow). A linkage is said to be positive if the independent dependent variables vary in the same direction. In other words, there is a direct proportionality between the two
variables. A negative linkage is one where the variables are inversely related, thus vary in opposite directions, i.e. one is increasing and the other is decreasing.

At the heart of the system dynamics methodology is the notion of feedback. Succinctly, feedback is the "return of information to the source of a process or action for the purpose of control or correction". (American Heritage Dictionary, 1989). According to Forrester, feedback loops are the basic building blocks of a system. A simple feedback loop is a closed sequence of causes and effects. A feedback loop is formed when two or more linkages are connected in such a way that the arrows are all pointing in the same direction and the point of origin and termination around the loop are one and the same variable (12). Like linkages, feedback loops are identified either as positive or negative feedback based on their polarities. A positive feedback amplifies growth or decline around the loop -- frequently more than what is desired. Positive loops are characterized as growth-producing, or self-reinforcing. The "goal-seeking" or negative feedback attempts to negate any deviations from the goal or desired value for a level. Determination of the polarity of a feedback loop can be done by counting the number of negative links it contains. A loop carrying an odd number of negative links is a negative feedback loop. An even number of negative linkages indicate
positive feedback loop. The order of the feedback loop is
determined by the number of level variables in the loop.
Moreover, the order of a feedback system is regulated by the
feedback loop with the maximum number of level variables in
the loop (8).

3.2 SYSTEM DYNAMICS MODELING

There are three types of basic variables used in system
dynamics: (1) level variable -- state variable which
represents the accumulation of resources over time; (2)
rate--represents the changing activities and decisions in
the system as influenced by factors acting upon it; and (3)
auxiliary variable -- a variable used to simplify
computations. These different variables are taken into
consideration in the development of a causal diagram from
which mathematical equations can be formed.

3.3 DYNAMO EQUATIONS

DYNAMO (DYNAmic MODEls) is a computer simulation
language developed to model real-world systems to be able to
trace their dynamic behavior over time. (Richarson and Pugh,
1981). This program compiles and executes system dynamic
equations. Because of the inability of DYNAMO to handle
subscripts, it uses alternative postscripts notations like
the ones shown below:

- \( .K \) represents present time \( t \)
- \( .J \) denotes past time \( t - dt \)
- \( .L \) stands for the future time \( t + dt \)
- \( .JK \) represents time interval between past and present
- \( .KL \) denotes time interval between present and future

DYNAMO also utilizes different postscripts for the different types of variables in system dynamics. Table 3.1 lists these postscripts.

<table>
<thead>
<tr>
<th>Table 3.1. Summary of DYNAMO Postscript Convention</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE OF EQUATION</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>L: LEVEL</td>
</tr>
<tr>
<td>R: RATE</td>
</tr>
<tr>
<td>A: AUXILIARY</td>
</tr>
</tbody>
</table>
CHAPTER 4
UNDERLYING STRUCTURES

At the core of both the Development Model of the Philippines (DMP) and BUKID are feedback loops which determine the behavior of the models. As discussed in Chapter 3, there are two basic feedback patterns, namely: positive feedback and negative feedback. A positive feedback loop is self-perpetuating, whereas a negative feedback loop seeks to maintain the status quo, so to speak. The order of a feedback loop is determined by the number of the level variables it contains. Likewise, the order of a feedback system is determined by the feedback loop with the maximum number of level variables in it. This section examines the occurrence of these feedback patterns and the repercussions on the simulation trends of both models.

4.1 NEGATIVE FEEDBACK LOOPS

A negative feedback loop is formed when two or more variables are indirectly related. This feedback pattern seeks to maintain a particular value or level in two manners. It can either act as a change-resisting loop or as a goal seeking interaction. A change-resisting loop contains a rate variable which subtracts from the level. Figure 4.1
shows the basic structure governing a change-resisting loop. An increase in A causes a decrease in B and vice-versa.

---

**Figure 4.1 CHANGE-RESISTING LOOP**

---

Typical of this category of negative-feedback loop is that involving population and deaths. The rate of death constantly seeks to reduce the level of population. In effect the death rate negates any change in the population level (figure 4.2). This structure occurs in DMP for both the urban and rural sectors and is also used in the demographic sub-sector of BUKID.

---

**Figure 4.2 POPULATION-DEATH RATE LOOP**

---

33
Other interdependencies in the models with a similar structure are:

1. Capital-Depreciation Loop (for all industries, infrastructure and social development) - appears in both DMP and BUKID.
2. Pollution - Pollution Absorption Loop - present in DMP
3. Housing Units-Deterioration Rate Loop - present in BUKID
4. Machinery in Use-Depreciation Rate Loop - occurs in BUKID
5. Outstanding Loan - Loan Repayment Loop - appears in BUKID

The second prevalent form of negative feedback pattern is that which is one that is goal-seeking. In this structure, a desired goal is set and the system seeks to achieve the established value and then strives to maintain it. This negative feedback structure, as used in BUKID, enables the model to simulate possible behavioral patterns arising from the establishment of a desired level or goal. The rate of change gradually abates as the discrepancy between the existing and the desired value decreases. Figure 4.3 displays the structure of this category of feedback loop.
One example of this category of loop found in BUKID is the Road Density - Demand for Road - Road Construction Rate - Rural Road Length Loop. As shown in figure 4.4 below, an increase in the demand for road increases the rate of construction. Demand for road, in turn, is dependent on the discrepancy between the desired road density and the actual road density. Once the desired value is obtained, road construction is assumed to cease.

---

**FIGURE 4.3 FIRST-ORDER GOAL SEEKING LOOP**

---

---

**FIGURE 4.4 ROAD DENSITY - DEMAND FOR ROAD - ROAD CONSTRUCTION RATE LOOP**

---

35
Other loops found in the models with similar underlying structures are as follows:

1. **Number of Compact Farms** - Additional Compact Farms Required - Compact Farm Addition Rate Loop - found in BUKID

2. **Fertilizer Application Level** - Discrepancy from the Desired Level - Fertilizer Application Increase Rate Loop - found in BUKID

3. **Machinery Use** - Deviation from Desired Machinery Use - Machinery Increase Rate Loop - found in BUKID

**DMP contains other negative feedback loops which contain more than two variables. Below is the discussion of selected loops which typify those contained in the model.**

**Rural – urban interdependency** is embodied in the model through the **Relative Earning Agricultural – Rural Urban Migration – Rural Population Loop**. This loop, shown in figure 4.5, indicates that an overwhelming increase in rural population is constrained by the rate of land conversion. An increase in rural population would bring about an increase in the labor force of the rural sector, which in
turn increases agricultural productivity. Concomitant with an increase in agricultural productivity is the increase of the Gross National Product, thus resulting in an increase in investment for infrastructure and consequently, an increase in urban industrial capital. Increase availability of urban industrial capital creates a demand for urban industrial land thus speeding up urban industrial land conversion rate.

\[ \text{CULTL} \rightarrow \text{CROP A} \rightarrow \text{WEA} \]
\[ \text{Worker Earnings} \]
\[ \text{In Agri.} \]
\[ \downarrow \]
\[ \text{REA} \]
\[ \text{Relative Earning} \]
\[ \text{Agri.} \]
\[ \downarrow \]
\[ \text{RUMM} \]
\[ \text{Rural-Urban Mig.} \]
\[ \text{Multiplier} \]
\[ \downarrow \]
\[ \text{RUM} \]
\[ \text{Rural-Urban Migration} \]
\[ \downarrow \]
\[ \text{RP} \]
\[ \text{Rural Pop.} \]

\[ \text{ULIR} \]
\[ \text{Urban Industrial Land Required} \]
\[ \uparrow \]
\[ \text{UIC} \]
\[ \text{Urban Industrial Capital} \]
\[ \uparrow \]
\[ \text{IF} \]
\[ \text{Infrastructure} \]
\[ \downarrow \]

\[ \text{GNP} \rightarrow \text{AP} \rightarrow \text{LFA} \]
\[ \text{Gross National Product} \rightarrow \text{Agricultural Product} \rightarrow \text{Labor Force Agri.} \]

**FIGURE 4.5 GNP-INDUSTRIAL CAPITAL-AGRICULTURAL PRODUCT LOOP**
Land conversion for industrial use decreases the expanse of land that will be under agricultural cultivation thereby decreasing the area available for cropping. A decrease in cropping area will result in lower earnings for agricultural workers, thereby decreasing the relative earnings of agricultural workers to non-agricultural workers, promoting migration of people to the urban areas for better employment prospects. A surge of migration to the cities will decrease the rural population.

A similar structure also underlies the relationship between social development and urban population.

Likewise, a first-order negative feedback loop also underlies the environment sector. Figure 4.6 indicates that as industrial output increases, pollution generation also increases, thereby augmenting level of pollution. An increased level of pollution would result in a larger value of the capital-output ratio, brought about by increased cost for clean-up, thus decreasing the industrial output. This feedback loop enables the model to evaluate environmental protection policies.

Underlying BUKID are several negative feedback structures which seek to constrain growth. One of such loops is that consisting of the level of rice and corn farmers, the number of agricultural technicians and yield/hectare.
In this loop the ratio of agricultural technicians to rice and corn farmers hinders the continuing increase in yield per hectare. Restraining the increase in yield also decreases the attractiveness of rice and corn farming thereby slowing down the rate of new farmers in joining the work force. This loop is presented in figure 4.7.

Negative feedback loops found in BUKID with similar structures are:

1. Market Accessibility - Production in Agro-based Industries - Road Deterioration Rate Loop.

2. Number of Compact Farms - Average Machinery Usage - Compact Farm Conversion Rate
4.2 POSITIVE FEEDBACK LOOPS

Conversely, positive feedback loops do not resist change nor do they seek to maintain a particular value or level. Instead, positive feedback loops signify the continuous growth or decline of a particular level or system. This category of loops can be termed as "vicious cycles" or "virtuous cycles", whatever the case may be. Figure 4.8 presents the basic structure of a positive feedback loop. An increase in the value of variable A will bring about a corresponding increase in variable B and vice-versa. In this feedback pattern the rate variable seeks to amplify the value of the level variable.
An example of a positive feedback loop that is present in both DMP and BUKID is that consisting of the level of population and birth rate (figure 4.9). As the rate of birth increases, population swells in number. In the same manner, as population increases, birth rate speeds up.

Other interactions in the models with similar structures are:

1. Pollution Absorption Time - Pollution Absorption - Pollution Loop - found in DMP
2. Industrial Output - Capital Formation - Industrial Capital Loop - found in DMP
3. Social Capital Investment - Rural Population - Agricultural Product Loop - found in DMP
4. Infrastructure Investment - Industrial Product - Gross National Product Loop - found in DMP
5. Average Agricultural Product - Credit Crop Production - Yield Per Hectare Loop - found in BUKID

A second-order positive feedback loop is contained in DMP and is shown in figure 4.10. The two level variables found in the loop are urban population and cultivated area. As the discrepancy of incomes between the rural and urban sectors increases, migration to the cities occur, in effect increasing the urban population. As more people stay in the cities, requirement for urban industrial land is increased resulting to a need for spedier land conversion rate. As more land is made available for industrial use, the level of cultivated area decreases thereby reducing the crop area available for agricultural workers. A reduction in crop area signifies a corresponding reduction in worker earnings in agriculture, augmenting the discrepancy between urban and rural incomes and thus perpetuating this cycle of decay.
FIGURE 4.10. URBAN POPULATION - CULTIVATED AREA - RURAL URBAN MIGRATION LOOP
CHAPTER 5

TECHNICAL DESCRIPTION

5.1. Development Model of the Philippines (DMP)

DMP is organized into seven sectors so as to accommodate three development orientations: (1) resource development, (2) regional development, and (3) sectoral development. Resource components include natural resources, land resources, water resources, and human resources (manpower). Regional development is partitioned into the urban and rural sectors. Agriculture, manufacturing, business, infrastructure and government provide the economic elements in the model. These orientations overlap in that they are tied together by two quantities most responsible for material growth: (1) population—including the effects of all economic and environmental factors that influence human birth, death, and migration rates, and (2) capital—including the means of producing industrial, service and agricultural outputs.

For the purposes of national income analysis, Gross National Product (GNP) statistics are subdivided into mutually exclusive, collectively exhaustive categories. The most commonly used scheme is that based on the International Standard Industrial Classification (ISIC) (Table 5.1). In DMP the agriculture sector provides the output for the first
classification division. Output for divisions 2, 3, and 5 is obtained in DMP through the mining, manufacturing, and construction sub-sectors. The business sub-sector represents activities listed under ISIC division 6 and 8. Divisions 4 and 7 are integrated into DMP through the infrastructure sector and the social development sector corresponds to ISIC division 9.

Table 5.2 lists the different parameters used in DMP to measure the effectiveness of the programs or policies that will be simulated using the model. These indicators enable the user of the model to express development in a more equitable manner. DMP reflects the philosophy that the development of a nation is measured by the development of its people. Traditionally, the Gross National Product and national per capita income are used as indicators of economic development or underdevelopment as the case may be. Yet, over and above the determination of the nation's wealth, DMP endeavors to provide a means of envisaging the effectivity in the distribution of this wealth. In the model rural to urban migration is assumed to depend on Relative Earnings in Agriculture, REA, an indicator of the distribution of wealth. A second indicator used in the model is Unemployment Non-Agriculture, UNEMNA.
Indicators of the quality of life and of the environment are Infrastructure Capital per Capita Ratio, IFCPCR, Social Development Capital per Capita, SDCPCR, and Pollution Ratio, POLR. Since infrastructure capital in the model includes highways, rails, ports, airports, power, water, telecommunications and sanitary engineering services, and social development capital includes health, education, housing, family planning and welfare, the two indicators combine to provide surrogate measures of a vast spectrum of personal service. The causal diagram of DMP which appears in Figure 5.1 illustrates how these different parameters are interconnected.

5.1.1 INDUSTRIAL SECTOR

The industrial sector of DMP is subdivided into mining, manufacturing, construction and business sub-sectors based on the International Standard Industrial Classification (ISIC) used for GNP statistics. The equations are subscripted with A to enable the model to compute for each sub-sector.

Capital investment in industry is denoted in the model by Industrial Capital (IC). It is increased by capital formation and decreased by capital depreciation. An initial total capital of 1000 Billion Pesos divided among the 4 sub-
Table 5.1. International Standard Industrial Classification

<table>
<thead>
<tr>
<th>Code</th>
<th>Classification and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agriculture, hunting, forestry, and fishing</td>
</tr>
<tr>
<td>2</td>
<td>Mining and quarrying</td>
</tr>
<tr>
<td>3</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>4</td>
<td>Electricity, gas, and water</td>
</tr>
<tr>
<td>5</td>
<td>Construction</td>
</tr>
<tr>
<td>6</td>
<td>Wholesale and retail trade, restaurants, and hotels</td>
</tr>
<tr>
<td>7</td>
<td>Transport, storage, and communication</td>
</tr>
<tr>
<td>8</td>
<td>Financing, insurance, real estate, and business services</td>
</tr>
<tr>
<td>9</td>
<td>Community, social, and personal services</td>
</tr>
</tbody>
</table>

Sectors is reflected in the model and an annual rate of inflation is taken to be 21%.

\[
ICK(A) = ICJ + (DT)(\{(CFJK(A))((1+AROI*DT))\} - CDJK(A))
\]

\[
IC(A) = ICN(A)
\]

\[
ICN(*) = 70E9/570E9/180E9/180E9
\]

AROI = 0.21

IC - INDUSTRIAL CAPITAL (Pesos)

ICN - INITIAL INDUSTRIAL CAPITAL FOR EACH SUB-SECTOR

AROI - ANNUAL RATE OF INFLATION (FRACT)
The rate of capital depreciation is directly proportional to industrial capital and inversely affected by lifetime of the industrial capital which is assumed to be 25 years for each of the sub-sector.

\[ CD_{KL}(A) = IC_{K}(A)/LIC(A) \]

\[ LIC(*) = 25/25/25/25 \]

CD - CAPITAL DEPRECIATION (PESOS/YR)

LIC - LIFETIME INDUSTRIAL CAPITAL (YRS)

---

**Table 5.2. DMP Development Indicators**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>INDICATOR</th>
<th>VARIABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resources</td>
<td>Total Population</td>
<td>TP</td>
</tr>
<tr>
<td></td>
<td>Frac. Urban Pop.</td>
<td>FPU</td>
</tr>
<tr>
<td>Wealth</td>
<td>Gross National Product</td>
<td>GNP</td>
</tr>
<tr>
<td></td>
<td>Per Capita Income</td>
<td>‘PCI</td>
</tr>
<tr>
<td>Distribution of Wealth</td>
<td>Unemployment Non-Agriculture</td>
<td>UNEMNA</td>
</tr>
<tr>
<td></td>
<td>Relative Earnings Agri.</td>
<td>REA</td>
</tr>
<tr>
<td>Land Resources</td>
<td>Population Density</td>
<td>PD</td>
</tr>
<tr>
<td></td>
<td>Average Farm Size</td>
<td>AFS</td>
</tr>
<tr>
<td>Agriculture/Food</td>
<td>Per Capita Crop Prod. Ratio</td>
<td>PCCPR</td>
</tr>
<tr>
<td></td>
<td>Population Per Farmer</td>
<td>PPF</td>
</tr>
<tr>
<td>Environment</td>
<td>Infrastructure Capital per Capita Ratio</td>
<td>IFCPCR</td>
</tr>
<tr>
<td></td>
<td>Social Dev. Capital Per Capital Ratio</td>
<td>SDCPCR</td>
</tr>
<tr>
<td></td>
<td>Pollution Ratio</td>
<td>POLR</td>
</tr>
</tbody>
</table>

The rate of capital formation is dependent on the Gross National Product (GNP) and the fraction of GNP allocated to
capital formation. It is assumed that the fraction of Gross National Product for Capital Formation (FGNPCF) is equal to 30% based on 1980 statistics.

\[ \text{CF.KL}(A) = \text{GNP.K} \times \text{FGNP}(A) \]
\[ \text{FGNCF}(*) = 0.022/0.17/0.054/0.054 \]

To reflect the effect of inflation in the model, the industrial capital is corrected for inflation.

\[ \text{ICCI.K}(A) = \text{ICCI.J}(A) + (\text{DT})(\text{CF.JK}(A) - \text{CD.JK}(A)) \]

ICCI - INDUSTRIAL CAPITAL CORRECTED FOR INFLATION

CF - RATE OF CAPITAL FORMATION

CD - RATE OF CAPITAL DEPRECIATION

Gross National Product (GNP) is the sum of the total industrial product and agricultural product.

\[ \text{GNP.K} = \text{SUM(IP.K)} + \text{AP.K} \]

GNP - GROSS NATIONAL PRODUCT (PESOS/yr)

IP - INDUSTRIAL PRODUCT (PESOS/yr)

AP - AGRICULTURAL PRODUCT (PESOS/yr)

Industrial production is dependent on industrial output and fraction industrial output to input (FIOI) which is the sum of the fraction industrial output to raw materials and fraction industrial output to infrastructure. FIOI is the fraction of industrial output consumed by industrial inputs namely raw materials and infrastructure.

\[ \text{IP.K}(A) = \text{IO.K}(A) \times (1 - \text{FIOI.K}(A)) \]
FI01.K(A)=FIORM(A)+(FI0IF.K(A)
FIORM(*)=.2/.2/.2/.2
FI0IF.K(A)=FI0IFN(A)*FI0IFM.K(A)
FI0IFN(*)=.4/.4/.4/.4
FI0IFM.K(A)=TABXT((FI0IFI,(TICCI.K/TIFCI.K)/
(TICN.K/TIFN.K),0,2,.5))

IP - INDUSTRIAL PRODUCT (PESOS/yr)
IO - INDUSTRIAL OUTPUT (PESOS/yr)
FI01 - FRACT. INDUSTRIAL OUTPUT TO INPUTS
FIORM - FRACT. INDUSTRIAL OUTPUT TO RAW MATERIALS
FI0IF - FRACT. INDUSTRIAL OUTPUT TO INFRA.
FI0IFN - FRACT. INDUSTRIAL OUTPUT TO INFRA. NORMAL
FI0IFM - FRACT. INDUSTRIAL OUTPUT TO INFRA. MULTIPLIER

Fraction industrial output to infrastructure multiplier reflects the effect of investment in infrastructure on effectiveness of industry. Figure 5.2 shows the assumed relationship between the ratio of total industrial capital corrected for inflation divided by the total infrastructure capital corrected for inflation to the quotient of industrial capital normal and infrastructure capital normal.

Industrial output is the quotient of industrial capital and the capital-output ratio (COR) which is the parameter indicating capital required for unit output. Figure 5.3 shows the assumed relationship between the capital-output ratio
FIGURE 5.2. FIOIFM VS. (TICCI.K/TICCI.K)/(TICN.K/TIFN.K)

FIGURE 5.3. CORM VS. POLR.K
multiplier and pollution ratio. CORM is increased by an increase in the level of pollution.

\[ IO.K(A) = IC.K(A)/COR.K(A) \]

\[ COR.K(A) = CORN(A) * CORM.K(A) \]

\[ CORN(*) = 1.75/1.75/1.75/1.75 \]

\[ CORM.K(A) = TABXT(CORT(*,A), POLR.K, 1, 11.4, 10.4) \]

\[ CORT(*, MIXING) = 1/1 \]

\[ CORT(*, MANUF) = 1/1 \]

\[ CORT(*, CONSTR) = 1/1 \]

\[ CORT(*, BUSIN) = 1/1 \]

**IO - INDUSTRIAL OUTPUT (PESOS/yr)**

**IC - INDUSTRIAL CAPITAL (PESOS)**

**COR - CAPITAL OUTPUT RATIO (1/yr)**

**CORM - CAPITAL OUTPUT RATIO MULT.**

Per capita income is computed in the model by dividing the Gross National Product (GNP) by the total population.

\[ PCI.K = GNP.K/TP.K \]

**PCI - PER CAPITA INCOME (PESOS/PERSON-YR)**

**GNP - GROSS NATIONAL PRODUCT (PESOS/yr)**

**TP - TOTAL POPULATION (PERSONS)**

The normal value of PCI is dependent on the normal GNP divided by the population normal. In the model, population normal is equal to 48.2 million which was the Philippine population in 1980.
PCIN.K = GNPN.K / TPW

GNPW.K = (TICN.K * (1 - AFIORM.K - AFIOIF.K) / ACORN.K) +
          (WEAN * RPW * RLPF)

TICN.K = SUM(ICN)

AFIORM.K = SUM(FIORM) / 4

AFIOIF.K = SUM(FIIOIFN) / 4

ACORN.K = SUM(CORN) / 4

PCIN - PER CAPITA INCOME NORMAL (PESOS/PERSON-YR)

GNPN - GROSS NATIONAL PRODUCT NORMAL (PESOS/YR)

TPW - TOTAL POPULATION NORMAL

TICN - TOTAL INDUSTRIAL CAPITAL NORMAL

AFIORM - AVE. FRACT. IND. OUTPUT TO RAW MATERIAL

AFIOIF - AVE. FRACT. IND. OUTPUT TO INFRA

ACORN - AVE. CAPITAL-OUTPUT RATIO NORMAL

WEAN - WORKER EARNING AGRICULTURE NORMAL

RPW - RURAL POPULATION NORMAL

RLPF - RURAL LABOR PARTICIPATION FACTOR

5.1.2 ENVIRONMENTAL SECTOR

Increased industrial activity will inevitably bring about an increase in the level of pollution. DMP has included a sector on environment to enable the user to evaluate impact of increased investment in industries.

The environmental sector in DMP is a single level
positive feedback loop which tends to feed upon itself promoting a vicious cycle.

The level of pollution is increased by pollution-generation and decreased by pollution absorption.

\[ \text{POL} \cdot K(A) = \text{POL} \cdot J(A) + (\text{DT})(\text{POLG} \cdot JK(A)/(1+\text{AROI} \cdot \text{DT})) - \]
\[ \text{POLA} \cdot JK(A)) \]

\text{POL} - \text{POLLUTION (GRAM)}
\text{POLG} - \text{POLLUTION GENERATION (GRAM/YR)}
\text{AROI} - \text{ANNUAL RATE OF INFLATION}
\text{POLA} - \text{POLLUTION ABSORPTION (GRAM/YR)}

The rate of pollution absorption is increased by the level of pollution and decreased by the pollution absorption time which is the length of time required to destroy 63% of the existing pollution.

\[ \text{POLA} \cdot KL(A) = \text{POL} \cdot K(A)/\text{POLAT} \cdot K(A) \]

\text{POLA} - \text{POLLUTION ABSORPTION RATE (GRAM/YR)}
\text{POL} - \text{POLLUTION (GRAM)}
\text{POLAT} - \text{POLLUTION ABSORPTION TIME}

Pollution absorption time is not a constant. Instead, it depends on the level of pollution. Figure 5.4 shows the assumed relationship between pollution level and pollution absorption time multiplier. As pollution level increases, pollution absorption time multiplier also increases. In effect, the time required for pollution decay is increased.
This has been attributed to the possible break-down in clean-up mechanisms and an increase in the level of poison in the environment (12).

\[
\text{POLAT.K(A)} = \text{POLATN(A)} \times \text{TABXT(POLATM(*,A), POLR.K,0,10,1)}
\]

\[
\text{POLATM(*,MINING)} = 1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.75/1.78
\]

\[
\text{POLATM(*,MANUF)} = 1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.75/1.78
\]

\[
\text{POLATM(*,CONSTR)} = 1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.75/1.78
\]

\[
\text{POLATM(*,BUSIN)} = 1/1.19/1.32/1.41/1.5/1.57/1.63/1.68/1.75/1.78
\]

\[
\text{POLAT} - \text{POLLUTION ABSORPTION TIME (YR)}
\]

\[
\text{POLATM} - \text{POLLUTION ABSORPTION TIME MULT.}
\]

\[
\text{POLR} - \text{POLLUTION RATIO}
\]

Increase or decrease in the level of pollution as compared to the normal value is indicated by the parameter POLR.

\[
\text{POLR.K(A)} = \text{SUM(POL.K)}/\text{SUM(POLN)}
\]

\[
\text{POLN(A)} = \text{ICN(A)}
\]

The rate of pollution generation is dependent on industrial output and the pollution generated per peso of industrial output.

\[
\text{POLG.KL(A)} = \text{IO.K(A)} \times \text{UPG(A)}
\]

POLG - POLLUTION GENERATION (GRAM/YR)

IO - INDUSTRIAL OUTPUT (PESOS/YR)

UPG - UNIT POLLUTION GENERATION (GRAM/PESO)

5.1.3 INFRASTRUCTURE SECTOR

Programs to expand production and employment in agriculture and industry will need to be complemented by an investment in infrastructure.

The infrastructure sector in DMP includes highways, railways, ports, airports, power, water, telecommunications and sewerage. It is disaggregated and allows for computation in each sub-sector. A subscript of B is used to differentiate each division.

The level of capital investment in infrastructure as modeled in DMP is increased by infrastructure investment rate and decreased by infrastructure investment depreciation.

IF.K(B) = IF.J(B) + (DT)(IFI.JK(B) - IFD.JK(B))

IF - INFRASTRUCTURE (PESOS)

IFI - INFRASTRUCTURE INVESTMENT (PESOS/YR)

IFD - INFRASTRUCTURE DEPRECIATION (PESOS/YR)

The rate of infrastructure investment depreciation is dependent on infrastructure capital and lifetime of
infrastructure capital which is assumed to be 50 years for all the sub-sectors.

$$\text{IFD}.KL(B) = \frac{\text{IF}.K(B)}{\text{LIF}(B)}$$

$$\text{LIF}(*) = 50/50/50/50/50/50/50/50$$

$\text{IFD - INFRASTRUCTURE DEPRECIATION (PESOS/YR)}$

$\text{IF - INFRASTRUCTURE (PESOS)}$

$\text{LIF - LIFETIME INFRASTRUCTURE CAPITAL (YR)}$

The rate of infrastructure investment is dependent on Gross National Product (GNP) and fraction of GNP for infrastructure (FGNPIF). It is deduced from 1980 Philippine statistics that about 8% of the country's GNP is invested in infrastructure.

$$\text{IFI}.KL(B) = \text{GNP}.K*\text{FGNPIF}(B)$$

$$\text{FGNPIF}(*) = .01/.01/.01/.01/.01/.01/.01/.01$$

The level of infrastructure capital corrected for inflation is also computed for in the model. The initial value of IFCI is taken to be equal to IFN.

$$\text{IFCI}.K(B) = \text{IFCI}.J(B) + (\text{DT}) \left( \frac{\text{IFI}.J(K(B))}{(1+\text{AROI*DT})} - \frac{\text{IFD}.J(K(B))}{1} \right)$$

$$\text{IFCI}(B) = \text{IFN}(B)$$

$\text{IFCI - INFRA. CAPITAL CORRECTED FOR INFLATION}$

$\text{IFI - INFRA. INVESTMENT}$

$\text{AROI - ANNUAL RATE OF INFLATION}$

$\text{IFD - INFRA. DEPRECIATION}$
To evaluate impact of investment of infrastructure on the quality of life, a parameter Infrastructure Capital Per Capita Ratio (IFCPCR) is determined in the model.

\[
\text{IFCPCR}.K = \frac{\text{TIFCI}.K/\text{TP}.K}{\text{TIFN}.K/\text{TPN}}
\]

\[
\text{TIFCI}.K = \text{SUM}(\text{IFCI}.K)
\]

\[
\text{TIFN}.K = \text{SUM}(\text{IFN})
\]

IFCPCR - INFRA. STRUCTURE CAPITAL PER CAPITA RATIO
TIFCI - TOT. INFRA. CAPITAL CORRECTED FOR INFLATION
TIFN - TOTAL INFRA. CAPITAL NORMAL
IFCI - INFRA. CAPITAL CORRECTED FOR INFLATION
IFN - INFRA. CAPITAL NORMAL

5.1.4 SOCIAL DEVELOPMENT SECTOR

Social development is a significant aspect of national development. An investment in the social development sector is an investment in and for the people. The challenge for the Philippines which has a poverty level of 88% is to translate economic development into social services accessibility.

The social development sector of DMP is subdivided into 5 sub-sectors namely; health, education, housing, family planning, and welfare. A subscript C is used for computation in each of these sub-sectors.
The level of social development capital is increased by the social development investment rate which in this model relies heavily on the Gross National Product and the Fraction of Gross National Product for Social Development (FGNPSD). The model reflects a FGNPSD of 6% divided among the 5 sub-sectors. An initial investment of 475 Billion Pesos is assumed.

\[
SDC.K(C) = SDC.J(C) + (DT)(SCI.JK(C) - SCD.JK(C))
\]

\[
SDC(C) = SDCN(C)
\]

\[
SDCN(*) = 95E9/95E9/95E9/95E9/95E9
\]

\[
SCI.KL(C) = GNP.K*FGNPSD(C)
\]

\[
FGNPSD(*) = .012/.012/.012/.012/.012
\]

SDC - Social Development Capital (Pesos)
SCI - Social Dev. Capital Investment Rate (Pesos/yr)
SDC - Social Dev. Capital Depreciation Rate
SDCN - Social Dev. Capital Normal
GNP - Gross National Product (Pesos/yr)
FGNPSD - Fract. of GNP for Social Dev.

The depreciation of social development capital is dependent on level of social development capital and lifetime of social development capital which is assumed to be 50 years for each of the sub-sectors.

\[
SCD.KL(C) = SDC.K(C)/LSDC(C)
\]

\[
LSDC(*) = 50/50/50/50/50
\]

SCD - Social Dev. Capital Depreciation Rate (Pesos/yr)
LSDC - Lifetime Social Dev. Capital (Yr)

The total Social Development Capital is taken to be the sum of the capital in each of the 5 sub-sectors.

\[ TSDC.K = \text{SUM}(SDC.K) \]

\[ TSDCN.K = \text{SUM}(SDCN) \]

TSDC - Total Social Dev. Capital (Pesos)

SDC - Social Dev. Capital

TSDCN - Total Social Dev. Capital Normal (Pesos)

SDCN - Social Development Capital Normal

To accommodate the effect of the annual rate of inflation, the level of social development capital is also computed for.

\[ SDCCI.K(C) = SDCCI.J(C) + (\text{DT})((SCI.JK(C))/(1+AROI*\text{DT}))-SCD.JK(C) \]

SDCCI(C) = SDCN(C)

SDCCI - Social Dev. Capital Corrected for Inflation

SCI - Social Development Capital

AROI - Annual Rate of Inflation

SCD - Social Dev. Capital Depreciation

The social development capital per capita ratio is computed for in the model to determine whether improvement or deterioration in the quality of life has been achieved.

\[ SDCPCR.K = (TSDCCI.K/TP.K)/(TSDCN.K/TPN) \]

\[ TSDCCI.K = \text{SUM}(SDCCI.K) \]

SDCPCR - Social Dev. Capital per Capita Ratio
TP - Total Population
TSDCN - Total Soc. Dev. Capital Normal
TPN - Total Population Normal

5.1.5 DEMOGRAPHIC SECTOR

Rapid population growth is one of the most serious problems facing the country. It hampers economic growth, and exacerbates the problems of unemployment and nutrition, and overloads the schools and other service facilities. The challenge for the Philippines is to promote a development strategy that will contain population growth, increase quality of life, and sustain economic development.

The demographic sector of DMP is composed of the two components of Philippine population; rural and urban sub-sectors. Initial value of population of taken to be 48.2 million.

\[ TP.K = UP.K + RP.K \]
\[ TPN = UPN + RPN \]
\[ TPN = 42.8E6 \]

TP - TOTAL POPULATION (PERSONS)
UP - URBAN POPULATION
RP - RURAL POPULATION
TPN - TOTAL POPULATION INITIAL
Urban population is increased by urban births, immigration, and rural-urban migration and decreased by urban deaths and emigration.

\[ \text{UP}_K = \text{UP}_J + (\text{DT})(\text{UB}_J \cdot \text{UD}_K - \text{ER}_J \cdot \text{JK} + \text{IM}_K + \text{RUM}_K) \]

\[ \text{UPN} = 19.32E6 \]

\[ \text{UP} = \text{URBAN POPULATION (PERSONS)} \]
\[ \text{UB} = \text{URBAN BIRTHS (PERSONS/YR)} \]
\[ \text{UD} = \text{URBAN DEATHS (PERSONS/YR)} \]
\[ \text{ER} = \text{EMIGRATION RATE (PERSON/YR)} \]
\[ \text{RUM} = \text{RURAL-URBAN MIGRATION} \]

Urban births is influenced by urban fertility. In the Philippines, urban fertility was 4.0 as of 1980.

\[ \text{UB}_K = \text{UP}_K \cdot \text{UF}_K \]

\[ \text{UB} = \text{URBAN BIRTHS} \]
\[ \text{UP} = \text{URBAN POPULATION} \]
\[ \text{UF} = \text{URBAN FERTILITY} \]

Urban fertility has been found to be lower in the urban areas than in the rural areas. In the model, a fertility multiplier is introduced to accommodate the effect of government efforts in family planning.

\[ \text{UF}_K = \text{UFN} \cdot \text{UFM}_K \]
\[ \text{UFM}_K = \text{TABXT} (\text{UFMT}, \text{SDCPCR}_K, .5, 6, 5) \]
\[ \text{UFMT} = 1.1/1/.92/.85/.79/.74/.70/.67/.65/.64/.634/.63 \]
\[ \text{UFN} = .04 \]
UF - URBAN FERTILITY

UFM - URBAN FERTILITY MULTIPLIER

SDCPCR - SOC. DEV. CAPITAL PER CAPITA RATIO

UFN - URBAN FERTILITY NORMAL

DMP uses the parameter called Social Development Capital per Capita (SDCPCR) to evaluate impact of added investment in social development on population. The assumed impact of SDCPCR on fertility multiplier is shown in Figure 5.5.

DMP contends that mortality is affected by the level of health care available and the quality of the environment.

UD.KL=UP.K*UM.K

UM.K=PMM.K*ULEM.K/ULEN

ULEN=64

ULEM.K=TABXT(ULEMT,SDCPCR.K,.5,6,.5)


PMM.K=TABXT(PMRT,POLR.K,0,10,1)

PMRT=1/1/1.005/1.013/1.025/1.043/1.07/1.11/1.16/

1.22/1.29

UD - URBAN DEATH

UM - URBAN MORTALITY

ULEN - URBAN LIFE EXPECTANCY NORMAL (YR)

ULEM - URBAN LIFE EXPECTANCY MULTIPLIER

SDCPCR - SOC. DEV. CAPITAL PER CAPITA RATIO
PMK - POLLUTION MORTALITY MULTIPLIER

Two parameters are used in the aforementioned equations to reflect the effects of social development investment and level of pollution. ULEM is dependent on the quality of the social sector. An increase in investment for health and nutrition will decrease the ULEM, thereby decreasing urban mortality. Figure 5.6 depicts the assumed relationship between these two factors. The other parameter used to indicate dependency of mortality on environment is the Pollution Mortality Multiplier. This relationship between level of pollution and mortality is pictured in figure 5.7.

As per capita income decreases due to an expansion of population, people would tend to move out of the area. Figure 5.8 portrays the assumed relationship between the ratio of per capita income to normal per capita income and emigration factor. An increase in the ratio will cause a corresponding decrease in the emigration multiplier, thereby decreasing the rate of emigration.

\[ ER_{KL} = UP_{K} \times EF \times EM_{K} \]

\[ EF = .001 \]

\[ EM_{K} = TABXT(EMT, PCI_{K}/P CIN, 0, 2, .25) \]

\[ EMT = 20/8/4/2/1/.85/.8/.8/.8 \]

The rate of immigration is modeled to include the ratio of natural immigration and the presence of the 'boat people',
FIGURE 5.8. EMIGRATION MULTIPLIER VS. RATIO OF PER CAPITA INCOME

FIGURE 5.9. RFM VS. SDCPCR
people who came from Vietnam and other neighboring Asian countries experiencing civil conflicts.

\[ IM.KL = CLIP(BP, 0, TIME.K, 1992) - CLIP(BP, 0, TIME.K, 1997) + WIM \]

\[ BP = 100 \]

\[ NIM = 1000 \]

\[ IM - IMMIGRATION \ (PERSONS/yr) \]
\[ BP - BOAT PEOPLE \ (PERSONS/yr) \]
\[ NIM - NATURAL IMMIGRATION \ (PERSONS./yr) \]

The rural demographic sub-sector is modeled similar to the urban sub-sector. Rural population is increased by rural births and decreased by rural deaths and rural-urban migration.

\[ RP.K = RP.J + (DT)(RB.JK - RD.JK - RUM.JK) \]

\[ RP - RURAL POPULATION \ (PERSONS) \]
\[ RB - RURAL BIRTHS \ (PERSONS./yr) \]
\[ RD - RURAL DEATHS \ (PERSONS./yr) \]
\[ RUM - RURAL-URBAN MIGRATION \ (PERSONS./yr) \]

In the Philippines, rural birth rate is higher than urban birth rate. The problem of high fertility is acute in the rural areas. Rural fertility is about 4.5 compared to the 4.0 recorded for the urban areas. As evidenced by figure 5.9, increase of SDCPCR will decrease rural fertility consequently slowing down population growth.

\[ RB.KL = RP.K \times RF.K \]
\[ RF.K = RFN \times RFM.K \]

69
RFM.K=TABXT(RFMT,SDCPCR.K,.5,.6,.5)

     .382/.372

RFN=0.06

RB - RURAL BIRTHS (PERSONS/yr)

RP - RURAL POPULATION

RF - RURAL FERTILITY

RFN - RURAL FERTILITY NORMAL

RFM - RURAL FERTILITY MULTIPLIER

Rural deaths is computed as the product of rural population and rural mortality. Rural mortality is decreased by increasing access of the rural sector to social services. Figure 5.10 shows the assumed dependency of rural life expectancy multiplier and SDCPCR.

RD.KL=RP.K*RM.K

RM.K=RLEM.K/RLEN

RLEM.K=TABXT(RLEMT,SDCPCR.K,.5,.6,.5)


RD - RURAL DEATHS (PERSONS/yr)

RM - RURAL MORTALITY (FRAC/yr)

RLEM - RURAL LIFE EXPECTANCY MULTIPLIER

The fraction of urban population is determined as the quotient of the urban population and the total population.

FPU.K=UP.K/TP.K
FIGURE 5.10. RLEM VS. EDCPCR

FIGURE 5.11. RUMM VS. REA RATIO
FPN - FRACTION URBAN POPULATION
UP - URBAN POPULATION
TP - TOTAL POPULATION

5.1.6 AGRICULTURE SECTOR

Considering the dominance of agriculture in the Philippines, agricultural development is a very essential part of any national economic plan.

The agricultural sector of DMP reflects the "bottom up" development strategy i.e., progressive modernization from the traditional sector itself.

One of the main resources for agricultural development is cheap and readily available labour. Yet, because of the disparity of incomes between agricultural and non-agricultural workers, rural-urban migration has decreased rural labor work force and increased urban labor force thereby exacerbating the problems of urban unemployment and congestion. This trend is reflected in the model.

RUN.KL=NRPG.K*RUMM.K
NRPG.K=RB.JK-RD.JK
RUMM.K=TABXT(RUMMT,REA.K/REAN.K,0,2,.5)
RUMMT=2/1.4/1/.75/.6

RUM - RURAL-URBAN MIGRATION (PERSONS/YR)
NRPG - NATURAL RURAL POPULATION GROWTH
RUMM - RURAL-URBAN MIGRATION MULTIPLIER
RB - RURAL BIRTHS
RD - RURAL DEATHS
REA - RELATIVE EARNINGS AGRICULTURAL
REAN - RELATIVE EARNING AGRICULTURAL NORMAL

The parameter Rural-Urban Migration Multiplier (RUMM) is used in the model to account for the changes in the pattern of migration as a result of the disparity in incomes. This difference in incomes is expressed in the model as Relative Earnings Agricultural (REA). It is the ratio of the earning of an agricultural worker to that of a non-agricultural worker. Figure 5.11 displays the assumed effect of the improvement or depreciation of agricultural income on migration.

\[ \text{REA}_K = \frac{\text{WEA}_K}{\text{WENA}_K} \]

REA - RELATIVE EARNINGS AGRICULTURAL
WEA - WORKER EARNING IN AGRICULTURE
WENA - WORKER EARNING IN NON-AGRICULTURE

Earnings of those in the non-agricultural sector is dependent on the total industrial capital and the number of jobs available.

\[ \text{WENA}_K = \sum (\text{IP}_K) / \text{JOBSNA} \]

WENA - WORKER EARNING NON-AGRICULTURAL
IP - INDUSTRIAL PRODUCT (PESOS/YR)
JOBSNA - JOBS NON-AGRICULTURE
The normal value of worker earnings in non-agricultural is dependent on the normal value of GNP and the size of the labor forces in both sub-sectors.

\[ W_{ENAN,K} = \frac{(GNPN,K - WEAN*RPN*RLPF)}{LFNAN} \]

RLPF = 0.36

\[ LFNAN = UPN*ULPF \]

Earnings of workers involved in agricultural labor is affected by the level of cultivation of the crop area and agricultural diversity. Worker earnings agricultural normal is assumed to be 5000 pesos a year.

\[ W_{EA,K} = WEAN*(CROPA.K/CROPAN)*(ADI.K/ADIN)* \]

\[ (A+ARCI*DT)**(TIME.K-1980) \]

\[ WEAN = 5000 \]

WEA - WORKER EARNINGS AGRICULTURAL

WEAN - WORKER EARNINGS AGRICULTURAL NORMAL

CROPA - CROP AREA (HA)

CROPAN - CROP AREA NORMAL (HA)

ADI - AGRICULTURAL DIVERSITY INDEX

ADIN - AGRICULTURAL DIVERSITY INDEX NORMAL

AROI - ANNUAL RATE OF INFLATION

Crop area is the product of the level of area cultivated and the multiple cropping index. At the base year it is assumed that there will be two cropping seasons per year. The model indicates that the number of croppings per
year may be improved as the level of agricultural investment is increased (Figure 5.12) and as the intensity of land use increases as depicted by Figure 5.13. Agricultural investment is derived from the GNP.

\[
\text{CROPA}_k = \text{CULTL}_k \times \text{MCI}_k
\]

\[
\text{MCI}_k = \text{TABXT}((\text{MCIMT}, \text{FGNPA}/\text{FGNPAN}, 0, 4, 1) \ast
\text{TABXT}((\text{MCIT}, \text{TIME}_k, 1980, 2050, 10)
\]

\[
\text{MCIT} = 2/2.6/3.0/3.4/3.4/3.5/3.5
\]

\[
\text{MCIMT} = 1/1.6/1.8/2.0/2.0
\]

\[
\text{FGNP} = .08
\]

\[
\text{FGNPAN} = .08
\]

CROPA - CROP AREA
CULTL - CULTIVATED LAND
MCI - MULTIPLE CROPPING INDEX
FGNPA - FRACT. GNP TO AGRICULTURE
FGNPAN-FRACT. GNP TO AGRICULTURE NORMAL

The normal value for crop area is taken to be equal to the product of the expanse of land initially cultivated and the initial multiple cropping index.

\[
\text{CROPN} = \text{CULTLN} \times \text{MCIN}
\]

\[
\text{CULTLN} = 15.6E6
\]

\[
\text{MCIN} = 2
\]

CROPN - CROP AREA NORMAL
CULTLN - CULTIVATED LAND INITIALLY
MCIN - MULTIPLE CROPPING INDEX NORMAL

75
FIGURE 5.12. AGRICULTURE DIVERSITY INDEX VS. TIME

FIGURE 5.13. MULTIPLE CROPPING INDEX MULTIPLIER VS. TIME
The agricultural diversity index (ADI) is an indicator of the variation of agricultural crops that are being cultivated. The parameter is assumed to increase as agriculture moves from the traditional crops to more export-oriented cultivation. Figure 5.14 shows the assumed trend used in this model. Initial value of ADI is 10.

\[ \text{ADI.K} = \text{TABXT(ADI.TIME.K,1980,2050,10)} \]

\[ \text{ADIT}=10/11.4/11.9/12.7/13.2/13.6/14/14.3 \]

\[ \text{ADIN}=10 \]

ADI - AGRICULTURAL DIVERSITY INDEX

ADIN - AGRICULTURAL DIVERSITY NORMAL

The level of food production as compared to population is measured by the Per Capita Crop Production Ratio (PCCPR). PCCPR indicates whether there has been an improvement in food production in the light of population growth compared to the status quo.

\[ \text{PCCPR.K} = \frac{\text{CROPA.K/TP.K}}{\text{CROPA/TPN}} \]

PCCPR - PER CAPITA CROP PRODUCTION RATIO

CROPA - CROP AREA

TP - TOTAL POPULATION

CROPA - CROP AREA NORMAL

TPN - TOTAL POPULATION NORMAL

Another parameter used to measure effectiveness of food production is by computing population per farmer.
FIGURE 5.14. AGRICULTURAL DIVERSITY INDEX VS. FGNPA RATIO

FIGURE 5.15. LPCM VS. UIL RATIO
$PPF.K = TP.K / LFA.K$

*PPF* - POPULATION PER FARMER  
*TP* - TOTAL POPULATION  
*LFA* - LABOR FORCE AGRICULTURE

The agricultural labor force increases with the population.

$LFA.K = RP.K \times RLPF$

*LFA* - LABOR FORCE AGRICULTURAL  
*RP* - RURAL POPULATION  
*RLPF* - RURAL LABOR PARTICIPATION FACTOR

The availability of agricultural land to be cultivated is affected by the rate of land conversion for industrial purposes.

$CULTL.K = CULTL.J - (DT)(LCR.JK)$

*CULTL* - CULTIVATED LAND (HA)  
*LCR* - LAND CONVERSION RATE

The rate of conversion of seen to be affected by the demand for industrial land.

$LCR.K = (UILR.K - UIL.K) / LCT$

$LCT = 5$

$UILR. = (TIC.K + TIF.K + TSDC.K) \times LPC.K + UP.K \times LPP.K)$

*LCR* - LAND CONVERSION RATE  
*UILR* - URBAN INDUSTRIAL LAND REQUIRED  
*UIL* - URBAN INDUSTRIAL LAND

79
LCI - LAND CONVERSION TIME
TIC - TOTAL INDUSTRIAL CAPITAL
TiF - TOTAL INFRASTRUCTURE CAPITAL
TSDC - TOTAL SOCIAL DEVELOPMENT CAPITAL
LPC - LAND PER CAPITAL
UP - URBAN POPULATION
LPP - LAND PER PERSON

The initial value of urban industrial land is dependent on the normal level of capital in industry, infrastructure and social development.

\[
UILN = ((ICN(1)+ICN(2)+ICN(3)+ICN(4))+(IFN(1)+IFN(2)+
IFN(3)+IFN(4)+IFN(5)+IFN(6)+IFN(7)+IFN(8))+
(SDCN(1)+SDCN(2)+SDCN(3)+SDCN(4)+SDCN(5)))\times LPCN + UPN\times LPPN
\]

LPCN = 1.2E-8
LPPN = .006

ILN - URBAN INDUSTRIAL LAND INITIAL
ICN(*) - INDUSTRIAL CAPITAL FOR EACH IND. SUB-SECTOR
IFN(*) - INFRA. CAPITAL FOR EACH INF. SUB-SECTOR
SDCN(*) - SOC. DEV. CAPITAL FOR EACH SUB-SECTOR
LPCN - LAND PER CAPITAL NORMAL
LPPN - LAND PER PERSON NORMAL

Land per capital decreases when more land is utilized for industries (figure 5.15). This can be seen as the effect
of decline in land availability and increase in land value.

\[ LPC.K = LPCN \times LPCM.K \]

\[ LPCM.K = TABXT(LPCMT, UIL.K/UILN, 0, 5, 1) \]

\[ LPCMT = 1.2/1/.9/.85/.82/.8 \]

\[ LPC - LAND PER CAPITAL \]

\[ LPCN - LAND PER CAPITAL NORMAL \]

\[ LPCM - LAND PER CAPITAL MULTIPLIER \]

\[ UIL - URBAN INDUSTRIAL LAND \]

\[ UILN - URBAN INDUSTRIAL LAND NORMAL \]

The available land per person is likewise affected by the level of industrial land utilized as shown in figure 5.16.

\[ LPP.K = LPPN \times LPPM.K \]

\[ LPPM.K = TABXT(LPPMT, UIL.K/UILN, 0, 5, 1) \]

\[ LPPMT = 1.2/1/.9/.85/.82/.8 \]

The total production in agriculture is the product of worker earnings in agriculture and the rural labor force.

\[ AP.K = WEA.K \times LFA.K \]

\[ AP - AGRICULTURAL PRODUCT \]

\[ WEA - WORKER EARNINGS AGRICULTURE \]

\[ LFA - LABOR FORCE AGRICULTURE \]
FIGURE 5.16. LPPM VS. UIL RATIO

FIGURE 5.17. IMPACT OF INDUSTRIAL INVESTMENT ON INDUSTRIAL EMPLOYMENT
The average farm size increases or decreases with population and total area cultivated.

\[ \text{AFS}_K = \left( \frac{\text{CULTL}_K}{\text{CULTLN}} \right) \times \left( \frac{\text{RPN}}{\text{RP}_K} \right) \times \text{AFSN} \]

\[ \text{AFSN} = 2.6 \]

- \text{AFS} - AVERAGE FARM SIZE
- \text{CULTL} - CULTIVATED AREA
- \text{CULTLN} - CULTIVATED AREA NORMAL
- \text{RPN} - RURAL POPULATION NORMAL
- \text{RP} - RURAL POPULATION
- \text{AFSN} - AVERAGE FARM SIZE NORMAL

5.1.7 EMPLOYMENT SECTOR

The employment sector of DMP estimates jobs generated in the industrial, infrastructure and social development sectors and the rate of unemployment.

In the industrial sector, the number of jobs created is computed for using the industrial capital corrected for inflation and the industrial capital-labor ratio.

\[ \text{JII}_K(\text{A}) = \frac{\text{ICCI}_K(\text{A})}{\text{ICLR}_K(\text{A})} \]

- \text{JI} - JOBS IN INDUSTRY
- \text{ICCI} - INDUSTRIAL CAPITAL CORRECTED FOR INFLATION
- \text{ICLR} - INDUSTRIAL CAPITAL-LABOR RATIO

Industrial capital-labor ratio is observed to increase as industrial investment accrues in a trend approximating that shown in figure 5.17. Initial value of industrial
capital-labor ratio is assumed equal to 200000 pesos, the estimated amount of capital necessary to create one job (7).

\[ \text{ICLR.K} = \text{ICLRN}(\text{A}) \times \text{ICLM}.K(\text{A}) \]
\[ \text{ICLRN}(\text{A}) = .20E6/.20E6/.20E6/.20E6 \]
\[ \text{ICLM}.K = \text{TABXT}(\text{ICLRT}(\text{A}), \text{ICCI.K}/\text{ICN}(\text{A}), 1, 8, 1) \]
\[ \text{ICLRT}(\text{A}, 1) = 1/1.5/1.96/2.38/2.76/3.10/3.4/3.66 \]
\[ \text{ICLRT}(\text{A}, 2) = 1/1.5/1.96/2.38/2.76/3.10/3.4/3.66 \]
\[ \text{ICLRT}(\text{A}, 3) = 1/1.5/1.96/2.38/2.76/3.10/3.4/3.66 \]
\[ \text{ICLRT}(\text{A}, 4) = 1/1.5/1.96/2.38/2.76/3.10/3.4/3.66 \]

ICLR - INDUSTRIAL CAPITAL-LABOR RATIO

ICLRN - INDUSTRIAL CAPITAL-LABOR RATIO NORMAL

ICLM - INDUSTRIAL CAPITAL-LABOR RATIO MULTIPLIER

ICLRT(\text{A}) - INDUSTRIAL CAPITAL-LABOR RATION TABLES

Jobs in infrastructure is dependent on the investment and infrastructure capital-labor ratio.

\[ \text{JIIF.K(B)} = \text{IFCI.K(B)}/\text{IFCLR.K(B)} \]

JIIF - JOBS IN INFRASTRUCTURE

IFCI - INFRA. CAPITAL CORRECTED FOR INFLATION

IFCLR - INFRA. CAPITAL-LABOR RATIO

The ratio of infrastructure capital to labor is affected by the level of infrastructure capital. To account for this effect, a parameter called Infrastructure Capital-Labor Ratio Multiplier (IFCLRM) is introduced in the
computation for IFCLR. In the model, it is assumed that an initial value of the ratio is 200000.

IFCLR.K = IFCLRN(B) * IFCLRM.K(B)


IFCLRM.K = TABXT(IFCLRT, IFFI.K/IFN(B), 1, 8, 1)

IFCLRT(*,1) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,2) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,3) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,4) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,5) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,6) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,7) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLRT(*,8) = 1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

IFCLR - INFRA. CAPITAL-LABOR RATIO

IFCLRN - INFRA. CAPITAL-LABOR RATIO NORMAL

IFCLRM - INFRA. CAPITAL-LABOR RATIO MULTIPLIER

IFFI - INFRA. CAPITAL CORRECTED FOR INFLATION

IFN - INFRA. CAPITAL NORMAL

IFCLRT(*) - INFRA. CAP.-LABOR RATIO MULT. TABLE VALUES

Jobs generated in the social development sector is increased by investment and decreased by social development capital-labor ratio.

JISD.K(C) = SDCCI.K(C)/SDCLR.K(C)

85
JISD - JOBS IN SOCIAL DEVELOPMENT

SDCCI - SOC. DEV. CAPITAL CORRECTED FOR INFLATION

SDCLR - SOC. DEV. CAPITAL-LABOR RATIO

A multiplier is likewise used to take into account the impact of social development investment on SDCLR. Figure 5.18 depicts this assumed effect of SDCLR on the multiplier.

SDCLR.K(C)=SDCLRN(C)*SDCLRM.K(C)

SDCLRN=0.20E6/.20E6/.20E6/.20E6/.20E6

SDCLRM.K(C)=TABXT(SDCLRT,SDCCI.K(C)/SDCN(C),1,8,1)

SDCLRT(*,1)=1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

SDCLRT(*,2)=1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

SDCLRT(*,3)=1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

SDCLRT(*,4)=1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

SDCLRT(*,5)=1/1.5/1.96/2.38/2.76/3.10/3.40/3.66

SDCLR - SOCIAL DEV.CAPITAL-LABOR RATIO

SDCLRN - SOCIAL DEVELOPMENT CAPITAL-LABOR RATIO NORMAL

SDCLRM - SOCIAL DEV. CAPITAL-LABOR RATIO MULT.

SDCCI - SOCIAL DEV. CAPITAL CORR. FOR INFLATION

SDCN - SOCIAL DEVELOPMENT CAPITAL NORMAL

The total number of jobs generated for urban employment is the sum of those available in the three sectors.

JOBSNA.K=TJII.K+TJIIF.K+TJISD.K

TJII.K=SUM(JII.K)

TJIIF.K=SUM(JIIF.K)

TJISD.K=SUM(JISD.K)
FIGURE 5.10.  SDCLR vs. SDCCI/SDCN
JOBSNA – JOBS NON-AGRICULTURE
TJI – TOTAL JOBS IN INDUSTRY
TJIIF – TOTAL JOBS IN INFRASTRUCTURE
TJISD – TOTAL JOBS IN SOCIAL DEVELOPMENT

The rate of unemployment is dependent on the number of available jobs and the size of the urban labor force.

\[ \text{UNEMNA.K} = \frac{\text{LFNA.K - JOBSNA.K}}{\text{LFNA.K}} \]

\[ \text{LFNA.K} = \text{UP.K} \times \text{ULPF} \]

\[ \text{ULPF} = .60 \]

UNEMNA – UNEMPLOYMENT NON-AGRICULTURE
LFNA – LABOR FORCE NON-AGRICULTURE
JOBSNA – JOBS NON-AGRICULTURE
UP – URBAN POPULATION
ULPF – URBAN LABOR PARTICIPATION FACTOR

5.2. REGIONAL MODEL

BUKID is a regional model developed using system dynamics methodology designed to evaluate impact of investments in agricultural infrastructure on the rural and urban sectors of the region. The model endeavors to emphasize increased rice & corn production, which typically have been grown in small operational units. It explores the impact of developing compact farming for rural development. Dynamic interplay between these two sectors are shown in Figure 5.19.
The rural sector is represented by three sub-sectors namely; demographic, agricultural, and transportation. The demographic sub-sector is designed to project level of rural population, the supply of labor force, and the housing stock of the rural area. The agricultural sector evaluates the cultivation level of the rice and corn industry, number of jobs generated in agriculture, and gross per capita income of agricultural workers, particularly the rice and corn farmers which constitute 80% of the total agricultural work force. The agricultural sub-sector is modeled to accommodate the impacts of the various infrastructures necessary for agricultural development namely; credit availability, agricultural technicians' availability, accessibility of farm inputs such as fertilizers and machines, and agrarian reform. The transportation sector emphasizes impact of road investment on effective travel time, road maintenance or deterioration, and ultimately its impact on agricultural yield.

The urban sector of the model is designed to incorporate the impacts due to investments in the rural region. It is subdivided into demographics, employment in urban business and services sectors, and urban housing.

Table 5.3 lists the different parameters used in BUKID to evaluate effectiveness of programs or policies that will be simulated in the model. These indicators enable the
user to identify needs for more equitable distribution of income. BUKID assumes that migration from the rural areas to urban areas is dependent on the availability of employment in the respective sectors.

BUKID is modeled to enable user to evaluate strategies involving land reform, feeder road construction, crop production credit policy, and agro-based industries.

5.2.1 RURAL DEMOGRAPHIC SUB-SECTOR

The rural demographic sector of the model is designed to project changes in the level of rural population, rural labor force, number of rice and corn farmers actively participating in agricultural activities, and the pattern of rural-urban migration.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>INDICATOR</th>
<th>VARIABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resources</td>
<td>Rural Population</td>
<td>RP</td>
</tr>
<tr>
<td></td>
<td>Urban Population</td>
<td>UP</td>
</tr>
<tr>
<td>Wealth</td>
<td>Average Value of Agricultural Products</td>
<td>AVAGP</td>
</tr>
<tr>
<td></td>
<td>Per Capita Income</td>
<td>PCI</td>
</tr>
<tr>
<td>Distribution of Wealth</td>
<td>Urban-Rural Unemployment Ratio</td>
<td>URUR</td>
</tr>
<tr>
<td>Land Resources</td>
<td>Compact Farmland Area</td>
<td>CFLA</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Rural Road Length</td>
<td>RRL</td>
</tr>
</tbody>
</table>

Table 5.3. BUKID Development Indicators
Rural population is increased by births and decreased by deaths and the rate of rural-urban migration. Because of inefficient and inaccessible health care programs rural fertility and mortality is higher than that of the urban region.

\[ RP.K = RP.J + (RB.JK - RD.JK - RUM.JK) \]
\[ RB.KL = RP.K \times RBRN \]
\[ RBRN = 0.04 \]
\[ RD.KL = RP.K \times RDRN \]
\[ RDRN = 0.008 \]

RP  - RURAL POPULATION
RB  - RURAL BIRTHS
RD  - RURAL DEATHS
RUM - RURAL - URBAN MIGRATION
RBRN - RURAL BIRTH RATE NORMAL
RDRN - RURAL DEATH RATE NORMAL

Rural-urban migration is brought about principally by people moving out of the agricultural area to seek better employment. BUKID reflects this theory by introducing a multiplier called Rural-Urban Migration Multiplier (RUMM). RUMM is directly affected by the extent of unemployment in the rural area in comparison to the urban area which is expressed in the model as Urban-Rural Unemployment Ratio (URUR).
RUM.KL=NRPG.K*RUMM.K
NRPG.K=RB.JK-RD.JK
RUMM.K=TABHL(RUMMT,URUR.K,0,2,.5)
RUMMT=2/1.4/.75/.6
URUR.K=UUR.K/RUR.K

RUM - RURAL-URBAN MIGRATION
NRPG - NATURAL RURAL POPULATION GROWTH
RUMM - RURAL-URBAN MIGRATION MULTIPLIER
URUR - URBAN-RURAL UNEMPLOYMENT RATIO

The size of the rural labor force is dependent on population and the fraction of rural population eligible for employment.

RLF.K=RP.K*RPPF
RPPF=0.30
RLF - RURAL LABOR FORCE
RPPF - RURAL POPULATION PARTICIPATION FACTOR

BUKID's primary target labor sector is the rice and corn farmers. The number of rice and corn farmers is dependent on the rate of new farmers joining the labor force and the rate of farmers leaving the force.

RCF.K=RCF.J+(DT)(NF.JK-FLR.JK)
RCFN=2150
RCF - RICE AND CORN FARMERS
RCFN - RICE AND CORN FARMERS NORMAL
The rate of new farmers joining the force is constrained by the desired number of farmers based on the expanse of compact farmland area cultivated and unemployment situation in the locality.

\[
NF.KL = DNF.K \times RURM.K
\]

\[
DNF.K = CFLA.K / DLPF
\]

\[
DLPF = 4
\]

\[
NF \quad - \quad NEW \quad FARMERS
\]

\[
DNF \quad - \quad DESIRED \quad NUMBER \quad OF \quad FARMERS
\]

\[
RURM \quad - \quad RURAL \quad UNEMPLOYMENT \quad RATE \quad MULTIPLIER
\]

\[
CFLA \quad - \quad COMPACT \quad FARMLAND \quad AREA
\]

\[
DLPF \quad - \quad DESIRED \quad LAND \quad PER \quad FARMER
\]

The Rural Unemployment Rate Multiplier (RURM) is assumed to increase as unemployment worsens in the pattern shown in figure 5.20.

\[
RUMM.K = TABHL(RUMMT, RUR.K / NUR, 0, 1, .1)
\]

\[
RUMMT = .1/ .1 / .2 / .5 / .8 / 1/ 1.2 / 1.4 / 1.5 / 1.8 / 2
\]

\[
NUR = 0.06
\]

\[
RUMM \quad - \quad RURAL \quad UNEMPLOYMENT \quad RATE \quad MULTIPLIER
\]

\[
RUR \quad - \quad RURAL \quad UNEMPLOYMENT \quad RATE
\]

\[
NUR \quad - \quad NORMAL \quad UNEMPLOYMENT \quad RATE
\]

The rate of farmers leaving rice and corn farming and switching to other forms of livelihood is affected by the ratio of agricultural to urban earnings. This relationship
is introduced in the model using a multiplier called Farmer Leaving Multiplier (FLM). Figure 5.21 displays the assumed relationship between FLM and Farmer to National Income Ratio (FTNIR).

\[ FLR.KL = RCF.K \times FLN \times FLM.K \]

FLN = 0.001

FLM.K = TABHL(FLMT, FTNIR.K, 0, 2, .2)

FTNIR.K = APPF.K/ANI

FLMT = 2/1.9/1.8/1.6/1.2/1/.58/.3/.2/.1/0

ANI = 30000

FLR - FARMER LEAVING RATE

FLN - FARMER LEAVING NORMAL

FLM - FARMER LEAVING MULTIPLIER

FTNIR - FARMER TO NATIONAL INCOME RATIO

ANI - AVERAGE NATIONAL INCOME

Average profit per farmer is dependent on the average profit per hectare and the amount of landholding per farmer.

APPF.K = PPH.K \times LPF

LPF = 2

APPF - AVERAGE PROFIT PER FARMER

LPF - LAND PER FARMER

The rural unemployment rate is dependent on the number of jobs created by farming activities, agro-based industries, and road construction.

\[ RUR.K = (RLF.K - (AJ.K + JFRC.K + EAB.K))/RLF.K \]
JFRC.K=(RCR.JK)*(JKR)

JKR=12

RUR - RURAL UNEMPLOYMENT RATIO
RLF - RURAL LABOR FORCE
AJ - AGRICULTURAL JOBS
JFRC - JOBS FROM ROAD CONSTRUCTION
EAB - EMPLOYMENT IN AGRO-BASED INDUSTRIES
JKR - JOBS PER KILOMETER ROAD

Availability of agricultural jobs is dependent on the extent of land cultivation. An increase in developed farming area produces an increase in agricultural jobs considering the number of workers needed per hectare remains the same.

AJ.K=CFLA.K*AWPH.K

AWPH.K=RLF.K/CFLA.K

AJ - AGRICULTURAL JOBS
CFLA - COMPACT FARM LAND AREA
AWPH - AVERAGE WORKERS PER HECTARE

Concomitant with an increase in population and agricultural activities is the expanding demand for housing units.

The number of housing units is increased by the rate of housing construction and decreased by the rate of deterioration of houses.

RH.K=RH.J+(DT)(RHC.JK-RHD.JK)

97
RHN=150

RH - RURAL HOUSING

RHN - RURAL HOUSING NORMAL

RHC - RURAL HOUSING CONSTRUCTION RATE (HOUSES/yr)

RHD - RURAL HOUSING DETERIORATION RATE (HOUSES/yr)

The rate of deterioration of houses is computed in the model as the product of the number of houses and the rural housing deterioration normal.

\[ \text{RHD}_{KL} = \text{RH}_K \times \text{RHDN} \]

\[ \text{RHDN} = 0.017 \]

RHD - RURAL HOUSING DETERIORATION

RH - RURAL HOUSING

RHDN - RURAL HOUSING DETERIORATION NORMAL

The rate of housing construction is spurred on by the demand for rural houses. In BUKID it is hypothesized that the demand for houses is increased as Rural Households-to-Houses Ratio (RHHR) increases. A parameter Rural Housing Construction Multiplier (RHCcm) is used to introduce this impact on the model. The relationship between these parameters is shown in figure 5.22.

\[ \text{RHC}_{KL} = \text{RH}_K \times \text{RHCN} \times \text{RHCcm}_K \]

\[ \text{RHCN} = 0.017 \]

\[ \text{RHCcm}_K = \text{TABHL} (\text{RHCmt}, \text{RHHR}_K, 0.2, .2) \]

\[ \text{RHHR}_K = \text{RP}_K / (\text{RH}_K \times \text{NPH}) \]

\[ \text{RHCmt} = 0.25 / .35 / .50 / .70 / 1 / 1.35 / 1.6 / 1.8 / 1.95 / 2 \]
FIGURE 5.22. RURAL HOUSING CONSTRUCTION MULTIPLIER VS.
DEMAND FOR RURAL HOUSES

FIGURE 5.23. IMPACT OF PROFITABILITY ON LAND CONVERSION
RATE
RHC - RURAL HOUSING CONSTRUCTION
RHCN - RURAL HOUSING CONSTRUCTION NORMAL
RHCM - RURAL HOUSING CONSTRUCTION MULT.
RHHR - RURAL HOUSEHOLDS-TO-HOUSES RATIO
RP - RURAL POPULATION
RH - RURAL HOUSES
NPH - NUMBER OF PERSONS/HOUSEHOLD

5.2.2 RURAL AGRICULTURAL SUB-SECTOR

The agricultural sub-sector of BUKID is comprised of the structures for land reform and compact farm development, rice and corn productivities and output, medium and short-term loans availability and credit crop policy, and agriculture-based industries.

LAND REFORM AND COMPACT FARM DEVELOPMENT

Under the land reform program, rice and corn lands are priorities in transfer. The expanse of potential land to be transferred decreases as transfer rate increases.

\[ PLT.K = PLT.J - (DT)(LTR.JK) \]

\[ PLTN = 2200 \]

PLT - POTENTIAL LAND FOR TRANSFER
PLTN - POTENTIAL LAND FOR TRANSFER INITIAL
LTR - LAND TRANSFER RATE
Land transfer rate is taken to be the smaller value between the transfer rate possible and the transfer rate desired.

\[ \text{LTR.KL} = \min(\text{LTRD.JK}, \text{LTRP.JK}) \]

**LTR** - LAND TRANSFER RATE  
**LTRD** - LAND TRANSFER RATE DESIRED  
**LTRP** - LAND TRANSFER RATE POSSIBLE

The land transfer rate possible is dependent on the amount of budget allocated to land reform and the costs involved.

\[ \text{LTRP.KL} = \frac{\text{LRBA.K}}{\text{LRC}} \]

**LRC** = 20000  
**LTRP** - LAND TRANSFER RATE POSSIBLE

**LRBA** - LAND REFORM BUDGET, ALLOCATION  
**LRC** - LAND REFORM COST (PESOS/HA)

**LAND CULTIVATION AND COMPACT FARM DEVELOPMENT**

Compact farm development is part of a rural development infrastructure aimed at empowering the rural populace. The farmers will have the advantages of bigger landholdings without losing ownership of their lands. BUKID assumes the size of the compact farm to be 25 hectares.

The number of compact farms is dependent on the compact farm conversion rate.
\[ NCF_k = NCF_j + \alpha (\text{DT})(\text{CFMR}_j k) \]

\[ NCFN = 80 \]

\textbf{NCF - NUMBER OF COMPACT FARMS}

\textbf{CFMR - COMPACT FARM CONVERSION RATE}

\textbf{NCFN - NUMBER OF COMPACT FARMS INITIAL}

The rate of conversion to compact farming is taken to be the lesser value between the compact farm conversion rate possible and the compact farm conversion rate desired.

\[ CFMR_{j k} = \min (CFMR_{p j k}, CFMR_{rd j k}) \]

\textbf{CFMR - COMPACT FARM CONVERSION RATE}

\textbf{CFMR}_{p j k} - COMPACT FARM CONVERSION RATE POSSIBLE

\textbf{CFMR}_{rd j k} - COMPACT FARM CONVERSION RATE DESIRED

The compact farm conversion possible is dependent on the availability of agricultural technicians, the number of compact farms that may be handled by a technician, and the impact of the profitability of compact farming in attracting potential farmers. The model considers profitability as one of the incentives that may encourage farmers to be involved. To accommodate this assumption, a parameter Rural Land Conversion Multiplier (RLCM) is introduced in the model. Figure 5.23 shows the relationship between RLCM and profitability as embodied in BUKID.

\[ CFMR_{p k} = \alpha \cdot CFMR_{r} \cdot CFMR_{p k} \]

\[ CFMR_{p k} = 14 \]
RLCM.K=TABHL(RLCMT,PPH.K/EFFH,0,2,.2)
RLCMT=.05/.1/.3/.4/.6/.8/1.5/1.6/1.7/1.8/2
CFCRP - COMPACT FARM CONVERSION RATE POSSIBLE
AT - AGRICULTURAL TECHNICIANS
CFHCFT - COMPACT FARM HANDLED BY COMPACT FARM TECH.
RLCM - RURAL LAND CONVERSION MULTIPLIER
PPH - PROFIT PER HECTARE
EFFH - EXPECTED PROFIT PER HECTARE

The compact farm conversion rate desired is determined
by the desired number of compact farms, the actual number of
compact farms, and compact farm conversion time.

CFCRD.KL=(DNCF-NCF.K)/CFCT
DNCF=860
CFCT=6

CFCRD - COMPACT FARM CONVERSION RATE DESIRED
DNCF - DESIRED NO. OF COMPACT FARMS
NCF - NUMBER OF COMPACT FARMS
CFCT - COMPACT FARM CONVERSION TIME

The total expanse of land under compact farming is the
product of the total number of compact farms and the size of
each compact farm which is taken to be 25 hectares.

CFLA.K=25*NCF.K
CFLA - COMPACT FARM LAND AREA
NCF - NUMBER OF COMPACT FARMS
FARM PRODUCTIVITY

The farm productivities considered in this section is that of rice and corn farmlands. It is assumed in this model that sufficient irrigation is already available in the area. Thus, production is assumed to be increased by farm mechanization, fertilizer application, agricultural technician availability and capital available for production. The effects of these parameters on yield per hectare is modeled through multipliers.

\[ \text{YPH.K} = \text{YPHN*FMM.K*FUM.X*ATM.K*CACFPM.K} \]

YPH - YIELD PER HECTARE
YPHN - YIELD PER HECTARE NORMAL
FMM - FARM MECHANIZATION MULTIPLIER
FUM - FERTILIZER USAGE MULTIPLIER
ATM - AGRI-TECH AVAILABILITY MULTIPLIER
CACFPM - CAPITAL AVAILABILITY-FARM PRODUCTIVITY MULT.

The dependency of farm productivity on farm mechanization is assumed to be that shown in figure 5.24.

\[ \text{FMM.K} = \text{TABHL(FMMT, AMU.K, 0,3,.5)} \]

FMMT=1/1.02/1.04/1.06/1.075/1.09/1.1
FMM - FARM MECHANIZATION MULTIPLIER
FMMT - FARM MECHANIZATION MULTIPLIER TABLE
AMU - AVERAGE MACHINERY USAGE
FIGURE 5.24. FMM VS. AMU

FIGURE 5.25. IMPACT OF AWPH ON FARMER AVAILABILITY MULTIPLIER
The average machinery usage is dependent on the level of machinery horsepower use and the total land area under cultivation. For this particular model, the total land area being developed is the compact farm land area.

\[ AMU.K = MHU.K / CFLA.K \]

AMU - AVERAGE MACHINERY USE
MHU - MACHINERY HP USE
CFLA - COMPACT FARM LAND AREA

The level of machinery use expressed in horsepower is augmented by the increase in machinery purchasing rate MHIR and decreased by the depreciation rate MHDR.

\[ MHU.K = MHU.J + (DT)(MHIR.JK - MHDR.JK) \]
\[ MHUN = 65 \]

MHU - MACHINERY HP USE
MHIR - MACHINERY HP INCREASE RATE
MHDR - MACHINERY HP DECREASE RATE
MHUN - MACHINERY HP USE NORMAL

The desired machinery horsepower increase rate is proportional to the difference between desired machinery usage intensity and the average machinery usage multiplied by the total area cultivated. It is inversely affected by the length of the implementation period.

\[ DMHIR.KL = (DMUI - AMU.K)(CFLA.K)/CFMIT \]
\[ DMUI = 2.78 \]
\[ CFMIT = 10 \]
DMHIR - DESIRED MACHINERY HP INCREASE RATE

DMUI - DESIRED MACHINERY USAGE INCREASE

AMU - AVERAGE MACHINERY USAGE

CFLA - COMPACT FARM LAND AREA

CFMIT - COMPACT FARM MECHANIZATION IMPLEMENTATION TIME

The possible machinery horsepower increase rate is dependent on the capital available for purchase of machines and the unit cost of farm machinery which is taken to be 25000 pesos.

PMHIR.KL=CFM.K/UCFM

UCFM=25000

PMHIR - POSSIBLE MACHINERY HP INCREASE RATE

CFM - CAPITAL FOR MECHANIZATION

UCFM - UNIT COST FOR MACHINERY (PESOS/YR)

The machinery horsepower increase rate is taken to be the smaller value between the possible machinery horsepower increase rate PMHIR and the desired machinery horsepower increase rate DMHIR, the value of which is multiplied with the Farmers Availability Multiplier (FAM).

MHIR.KL=MIN(PMHIR.JK,DMHIR.JK)*FAM.K

Farmer-availability multiplier is dependent on the total land area developed and the size of the rural labor force. Figure 5.25 represents the assumed dependency of the parameters.

FAM.K=TABHL(FAMT,AWPH.K,.5,2,.5)
FAMT=1.2/0.8/0.7/0.6

AWPH.K=RLF.K/CFLA.K

FAM - FARMER-AVAILABILITY MULTIPLIER
AWPH - AVERAGE WORKERS PER HECTARE
RLF - RURAL LABOR FORCE
CFLA - COMPACT FARM LAND AREA

Farm productivity is assumed to vary linearly with the level of fertilizer application. This relationship is introduced in the model using a variable Fertilizer Use Multiplier (FUM). Figure 5.26 shows the dependency of these two parameters.

FUM.K=TABHL(FUMT,FAL.K,0,1,0.02)

FUMT=1/1.02/1.04/1.06/1.08/1.1

FUM - FERTILIZER USE MULTIPLIER
FUMT - FERTILIZER USE MULTIPLIER TABLE
FAL - FERTILIZER APPLICATION LEVEL

Initial value of fertilizer application level is assumed to be zero in the model. It is gradually increased until desired level of application is achieved which in BUKID is assumed to be 0.09 metric tons per hectare per year.

FAL.K=FAL.J+(DT)(FALIR.JK)
FALIR.KL=((DFAL-FAL.K)/FALAT)(CAFAM)

DFAL=0.09
FALAT=6
FIGURE 5.26. FERTILIZER USE MULTIPLIER VS. FERTILIZER APPLICATION LEVEL

FIGURE 5.27. CAPITAL AVAILABILITY-FERTILIZER APPLICATION MULTIPLIER VS. CAPITAL AVAILABLE RATIO
FAL - FERTILIZER APPLICATION LEVEL
FALIR - FERTILIZER APPLICATION LEVEL INCREASE
DFAL - DESIRED FERTILIZER APPLICATION LEVEL
FALAT - FERTILIZER APPLICATION LEVEL ATTAINMENT TIME
CAFAM - CAPITAL AVAILABILITY-FERTILIZER APPLICATION MULT.

Capital availability for fertilizer application increases fertilizer application level as represented in figure 5. 27.

Concomitant with an improvement in yield per hectare is the potential increase of profit per hectare. In BUKID profit per hectare is increase by yield per hectare and selling price per ton of crop and decreased by farming costs.

\[ PPH.K = (YPH.K \times SPT) - CPH.K \]

PPH - PROFIT PER HECTARE
YPH - YIELD PER HECTARE
SPT - SELLING PRICE PER TON
CPH - COST OF FARMING PER HECTARE

Cost of farming consists of expenses for rent, labor, mechanical input, fertilizer, and transport.

\[ CPH.K = RCH.K + NLCH + NMICH + (FAL.K \times COF) + (FCOT \times YPH.K) \]

NLCH = 2000
NMICH = 2700
COF = 180
CPH - COST OF FARMING PER HECTARE

RCH - RENTAL COST PER HECTARE

NLCH - NORMAL LABOR COST PER HECTARE

NMICH - NORMAL MECHANICAL INPUT PER HECTARE

FAL - FERTILIZER APPLICATION LEVEL

COF - COST OF FERTILIZER

FCOT - FARMING COST OF TRANSPORTATION

YPH - YIELD PER HECTARE

The farming cost of transport is determined by the farming transport cost normal and the average road transport cost multiplier. This multiplier is affected by the ratio of the average road density and the desired road density.

FCOT.K=FTCN*ARTCM.K

FTCN=150

ARTCM.K=TABHL(ARTCMT,ARD.K/DRD,0,1,.1)

ARTCMT=1.5/1.45/1.4/1.35/1.3/1.2/1.1/1/.9/.85/.8

The normal rental cost is assumed to be constant until agrarian reform is fully implemented. At that time, rental cost will attain a value of zero.

RCH.K=CLIP(0,RCHN,TIME.K,LCT)

RCHN=400

RCH - RENTAL COST PER HECTARE (PESOS/HA)

LCT - LAND CONVERSION TIME (YR)
AGRO-BASED INDUSTRIES

Agro-based industries involve processing of agricultural products and fabrication of furniture and other wood products. Promotion of this class of industries has been observed to have considerable impact on employment and income in the rural sector.

The level of capital in agro-based industries is increase by the rate of capital realized in AB industries and decreased by the capital discard due to overhead costs involving production.

\[ \text{CAB}_K = \text{CAB}_J + (\Delta T)(\text{CARAB}_J - \text{CDAB}_J) \]

\[ \text{CABN} = 100000 \]

\text{CAB} - \text{CAPITAL IN AB INDUSTRIES}

\text{CABN} - \text{CAPITAL IN AB INDUSTRIES NORMAL}

\text{CARAB} - \text{CAPITAL ADD REALIZED IN AB INDUSTRIES}

\text{CDAB} - \text{CAPITAL DISCARD IN AB INDUSTRIES}

Considering the time elapsed between commitment of capital and the capital actually becoming productive, the rate of capital realized in AB is a third-order exponential delay. It is assumed that it takes two years before capital is realized.

\[ \text{CARAB}_{KL} = \text{DELAY}_3(\text{CAAB}_J, \text{DCARAB}) \]

\[ \text{DCARAB} = 2 \]

\text{CARAB} - \text{CAPITAL REALIZED IN AB INDUSTRIES}
CAAB - CAPITAL ADD IN AB INDUSTRIES
DCARAB - DELAY IN CAPITAL ADD IN AB INDUSTRIES

The average lifetime of capital in AB industries is taken to be 20 years. Thus, the rate of capital discard in AB industries is assumed to be 5% per year.

CDAB.KL = (CDRAB)(CAB.K)
CDRAB = .05

CDAB - CAPITAL DISCARD IN AB INDUSTRIES
CDRAB - CAPITAL DISCARD RATIO IN AB INDUSTRIES
CAB - CAPITAL IN AB INDUSTRIES

The amount of capital added annually in AB industries is dependent on the current level of capital in AB industries, the "normal" capital add, and the capital add multiplier. This capital add multiplier incorporates into the model the effect of demand-production ratio in attracting more capital in AB industries. Figure 5.28 represents the assumed relationship between these two parameters.

CAAB.KL = CAB.K * CANAB * CAMAB.K
CANAB = 0.10
CAMAB.K = TABHL(CAMTAB, DPRAB.K, .5, 2, .5)
CAMTAB = 0.5/1/1.2/1.4

The demand-production ratio is taken to be the quotient of the perceived demand and the production in AB industries.
FIGURE 5.28. CAMTAB VS. DPRAB

FIGURE 5.29. RAM VS. AVERAGE ROAD DENSITY

114
DPRAB\_K=DMPAB\_K/PAB\_K

DPRAB - DEMAND-PRODUCTION RATIO IN AB INDUSTRIES
DMPAB - DEMAND PERCEIVED IN AB INDUSTRIES
PAB - PRODUCTION AB INDUSTRIES

Production in agro-based industries is seen to be dependent on the perceived demand and the production capacity in AB industries. Actual production is the minimum between these two parameters.

PAB\_K=\min(DMPAB\_K,PCAB\_K)

PAB - PRODUCTION IN AB INDUSTRIES
DMPAB - DEMAND PERCEIVED IN AB INDUSTRIES
PCAB - PRODUCTION CAPACITY IN AB INDUSTRIES

Perception of demand for agro-based industries' products and the consequent production process takes time. BUKID assumes the delay to be equal to 9 months for want of a more accurate estimate. An initial value of the perceived demand is taken to be 300000 Pesos.

DMPAB\_K=DMPAB\_J+(DT/DDMPAB)\(DMAB\_J-DMPAB\_J\)

DMPAB=30000
DDMPAB=.75

DMPAB - DEMAND PERCEIVED IN AB INDUSTRIES
DDMPAB - DELAY IN DEMAND PERCEPTION IN AB INDUSTRIES
DMAB - DEMAND IN AB INDUSTRIES
Demand in AB industries' products is dependent on the local and export demand.

\[ DMAB_K = EDMAB_K + LDMAB_K \]

**DMAB** - DEMAND IN AB INDUSTRIES

**EDMAB** - EXPORT DEMAND IN AB INDUSTRIES

**LDMAB** - LOCAL DEMAND IN AB INDUSTRIES

The local demand for agro-based industries' products is taken to be dependent on the total rural population, a fraction called Demand Factor in AB Industries (DMFAB), and the per capita income.

\[ LDMAB_K = (RP.K)(DMFAB)(PCI.K) \]

**DMFAB** = 0.05

**RP** - RURAL POPULATION

**DMFAB** - DEMAND FACTOR IN AB INDUSTRIES

**PCI** - PER CAPITA INCOME

The export demand is dependent on the rate of change in export demand in AB industries. Initial export demand for AB industries' products is 250000 pesos.

\[ EDMAB_K = EDMAB_J + (DT)(CEDMAB.JK) \]

**EDMAB** = 250000

**CEDMAB** - CHANGE IN EXPORT DEMAND IN AB INDUSTRIES

The rate of change in export demand is increase by corresponding increase in export market growth in AB
industries and the existing export demand.

CEDMAB.KL=EMGAB.K*EDMAB.K

CEDMAB - CHANGE IN EXPORT DEMAND IN AB INDUSTRIES
EMGAB - EXPORT MARKET GROWTH IN AB INDUSTRIES
EDMAB - EXPORT DEMAND IN AB INDUSTRIES

Growth of export market is dependent on the existing growth rate of the industries, the relative cost index, and the cost elasticity in AB industries. The relative cost index is a parameter used to indicate the relative attractiveness of the industries and the relative cost index defines how this attractiveness affects the growth of AB industries. A growth rate of 4.5 per cent for the industries is reflected in BUKID.

EMGAB.K=MGAB*(1+(CEAB)*(1-RCIAB.K))

MGAB=0.045
CEAB=0.040

EMGAB - EXPORT MARKET GROWTH IN AB INDUSTRIES
MGAB - MARKET GROWTH IN AB INDUSTRIES
CEAB - COST ELASTICITY IN AB INDUSTRIES
RCIAB - RELATIVE COST INDEX IN AB INDUSTRIES

The relative cost index is the weighted sum of fixed costs, transportation costs, and labor costs. Weights assigned to each of these components depend on the relative
importance of the different costs to AB industries. Labor costs depend on the relative wage, while transportation costs are computed based on the proximity and accessibility of the industries' market and raw materials.

\[
RCIAB.K = WCCPAB + WRMAAB/RMAAB.K + WMAAB/MAAB.K + WLCAB*RW.K
\]

\[
WCCPAB = 0.763
\]

\[
WRMAAB = 0.023
\]

\[
WMAAB = 0.016
\]

\[
WLCAB = 0.198
\]

**RCIAB** - RELATIVE COST INDEX IN AB INDUSTRIES

**WCCPAB** - WEIGHTAGE OF CONSTANT COST OF PRODUCTION IN AB INDUSTRIES

**WRMAAB** - WEIGHTAGE OF RAW MATERIAL ACCESSIBILITY IN AB INDUSTRIES

**RMAAB** - RAW MATERIAL ACCESSIBILITY IN AB INDUSTRIES

**WMAAB** - WEIGHTAGE OF MARKET ACCESSIBILITY IN AB INDUSTRIES

**MAAB** - MARKET ACCESSIBILITY IN AB INDUSTRIES

**WLCAB** - WEIGHTAGE OF LABOR COST IN AB INDUSTRIES

**RW** - RELATIVE WAGE

The accessibility of raw material is a function of the average road density in the area. The dependency between regional mobility as represented by the average road density and raw material accessibility in AB industries is represented in figure 5.29.
RMAAB.K=TABHL(RAMTAB,ARD.K,0,1,.5)
RAMTAB=.01/1/1.5

**RMAAB** - **RAW MATERIAL ACCESSIBILITY IN AB INDUSTRIES**
**ARD** - **AVERAGE ROAD DENSITY**
**RAMTAB** - **RAW MATERIAL ACCESSIBILITY TABLE IN AB IND.**

Likewise, market accessibility in AB industries is dependent on the average road density in the manner shown in figure 5.30.

MAAB.K=TABHL(MAABT,ARD.K,0,1,.5)
MAABT=.01/1/1.5

**MAAB** - **MARKET ACCESSIBILITY IN AB INDUSTRIES**
**ARD** - **AVERAGE ROAD DENSITY**
**MAABT** - **MARKET ACCESSIBILITY IN AB INDUSTRIES TABLE**

The production capacities in AB industries is dependent on the capital in AB industries and a fraction called Capital Output Factor in AB Industries (COFAB). It is assumed in the model that no depreciation of the capital occurs. This assumption eliminates the task of disaggregating the capital stock and other pertinent parameters.

PCAB.K=CAB.K/COFAB.K

**PCAB** - **PRODUCTION CAPACITY IN AB INDUSTRIES**
**CAB** - **CAPITAL IN AB INDUSTRIES**
**COFAB** - **CAPITAL OUTPUT FACTOR IN AB INDUSTRIES**

119
FIGURE 5.30. MAAB VS. AVERAGE ROAD DENSITY

FIGURE 5.31. AGSAVF VS. PER CAPITA INCOME
The capital output factor represents the length of time in years to get an output of one peso for every one peso invested. For want of a more recent assumption, an average value of 4 months is assumed based on the study done in the Bicol area.

\[ \text{COFAB.K} = \text{COFAB.J} + (\text{DT})(\text{CCOFAB.JK}) \]

\[ \text{COFAB} = 0.33 \]

\[ \text{COFAB} = \text{CAPITAL OUTPUT FACTOR IN AB INDUSTRIES} \]

\[ \text{CCOFAB} = \text{CHANGE IN CAPITAL OUTPUT FACTOR IN AB IND.} \]

The change in capital-output factor in AB industries is assumed to increase with the passage of time and technological advancement. This implies that through the years the time required to produce an output of one peso for every one peso input will increase. BUKID reflects a 1.5% annual rate of capital deepening.

\[ \text{CCOFAB.KL} = \text{CCOFRAB} \times \text{COFAB.K} \]

\[ \text{CCOFRAB} = 0.015 \]

\[ \text{CCOFAB} = \text{CHANGE IN CAPITAL-OUTPUT FACTOR IN AB IND.} \]

\[ \text{CCOFRAB} = \text{CHANGE IN CAPITAL-OUTPUT FACTOR FRACTION IN AB INDUSTRIES} \]

\[ \text{COFAB} = \text{CAPITAL-OUTPUT FACTOR IN AB INDUSTRIES} \]

The transportation requirements for AB industries is dependent on the production in agro-based industries expressed in metric tons per year. The production in agro-based industries is measured based on the number of
employees and the production per person per year. It is the assumption of the model that one worker produces an average of 20000 metric tons per year.

\[ \text{ABP}_K = \text{EAB}_K \times \text{PEPAB} \]

\[ \text{PEPAB} = 20000 \]

**ABP** - AGRO-BASED INDUSTRIES PRODUCTION (MT/yr)

**PEPAB** - PER EMPLOYEE PRODUCTION IN AB INDUSTRIES

**EAB** - EMPLOYMENT IN AB INDUSTRIES

Employment in AB industries is dependent on the production in agro-based industries and labor-output factor in AB industries.

\[ \text{EAB}_K = \text{PAB}_K / \text{LOFAB}_K \]

**EAB** - EMPLOYMENT IN AB INDUSTRIES

**LOFAB** - LABOR-OUTPUT FACTOR IN AB INDUSTRIES

The labor-output factor is increased or decreased by the change in labor-output factor in AB industries. An initial value of 50000 is assumed for labor-output factor for the base year.

\[ \text{LOFAB}_K = \text{LOFAB}_{J+}(DT)(\text{CLOFAB}_{JK}) \]

\[ \text{LOFAB} = 50000 \]

**LOFAB** - LABOR-OUTPUT FACTOR IN AB INDUSTRIES

**CLOFAB** - CHANGE IN LABOR-OUTPUT FACTOR IN AB IND.

The change in labor-output factor is brought about passage of time and technological advancement. It is
dependent on the existing labor-output factor and a factor called capital-labor factor fraction in AB industries. A 1% annual rate of change is assumed.

CLOFAB.KL=CLOFRAB*LOFAB.K
CLOFRAB= 0.01

CLOFAB - CHANGE IN LABOR-OUTPUT FACTOR IN AB IND.
CLOFRAB - CHANGE IN LABOR OUTPUT FACTOR FRACTION IN AB INDUSTRIES
LOFAB - LABOR-OUTPUT FACTOR IN AB INDUSTRIES

AGRICULTURAL CREDIT

This agricultural sub-sector of the model deals with the available medium-term and short-term agricultural loans and the credit extended for crop production.

Medium-term agricultural loans are made available for farm mechanization. The level of medium-term loan in the locality is increased by the rate of receiving loans and decreased by the rate of loan repayments. Initial value of Agricultural Outstanding Medium-term Loan (AOMTL)

AOMTL.K=AOMTL.J + (DT)(AMTLRR.JK-AMTLRPR.JK)
AOMTL=0

AOMTL - AGRI. OUTSTANDING MEDIUM-TERM LOAN
AMTLRR - AGRI. MEDIUM-TERM LOAN RECEIVING RATE
AMTLRPR - AGRI. MEDIUM-TERM LOAN REPAYMENT RATE
The rate of repayment for medium-term agricultural loans is dependent on the existing level of outstanding medium-term loan and the medium-term loan repayment time. Repayment time for medium-term loan is taken to be 4 years.

\[ \text{AMTLRPR.KL} = \frac{\text{AOMTL.K}}{\text{MTLRT}} \]

\[ \text{MTLRT} = 4 \]

\[ \text{AMTLRPR} \quad \text{- AGRI. MEDIUM-TERM LOAN REPAYMENT RATE} \]

\[ \text{AOMTL} \quad \text{- AGRI. OUTSTANDING MEDIUM-TERM LOAN} \]

\[ \text{MTLRT} \quad \text{- MEDIUM-TERM LOAN REPAYMENT TIME} \]

The rate of receiving for agricultural medium-term loan is dependent on the rate of agriculture medium-term loan receiving rate initial and the trend of agriculture loan receiving rate.

\[ \text{AMTLRR.KL} = \frac{\text{AMTLRRN*TAMLRR.K}}{\text{AMTLRRN} \times 4500} \]

\[ \text{AMTLRRN} = 4500 \]

\[ \text{AMTLRR} \quad \text{- AGRI. MEDIUM-TERM LOAN RECEIVING RATE} \]

\[ \text{AMTLRR1} \quad \text{- AGRI. MEDIUM-TERM LOAN RECEIVING RATE 1} \]

\[ \text{AMTLRR2} \quad \text{- AGRI. MEDIUM-TERM LOAN RECEIVING RATE 2} \]

\[ \text{AMTLRRR} \quad \text{- AGRI. MEDIUM-TERM LOAN RECEIVING RATE INITIAL} \]

Trend in agriculture medium-term loan repayment period is a function of time. It increases for every increment of simulation period and assumed to retain the value of the last simulation period.
TAMLTR K=TABHL(TAMLTR,TIME,K,0,6,1)

TAMLTR=1/1.2/1.5/1.07/1.16/1.35

TAMLTR - TREND IN AGRI. MEDIUM-TERM LOAN RECEIVING RATE
TAMLTRT - TREND IN AGRI. MEDIUM-TERM LOAN RECEIVING RATE TABLE

The indicated available medium-term credit is dependent on the receiving rate and the repayment rate of the loan. However, in the event that the repayment rate is higher than the receiving rate, then the underlying assumption in BUKID is that there is no available credit.

AMTACI.K=AMTLRR.JK-AMTLRPR.JK

AMTAC.K=AMTLRR.JK

AMTACI - AGRI. MEDIUM-TERM AVAILABLE CREDIT INDICATED
AMTLRR - AGRI. MEDIUM-TERM LOAN RECEIVING RATE
AMTLRPR - AGRI. MEDIUM-TERM LOAN REPAYMENT RATE
AMTAC - AGRI. MEDIUM-TERM AVAILABLE CREDIT

The amount of agriculture medium-term credit available for farm mechanization is described as the product of the total available medium-term loan and a fraction called Fraction of Capital for Farm Mechanization (FCFM). This fraction is assumed to be equal to 0.60 for the study area.

CFM.K=(FCFM)(AMTAC.K)

FCFM =0.60

CFM - CAPITAL FOR FARM MECHANIZATION
FCFM - FRACTION OF CAPITAL FOR FARM MECHANIZATION

AMTAC - AGRI. MEDIUM-TERM AVAILABLE CREDIT

Short-term agricultural loans are made available for commodity production costs and for paying short-term investment such as purchase of seeds, repairs on farms and other non-farm inputs.

The level of short-term agricultural loans is increased by the rate of receiving and decreased by the repayment rate. The initial value of outstanding short-term loan is taken to be equal to 0.

\[ \text{AOSTL.K} = \text{AOSTL.J} + (\text{DT})(\text{ASTLRR.JK-ASTPR.JK}) \]

\[ \text{AOSTL=0} \]

AOSTL-AGRI. OUTSTANDING SHORT-TERM LOAN

ASTLRR - AGRI. SHORT-TERM LOAN RECEIVING RATE

ASTLRPR - AGRI. SHORT-TERM LOAN REPAYMENT RATE

The rate of repayment for short-term agricultural loans is dependent on the existing level of outstanding short-term loan, the repayment period for short-term loans which on the average is equal to one year, and a fraction called Agriculture Short-term Loan Repayment Fraction (ASTLRF).

\[ \text{ASTLRPR.KL} = (\text{AOSTL.K}/\text{STLRT}) \times \text{ASTLRF} \]

\[ \text{ASTLRF=0.2} \]

\[ \text{STLRT=1} \]

ASTLRPR - AGRI-SHORT-TERM LOAN REPAYMENT RATE

AOSTL - AGRI. OUTSTANDING SHORT-TERM LOAN
STLRT - SHORT-TERM LOAN REPAYMENT TIME

ASTLRF - AGRI. SHORT-TERM LOAN REPAYMENT FRACTION

The rate of receiving for short-term agricultural loans is taken as the product of initial value of agricultural short-term loan receiving rate and the trend of of loan receiving rate in the area.

ASTLRR.KL=ASTLRRN*TASTLR.K

ASTLRRN=50000

TASTLR.K=TABHL(TASTLRT,TIME.K,0,6,1)

TASTLRT=1/2.18/3.18/3.64/4.35/4.34

ASTLRR - AGRI SHORT-TERM LOAN RECEIVING RATE

ASTLRRN - AGRI SHORT-TERM LOAN RECEIVING RATE INITIAL

TASTLR - TREND IN AGRI SHORT-TERM LOAN RECEIVING RATE

Available short-term loan is given by the sum of the short-term receiving rate and agricultural savings allocated for re-investment.

ASTAC.K=ASTLRR.JK+AGSAVRI.K

ASTAC - AGRI. SHORT-TERM LOAN AVAILABLE

ASTLRR - AGRI. SHORT-TERM LOAN RECEIVING RATE

AGSAVRI - AGRICULTURAL SAVINGS FOR REINVESTMENT

Agricultural savings for reinvestment is dependent on the agricultural savings incurred by the area and the fraction of this savings allocated for re-investment which is assumed to be equal to 35% in the model.
AGSAVRI.K=FSAGI*AGSAV.K

FSAGI=.35

AGSAVRI - AGRICULTURAL SAVINGS FOR REINVESTMENT
FSAGI - FRACTION OF AGRI. SAVINGS FOR RE-INVESTMENT
AGSAV - AGRICULTURAL SAVINGS

The value of agricultural savings is dependent on the average value of agricultural products and the fraction of this value set aside for agricultural savings. The fraction of the average value of agricultural products allocated for savings is based on the rural per capita income. The dependency of the fraction of agricultural savings on per capita income is shown in figure 5.31.

AGSAV.K=AGSAVF.K*AVAGP.K

AGSAVF.K=TABHL(AGSAVFT,PCI.K,600,3600,600)

AGSAVFT=0/.05/.1/.15/.2

AGSAV - AGRI. SAVINGS
AGSAVF - AGRI. SAVINGS FRACTION
AVAGP - AVERAGE VALUE OF AGRICULTURAL PRODUCTS
PCI - PER CAPITA INCOME

Average value of agricultural products is determined by the net amount of unmilled crop for marketing, the selling price per ton, and the production in AB industries.

AVAGP.K=((UMCPR.JK-UMCL.JK)-(RP.K*RPCP))*SPT + PAB.K

RPCP=0.10

128
AVAGP - AVERAGE VALUE OF AGRICULTURAL PRODUCTS
UMCPPR - UNMILLED CROP PRODUCTION RATE (METRIC TONS/yr)
UMCL - UNMILLED CROP LOSS
RP - RURAL POPULATION
RPCP - RURAL POPULATION PER CAPITAL CONSUMPTION
SPR - SELLING PRICE PER TON
PAB - PRODUCTION IN AB INDUSTRIES

Unmilled crop production rate is dependent on yield per hectare and the total land cultivated.

UMCPPR.KL=YPH.K*MIN(CFLA.K,FLA)
FLA=35000

UMCPPR - UNMILLED CROP PRODUCTION RATE (METRIC TONS/yr)
YPH - YIELD PER HECTARE (MT/HA)
CFLA - COMPACT FARM LAND (HA)
FLA - FARM LAND AREA (HA)

After production loss is stimulated by the unmilled crop production rate and decreased by a corresponding increase in unmilled crop transport rate.

UMCL.K=UMCL.J+(DT)(UMCPPR.JK-UMCTR.JK)
UMCLN=0.12

UMCL - UNMILLED CROP LOSS (MT/yr)
UMCPPR - UNMILLED CROP PRODUCTION RATE (MT/yr)
UMCTR - UNMILLED CROP TRANSPORT RATE (MT/yr)
The per capita income of the rural population is the average value of agricultural products divided by the rural population.

$$PCI.K = \frac{AVAGP.K}{RP.K}$$

PCI - PER CAPITA INCOME

AVAGP - AVERAGE VALUE OF AGRICULTURAL PRODUCTS

RP - RURAL PRODUCTS

The credit available for crop production is the product of the agricultural short-term available credit and the fraction of the credit used for crop production which in the model is assumed to be about 90%.

$$CCP.K = (FCCP)(ASTAC.K)$$

FCCP = .90

CCP - CREDIT CROP PRODUCTION

FCCP - FRACTION FOR CREDIT CROP PRODUCTION

ASTAC - AGRI. SHORT-TERM AVAILABLE CREDIT

5.2.3 RURAL TRANSPORTATION SUB-SECTOR

The emphasis of BUKID is the evaluation of the impact of the construction of sufficient and efficient farm-to-market road networks on productivity and regional mobility. Regional mobility is expressed as the ratio of the average road density. The transportation sub-sector incorporates the impact of travel time on the transport capacity which in
turn affects after-production losses.

The total length of farm-to-market roads is increased by the rate of road construction. Initial length of rural roads is equal to 25 kilometers.

\[ RRL.K = RRL.J + (DT)(RCR.JK) \]

\[ RRLN = 25 \]

\[ RRL - RURAL ROAD LENGTH (KM) \]

\[ RCR - ROAD CONSTRUCTION RATE (KM/yr) \]

The actual rate of road construction is determined by the demand for road or to the road construction fund available divided by the road construction cost per kilometer. The smaller value between the two parameters is adopted by the model, multiplied by the rural road land availability multiplier and divided by the length of road construction period to obtain rate of construction. An average construction time of 6 years is reflected in the model.

\[ RCR.KL = \text{MIN}(DFR.K, RCB.K/RCC) \times RRLAM/RCT \]

\[ RCT = 6 \]

\[ RCR - ROAD CONSTRUCTION RATE \]

\[ DFR - DEMAND FOR ROAD \]

\[ RCB - ROAD CONSTRUCTION BUDGET \]

\[ RCC - ROAD CONSTRUCTION COST \]
RRLAM - RURAL ROAD LAND AVAILABILITY MULT.

RCT - ROAD CONSTRUCTION TIME

In the simulation, a desired road length is determined based on the desired road density. It is assumed that once this desired value is obtained, construction will no longer be necessary thus will cease to occur in the model.

\[ \text{DFR.K} = \text{DRL.K} - \text{RRL.K} \]

\[ \text{DRL.K} = (\text{DRD} \times \text{CFLA.K}) \times 0.01 \]

\[ \text{DRD} = 0.70 \]

DFR - DEMAND FOR ROAD

DRL - DESIRED ROAD LENGTH (KM)

RRL - RURAL ROAD LENGTH (KM)

DRD - DESIRED ROAD DENSITY (KM/SQ. KM)

CFLA - COMPACT FARMLAND AREA (HA)

The actual road density is determined by the total road length and the existing compact farm land area.

\[ \text{ARD.K} = (\text{RRL.K} / \text{CFLA.K}) \times 100 \]

ARD - ACTUAL ROAD DENSITY

RRL - RURAL ROAD LENGTH

CFLA - COMPACT FARMLAND AREA

Another factor that constrains the construction of roads is the road land availability. A multiplier called rural road land availability multiplier (RRLAM) is utilized in BUKID to incorporate the impact of land availability on construction of roads. The multiplier is dependent on the
road land fraction occupied. Figure 5.32 shows the assumed dependency between the two parameters.

\[ RRLAM.K = \text{TABHL}(RRLAMT, RDLFO.K, 0, 1, 2) \]

\[ RRLAMT = 1/1.3/1.45/1.3/.5/0 \]

- \text{RRLAM} - RURAL ROAD LAND AVAILABILITY MULTIPLIER
- \text{RDLFO} - ROAD LAND FRACTION OCCUPIED

The rural land fraction occupied is equal to the length of the rural road multiplier by the average right-of-way and divided by the total road land available in the area. For the study area, the road land area available is estimated to be 1200 hectares

\[ RDLFO.K = (RRL.K \times AROW) / RDLA \]

\[ AROW = 2.5 \]

\[ RDLA = 1200 \]

- \text{RDLFO} - ROAD LAND FRACTION OCCUPIED
- \text{RRL} - RURAL ROAD LENGTH
- \text{AROW} - AVERAGE RIGHT-OF-WAY (HA/KM)
- \text{RDLA} - ROAD LAND AVAILABLE (HA)

More pertinent to the computation of effective travel time is the length of roads in good working condition. This length is quantified in the model using the equation for effective road length.

\[ ERRL.K = ERRL.J + (DT)(RCR.JK - RDR.JK) \]

- \text{ERRL} - EFFECTIVE ROAD LENGTH
- \text{RCR} - ROAD CONSTRUCTION RATE
**Figure 5.32.** RRLAM vs. RDLO

**Figure 5.33.** ROAD MAINTENANCE MULTIPLIER vs. MAINTENANCE FUND PER KILOMETER
RDR - ROAD DETERIORATION RATE

Rate of road deterioration is dependent on the degree of maintenance exercised in the area and the total number of daily truck trips. The impact of road maintenance on road deterioration is incorporated into the model through a multiplier called Road Maintenance Multiplier. This multiplier is dependent on the road maintenance budget and the maintenance cost per kilometer of road. Figure 5.33 graphs the relationship between these parameters.

\[
RDR.KL = RRL.K / (ARUL*RMM.K*TTM.K)
\]

\[
ARUL = 10
\]

\[
RMM.K = TABHL(RMMT, MFPK.K/MCPK, 0, 1, 2)
\]

\[
RMMT = 1/1.4/1.65/1.8/1.9/2
\]

\[
MCPK = 17104
\]

RDR - ROAD DETERIORATION RATE (KM/YP)

RRL - RURAL ROAD LENGTH (KM)

ARUL - AVERAGE ROAD USEFUL LIFE (YR)

RMM - ROAD MAINTENANCE MULTIPLIER

TTM - TRUCK TRIPS MULTIPLIER

MFPK - MAINTENANCE FUND PER KILOMETER

MCPK - MAINTENANCE COST PER KILOMETER

Maintenance fund available per kilometer is dependent on the total maintenance fund divided by the existing rural road length.
MFPK,K=RMB,K/RRL,K

MFPK - MAINTENANCE FUND PER KILOMETER
RMB - ROAD MAINTENANCE BUDGET
RRL - RURAL ROAD LENGTH

The truck trip multiplier which considers the effect of frequency of road use on road deterioration is dependent on the number of daily truck trips and the design average daily traffic. Figure 5.34 graphs the dependency of these parameters.

TTM,K=TAHBL(TTMT,(TT.K/300)/DADT,0,2,.2)
TTMT=2/2/1.8/1.6/1.4/1.9/.8/.5/.3/.2
DADT=100
TTM - TRUCK TRIP MULTIPLIER
TT - TRUCK TRIPS
DADT - DESIGN AVERAGE DAILY TRAFFIC (TRUCK TRIPS/DAY)

The level of the rural road fund is dependent on the road funding rate. This fund is used for both construction and maintenance of the farm-to-market roads. The source of this fund is considered to be distinct.

RF,K=RF,J+(DT)(RFR.JK)
RFR,KL=RF,K*RFRN
RFRN=1000000
RF - ROAD FUNDS
RFR - ROAD FUNDING RATE
**Figure 5.34.** Impact of truck trips daily on road deterioration

**Figure 5.35.** Demand for road multiplier vs. actual-to-desired road density ratio
RFRN - ROAD FUNDING RATE NORMAL

The amount of road fund allocated to construction is determined by the factor called the Fraction for Construction. This factor is decreased as the actual road density approaches the desired road density. Moreover, this factor is increased by an increase in the ratio of the length of effective roads to actual road length increases. Figures 5.35 and 5.36 show the assumed relationships between the parameters.

\[ \text{RCB}_K = \text{RF}_K \times \text{FFC}_K \]

\[ \text{FFC}_K = \text{FFCN} \times \text{DFRM}_K \times \text{ETARM}_K \]

\[ \text{FFCN} = 0.60 \]

\[ \text{DFRM}_K = \text{TABHL}(\text{DFRMT}, \text{ARD}_K / \text{DRD}, 0, 1, .1) \]

\[ \text{DFRMT} = 1.95 / .9 / .95 / .85 / .75 / .6 / .5 / .5 / .2 / 0 \]

\[ \text{ETARM}_K = \text{TABHL}(\text{ETARMT}, \text{ETARR}_K, 0, 1, .1) \]

\[ \text{ETARMT} = 0 / .1 / .2 / .3 / .4 / .5 / .7 / .75 / .9 / .95 / 1 \]

RCB - ROAD CONSTRUCTION BUDGET
RF - ROAD FUND
FFC - FRACTION FOR CONSTRUCTION
FFCN - FRACTION FOR CONSTRUCTION NORMAL
DFRM - DEMAND FOR ROAD MULTIPLIER
ETARM - EFFECTIVE TO ACTUAL ROAD MULTIPLIER
ARD - ACTUAL ROAD DENSITY
ARDN - ACTUAL ROAD DENSITY NORMAL
DRD - DESIRED ROAD DENSITY
Figure 5.36. ARTCM vs. Actual-to-Desired Road Density Ratio

Figure 5.37. TDPM vs. ETARR
The road transport capacity is dependent on the number of trucks plying the network, the frequency of truck trips daily, the harvest peak periods, and the payload per truck.

\[ \text{RTC}_k = \text{TRUCK}_k \times \text{TTPD}_k \times \text{HPP} \times \text{PLPT} \]

\[ \text{HPP} = 60 \]

\[ \text{PLPT} = 7 \]

\[ \text{RTC} - \text{ROAD TRANSPORT CAPACITY (TONS/YR)} \]

\[ \text{TRUCK} - \text{NO. OF TRUCKS} \]

\[ \text{TTPD} - \text{TRUCK TRIPS PER DAY} \]

\[ \text{HPP} - \text{HARVEST PEAK PERIODS (DAYS)} \]

\[ \text{PLPT} - \text{PAYLOAD PER TRUCK} \]

The rate of transport of unmilled crop is determined by either the unmilled crop production rate or the road transport capacity, whichever is smaller.

\[ \text{UMCTR}_k = \text{MIN}(\text{RTC}_k, \text{UMCPR}_k) \]

\[ \text{UMCTR} - \text{UNMILLED CROP TRANSPORT RATE (MT/yr)} \]

\[ \text{RTC} - \text{ROAD TRANSPORT CAPACITY (MT/yr)} \]

\[ \text{UMCPR} - \text{UNMILLED CROP PRODUCTION RATE (MT/yr)} \]

The number of trucks is increased by the rate of purchase and decreased by the rate of deterioration. The importance of effective road maintenance can never be overemphasized in creating a progressive rural structure. Based on available figures for the area, there are 20 trucks servicing Impasug-ong.

140
TRUCK.K = TRUCK.J + (DT)(TPR.JK - TDR.JK)

TRUCK = 20

TRUCK - NO. OF TRUCKS

TPR - TRUCK PURCHASE RATE

TDR - TRUCK DETERIORATION RATE

Purchase rate of trucks is assumed to be the maximum value between the difference of the desired number of trucks and existing number of trucks and zero, divided by delay in purchase. The underlying assumption is that should the number of trucks equal to or becomes more than the desired number of trucks, no purchase or addition to the fleet is going to occur.

TPR.KL = MAX(DNT.K - TRUCK.K, 0)/DIP

DIP = 2

TPR - TRUCK PURCHASE RATE

DNT - DESIRED NUMBER OF TRUCKS

TRUCK - NO. OF TRUCKS

DIP - DELAY IN TRUCK PURCHASE

The desired number of trucks depends on the unmilled crop production rate and the production in AB industries.

DNT.K = (UMCPR.JK/HPP) + ABP.K*FABPM)/(PLPT*TTPB.K)

DNT - DESIRED NO. OF TRUCKS

UMCPR - UNMILLED CROP PRODUCTION RATE (MT/yr)

HPP - HARVEST PEAK PERIODS (DAYS)
ABP - AB INDUSTRIES PRODUCTION (MT/YR)
FABPM - FRACT AB PRODUCTION FOR MARKETING (MT/YR)
TTPD - TRUCK TRIPS PER DAY
PLPT - PAYLOAD PER TRUCK

Truck deterioration rate is assumed to vary with the existing effective road length. Figure 5.37 represents the effect of road condition on truck deterioration.

\[ \text{TDR.KL} = \text{TRUCK.K} \times \text{TDN} \times \text{TDRM.K} \]

\[ \text{TDN} = 0.10 \]

\[ \text{TDRM.K} = \text{TABHL} (\text{TDRMT}, \text{ETARR.K}, 0, 1, 1) \]

\[ \text{TDRMT} = 1.9/1.75/1.7/1.65/1.55/1.5/1.4/1.2/1.1/1 \]

TDR - TRUCK DETERIORATION RATE
TRUCK - NO. OF TRUCKS
TDN - TRUCK DET. NORMAL
TDRM - TRUCK DET. RATE MULTIPLIER
ETARR - EFFECTIVE-TO-ACTUAL ROAD RATIO

Truck trips per day is determined by the number of hours put in by truck drivers daily and the effective travel time. It is assumed that a truck driver works for an average of 8 hours per day.

\[ \text{TTPD.K} = \text{AWHD/ETT.K} \]

\[ \text{AWHD} = 8 \]

TTPD - TRUCK TRIPS PER DAY
AWHD - AVERAGE NO. OF WORKING HOURS DAILY
ETT - EFFECTIVE TRAVEL TIME
For rice and corn lands, a grid distance of 25 kilometers is recommended. The effective travel time depends on the initial grid distance, the average travel speed and the effective road deterioration multiplier as modeled below.

\[ \text{ETT}_K = (\text{IGD}/\text{ATS}) \times \text{ERDM}_K \]

IGD = 25
ATS = 15

**ETT - EFFECTIVE TRAVEL TIME**

**IGD - INITIAL GRID DISTANCE (KM)**

**ATS - AVERAGE TRAVEL SPEED (KM/HR)**

**ERDM - EFFECTIVE ROAD DET. MULTIPLIER**

The road deterioration multiplier decreases as the effective-to-actual road ratio increases. This variation is shown in figure 5.38.

\[ \text{ERDM}_K = \text{TABHL}(\text{ERDRT}, \text{ETARR}_K, 0, 1, .1) \]

ERDRT = 2/2/2/2/1.9/1.8/1.7/1.5/1.2/1.1/1

**ERDM - EFFECTIVE ROAD MAINTENANCE MULTIPLIER**

**ETARR - EFFECTIVE-TO-ACTUAL ROAD RATIO**

The effective-to-actual road ratio is dependent on the length of the effective road and the actual rural road length regardless of condition.

\[ \text{ETARR}_K = \text{ERRL}_K / \text{ERL}_K \]

**ETARR - EFFECTIVE-TO-ACTUAL ROAD RATIO**
Figure 5.36. Effective road deterioration multiplier vs. effective-to-actual road ratio.

Figure 5.39. Urban housing demand multiplier vs. urban houses-to-household ratio.
5.2.4 URBAN SECTOR

The dynamic relationship between rural and urban sectors is taken into consideration in BUKID. The assumption is that variation in the economic situation in the rural area would cause a corresponding reaction in the urban sector. The most common and most obvious result of the discrepancy of the standards of living between these two sectors of society is rural-to-urban migration. Seeking better financial prospects and yearning for the excitement and glamour of city living, people from the rural area flock to the cities.

This sector of the model consists of the urban demographic sector, urban housing sector, the urban business sector, the urban service sector, and the employment sector. These sectors are modeled to reflect the impact of agricultural investments, or non-investment as the case may be, on urban housing and employment.

Urban population is increased by urban birth rate and rural-urban migration and decreased by the rate of urban deaths and urban outmigration. Initial value of the urban population is set at 200000.
UP.K=UP.J+(DT)(UBR.JK+RUM.JK-UDR.JK-UOM.JK)

UPN=200000

UP - URBAN POPULATION
UBR - URBAN BIRTH RATE
RUM - RURAL-URBAN MIGRATION
UDR - URBAN DEATH RATE
UOM - URBAN OUTMIGRATION

Urban birth rate, urban death rate and urban outmigration are all computed by multiplying the value of urban population with a 'normal' fraction.

UBR.KL=UP.K*UBRN

UBRN =0.03

UBR - URBAN BIRTH RATE
UP - URBAN POPULATION

UBRN - URBAN BIRTH RATE NORMAL (FRACT/YR)

UDR.KL=UP.K*UDRN

UDRN=0.006

UDR - URBAN DEATH RATE
UP - URBAN POPULATION

UDRN - URBAN DEATH RATE NORMAL

UOM.KL=UP.K*UOMN

UOMN=0.001

UOM - URBAN OUT-MIGRATION

UP - URBAN POPULATION
UOMN - URBAN OUTMIGRATION NORMAL

The impact of urban population on land use is incorporated by including the housing sector. The number of houses at any time is estimated based on the urban housing construction rate and urban housing deterioration rate.

\[ UH_K = UH_J + (DT)(UHC_JK - UHD_JK) \]

\[ UHN = 2000 \]

UH - URBAN HOUSES

UHC - URBAN HOUSING CONSTRUCTION RATE

UHD - URBAN HOUSING DETERIORATION RATE

UHN - URBAN HOUSES NORMAL

The rate of housing construction is affected by the urban housing demand and the availability of land. The effect of urban housing demand on housing construction rate is included in the model by using a factor called Urban Housing Demand Multiplier. This multiplier is increased by an increase in the ratio of urban household-to-urban houses. Figure 5.39 shows this dependency.

\[ UHC_{KL} = UH_K \times UHCN \times UHDM_K \times ULAM_K \]

\[ UHCN = 0.019 \]

\[ UHDM_K = TAVHL(UHDMT, UHHR_K, 0.2, 2) \]

\[ UHDMT = .1 / .2 / .35 / .5 / .7 / 1 / 1.6 / 1.8 / 1.9 / 1.95 / 2 \]

\[ UHHR_K = UP_K / (UH_K \times PH) \]

\[ PH = 6 \]
HC - URBAN HOUSING CONSTRUCTION
UH - URBAN HOUSES
UHCN - URBAN HOUSING CONSTRUCTION NORMAL
UHDM - URBAN HOUSING DEMAND MULTIPLIER
ULAM - URBAN LAND AVAILABILITY MULT.
UHHR - URBAN HOUSEHOLDS-TO-HOUSES RATIO
UP - URBAN POPULATION
PH - PERSONS PER HOUSEHOLD

The effect of availability of land on the rate of housing construction is incorporated using a parameter called the Urban Land Availability Multiplier. The value of this multiplier is assumed to vary with the urban land fraction occupied. Figure 5.40 shows the assumed relationship between these two variables. As seen from the graph, at zero land fraction occupied construction occurs at some normal rate, increases as land fraction occupied increases then tapers off as more land is utilized.

ULAM.K=TABHL(ULAMT,ULFO.K,0,1,.2)
ULAMT=1/1.25/1.5/1.25/.75/0
ULAM - URBAN LAND AVAILABILITY MULT.
ULFO - URBAN LAND FRACTION OCCUPIED

Urban land fraction occupied is the sum of the total area utilized for housing, business and service structures divided by the total urban land area available.
ULFO.K = (UH.K*LUH + UBS.K*LBS + USS.K*LSS)/ULAN

LUH = 0.050
LBS = 4
LSS = 0.80
ULAN = 500000

ULFO - URBAN LAND FRACTION OCCUPIED (DIM)
UH - URBAN HOUSES
LUH - LAND REQUIRED PER URBAN HOUSE (HA)
UBS - URBAN BUSINESS STRUCTURES
LBS - LAND REQUIRED PER BUSINESS STRUCTURE (HA)
USS - URBAN SERVICE STRUCTURES
LSS - LAND REQUIRED PER SERVICE STRUCTURE (HA)
ULAN - URBAN LAND AVAILABLE

Employment in the urban sector of BUKID is provided by the business and service sectors. Increase in the number of business and service structures will bring about an increase in employment capacity. The number of business structures is increased by the urban business structure construction rate and decreased by the rate of deterioration.

UBS.K = UBS.J + (DT)(UBSC.JK - UBSD.JK)

UBS = 300

UBS - URBAN BUSINESS STRUCTURE
UBSC - URBAN BUSINESS STRUCTURE CONSTRUCTION RATE
UBSD - URBAN BUSINESS STRUCTURE DETERIORATION RATE
The rate of deterioration of urban business structures is determined by the existing number of structures multiplied by the normal deterioration rate of business structure which is taken to be a constant and set at 0.001.

\[ UBSD_{KL} = UBS_{K} \times UBSDN \]

\[ UBSDN = 0.001 \]

**UBSD** - URBAN BUSINESS STRUCTURE DETERIORATION

**UBS** - URBAN BUSINESS STRUCTURES

**UBSDN** - URBAN BUSINESS STRUCTURE DETERIORATION NORMAL

The rate of construction of business structures is estimated as the product of the number of urban business, the normal rate of business structure construction, the urban land availability multiplier, and the urban labor force availability multiplier.

\[ UBSC_{KL} = UBS_{K} \times UBSCN \times ULFAM_{K} \times ULAM_{K} \]

\[ UBSCN = 0.015 \]

**UBSC** - URBAN BUSINESS STRUCTURE CONSTRUCTION

**UBSCN** - URBAN BUSINESS STRUCTURE CONSTRUCTION NORMAL

**ULFAM** - URBAN LABOR FORCE AVAILABILITY MULTIPLIER

**ULAM** - URBAN LAND AVAILABILITY MULTIPLIER

The underlying assumption in introducing a multiplier for the effect of urban labor force availability on
business structure construction is that as unemployment worsens, the demand for business structures will also increase. Figure 5.41 graphs the assumed relationship between these parameters.

\[ \text{ULFAM.} \times \text{ULFAMT} = \text{ULFTJR.K} \times 0.2 \times 0.2 \]

\[ \text{ULFAMT} = .1/0.15/0.2/0.3/0.5/1/1.3/1.5/1.7/1.9/2 \]

\[ \text{ULFTRJR.K} = \text{ULF.K/ULJ.K} \]

\text{ULFAM} - \text{URBAN LABOR FORCE AVAILABILITY MULTIPLIER}

\text{ULFTRJR} - \text{URBAN LABOR FORCE TO JOB RATIO}

\text{ULF} - \text{URBAN LABOR FORCE}

\text{ULJ} - \text{URBAN JOBS}

The number of urban service structures at any time is determined using equations very similar to those used for the urban business sector with the same underlying assumptions.

\[ \text{USS.K} = \text{USS.J} + (\text{DT})(\text{USSC.JK} - \text{USSD.JK}) \]

\text{USSN} = 0.015

\text{USS} - \text{URBAN SERVICE STRUCTURES}

\text{USSC} - \text{URBAN SERVICE STRUCTURE CONSTRUCTION RATE}

\text{USSD} - \text{URBAN SERVICE STRUCTURE DETERIORATION RATE}

\text{USSN} - \text{URBAN SERVICE STRUCTURE NORMAL}

\[ \text{USSD.KL} = \text{USS.K} \times \text{USSDN} \]

\text{USSDN} = 0.001

\text{USSD} - \text{URBAN SERVICE STRUCTURE DETERIORATION}

\text{USS} - \text{URBAN SERVICE STRUCTURE}

152
USSDN - URBAN SERVICE STRUCTURE DETERIORATION NORMAL

USSC.KL=USS.K*USSCN*ULFAM.K*ULAM.K

USSCN=0.015

USSC - URBAN SERVICE STRUCTURE CONSTRUCTION RATE

USS - URBAN SERVICE STRUCTURE

USSCN - URBAN SERVICE STRUCTURE CONSTRUCTION NORMAL

ULFAM - URBAN LABOR FORCE AVAILABILITY MULTI.

ULAM - URBAN LAND AVAILABILITY MULTIPLIER

The size of the urban labor force is the product of the urban population at any time and the urban labor participation factor which is assumed to be equal to 60 percent.

ULF.K=UP.K*ULPF

ULPF=0.60

ULF - URBAN LABOR FORCE

UP - URBAN POPULATION

ULPF - URBAN LABOR PARTICIPATION FACTOR

The unemployment rate is determined by the equation shown below.

UUR.K=(ULF.K-UJ.K)/ULF.K*100

UUR - URBAN UNEMPLOYMENT RATE

ULF - URBAN LABOR FORCE

UJ - URBAN JOBS
The total number of urban jobs is the sum of the jobs created in the business and service sectors.

\[ UJ.K = UBS.K \times JBS + USS.K \times JSS \]

\[ JBS = 60 \]

\[ JSS = 60 \]

**UJ** - URBAN JOBS

**UBS** - URBAN BUSINESS STRUCTURES

**JBS** - JOBS PER BUSINESS STRUCTURE

**USS** - URBAN SERVICE STRUCTURE

**JSS** - JOBS PER SERVICE STRUCTURE
CHAPTER 6
MODEL SIMULATION

6.1 DEVELOPMENT MODEL OF THE PHILIPPINES (DMP)

To be useful to policy-makers, the Development Model of the Philippines (DMP) is structured such that it is capable of performing some information-producing tasks regarding the future. It provides a forecast of the future states of the system based on the interactions between system variables and the external constraints to, and forces for, change. A case in point: according to the model, people from the rural areas will soon flock to the cities, the extent of which is determined by the discrepancy between the urban and rural incomes as represented by the variable Relative Earnings Agriculture (REA). As a result of such migration, labor force for the non-agricultural sector will swell in number. Equipped with this future scenario, the policy-makers can then explore possible programs that must be implemented.

In countries pursuing economic development, the formation of policy is made difficult by two factors: first, the conflict that may exist between the policy's immediate effect and its long-term repercussion and, second, by the degree of which policies aimed at one set of economic phenomena may have unintended side effects on the other
aspects of the economy. Using DMP alternative policies can be investigated and its possible effects on the other sectors may be simulated thus aiding the policy-makers in taking the right actions. The validity of such simulations lies in DMP's representation of the real-world systems as expressed in the mathematical equations. DMP considers the interdependency of various variable and embodies the internal dynamics of these variables.

To illustrate the usefulness of DMP in evaluating alternative policies, six policy experiments are described in this section. They are as follows:

1. Government Support of Agriculture Policy
2. Government Allocation to Social Services
3. Industrial Development Policy
4. Infrastructure Induced Development Policy
5. Environmental Protection Policy
6. Zoning Policy

6.1.1 BASIC RUN

The basic model represents the existing conditions in the Philippines as gleaned from the secondary data available. Simulation of the basic model over a 50-year period (1980-2020) forecasts the behavior of the system barring any change in policy. Although DMP has many outputs
available, discussion shall be confined to following indicators:

1. Gross National Product (GNP)
2. Per Capita Income (PCI)
3. Total Population (TP)
4. Fraction Population Urban (FPU)
5. Pollution Mortality Multiplier (PMM)
6. Unemployment Non-Agriculture (UNEMNA)
7. Relative Earnings in Agriculture (REA)
8. Average Farm Size (AFS)
9. Per Capita Crop Production Ratio (PCCPR)

Based on the model simulation, the value of the Gross National Product increases from 300 Billion Pesos in 1980 to 36700 Billion Pesos in 2020, registering an increase rate of over 100% (Figure 6.1). It must be noted though that with an inflation rate of 21% as reflected in the model, this increase does not represent the real growth rate of GNP. Per capita income increases from 6000 Pesos in 1980 to 457000 Pesos in 2020. What is more encouraging to note is that Relative Earnings in Agriculture, one of DMP's indicators for equitable distribution of wealth, increases from 0.381 in 1980 to 1.674 in 2020. Between 1990 and 2000 earnings of agricultural workers will equal that of their urban counterparts. This causes a reversal in the population
movement. By the year 2000 DMP forecasts that 128000 people would be moving to the countryside.

Population is projected to peak around 2010 with 84.7 million Filipinos inhabiting the nation. By 2020 though this population would have decreased to 80.3 million (figure 6.2). This decline in population may be caused by any or all of the possible phenomena: (1) an increase in population density thereby creating overcrowding, (2) a decrease in food available per capita, and (3) an increase in environmental pollution which in DMP affects life expectancy through a variable called Pollution Mortality Multiplier (PMM). As forecasted in the basic run, PMM remains constant at 1.0 for the first 30 years of the simulation. Then by 2010 it will increase to 1.6 and will continue to increase to 4.70 by 2020. Fraction of Population Urban (FPU) increases to 46% in 1990 then decreases to 39% by the year 2020. The movement of people to the urban areas may have been brought about by the economic crisis that the country underwent during the 1980s. It is also interesting to note that despite the surge of rural-urban migration, Per Capita Crop Production Ratio (PCCPR) increases between 1980 and 1990. This may have been caused by the shift in orientation in the Philippine economic development strategy under the Aquino Administration which placed more emphasis on agriculture and agri-business. After the initial increase in
<table>
<thead>
<tr>
<th>YEAR</th>
<th>0</th>
<th>100 R</th>
<th>200 R</th>
<th>300 R</th>
<th>400 R</th>
<th>NMCBAU</th>
<th>NMCBAG</th>
<th>NMCBBAU</th>
<th>NMCBBAG</th>
<th>NMCBBDAU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1991</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1992</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1993</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1994</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1995</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1996</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1997</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1998</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>1999</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2000</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2001</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2002</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2003</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2004</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2005</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2006</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2007</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2008</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2009</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2010</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2011</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2012</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2013</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2014</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2015</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2016</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2017</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2018</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2019</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2020</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2021</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2022</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2023</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2024</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>2025</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

**LEGENDS:**
- IP(MARUF) = N
- IP(MIXING) = N
- IP(CONTO) = C
- IP(RUSIN) = B
- AF = A
- GNP = G

**FIGURE 6.1. COMPUTER SIMULATION OF GNP (BASE RUN)**
LEGEND:

UP = U
RP = R
TP = T

FIGURE 6.2. COMPUTER SIMULATION OF POPULATION (BASE RUN)
PCCPR it decreases to 1.50 in the year 2000 and levels off at 1.513 for the rest of the simulation years (Figure 6.3).

As more and more people move to the rural region and participate in agricultural activities, average farm size also declines. According to DMP, average farm size will decrease from the 1980 level of 2.60 hectares to 1.46 hectares in 2020 (Figure 6.4).

Model simulation using the current priorities of the Philippine government indicates that unemployment will peak at approximately 19% in 1990 but will decrease with the movement of people to the rural areas in 2000. Between 2000 and 2010 unemployment in the urban sector will be non-existent (figure 6.5).

Table 6.1 summarizes the results of the basic model simulation.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL POPULATION</td>
<td>48.3M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td>URBAN POP.</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.39</td>
</tr>
<tr>
<td>GROSS NATIONAL PRODUCT</td>
<td>300E</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td>PER CAPITA INCOME</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td>UNEMNA</td>
<td>0.062</td>
<td>0.191</td>
<td>0.075</td>
<td>-0.358</td>
<td>-0.949</td>
</tr>
<tr>
<td>REA</td>
<td>0.381</td>
<td>0.772</td>
<td>1.138</td>
<td>1.597</td>
<td>1.674</td>
</tr>
<tr>
<td>AFS (HA)</td>
<td>2.60</td>
<td>2.26</td>
<td>1.78</td>
<td>1.49</td>
<td>1.46</td>
</tr>
<tr>
<td>PCCPR</td>
<td>1.60</td>
<td>1.618</td>
<td>1.500</td>
<td>1.513</td>
<td>1.513</td>
</tr>
<tr>
<td>PMM</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.600</td>
<td>4.700</td>
</tr>
</tbody>
</table>

161
6.1.2 AGRICULTURAL DEVELOPMENT POLICY

In the first policy experiment, agricultural production is increased to enable society to meet future needs. This is accomplished by using more intensive agriculture, by bringing more land under cultivation, and by increasing on-farm policy. The policy control variable is Fraction GNP to Agriculture, FGNPA. The share of the other sectors except social development was reduced to increase agriculture's portion. For this policy experiment, the following statements were introduced to DMP:

\[
\begin{align*}
T & \quad \text{FGNPCF}(\star) = 0.0195/0.1675/0.0515/0.0515 \\
T & \quad \text{FGNPIF}(\star) = 0.009375/0.009375/0.009375/0.009375/0.009375 \\
X & \quad \text{FGNPSDL}(\star) = 0.012/0.012/0.012/0.012 \\
C & \quad \text{FGNPAD} = 0.095
\end{align*}
\]

Simulation results of the agriculture development policy indicates that Gross National Product does not improve in the first 30 years of simulation. In fact, in 1990 GNP for this experiment was only 900 Billion Pesos compared to the basic model GNP value of 1000 Billion Pesos (Figure 6.6). Likewise, population growth and decline do not differ by a big margin from the basic model run. PMM increases to 1.5 in 2010 and by 2020 will be equal to 4.6. The superiority of this policy lies in the improvement of the Relative Earnings in Agriculture (REA) indicating a more
FIGURE 6.6. COMPUTER SIMULATION OF GNP
AGRICULTURE DEVELOPMENT POLICY

LEGEND:
AP (BASE) = 1
GNP (BASE) = 2
AP (AGRI.) = A
GNP (AGRI.3) = 6
equitable distribution of wealth. An increase in REA of more than 4 per cent is incurred by the year 2000. Average farm size declines slightly faster under this policy experiment as compared to the base run (Figure 6.7), a natural consequence of an increase in people join the agricultural labor force.

By the year 2000, unemployment in the non-agriculture sector is eased by more than 12% using this policy (Figure 6.8). Table 6.2 compares the results of the basic model and the agriculture development policy.

6.1.3 GOVERNMENT ALLOCATION TO SOCIAL SERVICES

In the second policy experiment, the strategy to be investigated is increasing Government's allocation to social development program. The policy control variable is Fraction GNP to Social Development, FGNPSD, which has been increase to 1.5% for each sub-sector. The following statements were added to the basic model for this experiment.

\[
\begin{align*}
T & \quad FGNPCF(*)=0.0195/0.1675/0.0515/0.0515 \\
T & \quad FGNPIF(*)=0.009375/0.009375/0.009375/0.009375/ \\
X & \quad 0.009375/0.009375/0.009375/0.009375 \\
T & \quad FGNPSD(*)=0.015/0.015/0.015/0.015/ \\
C & \quad FGNPA=0.080
\end{align*}
\]

Investment in the Social Development Sector does not improve the Gross National Product. In fact, GNP declines in
<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>Year 1980</th>
<th>Year 1990</th>
<th>Year 2000</th>
<th>Year 2010</th>
<th>Year 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL POPULATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>48.30M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td>Agriculture</td>
<td>48.30</td>
<td>61.60</td>
<td>76.20</td>
<td>84.80</td>
<td>80.8M</td>
</tr>
<tr>
<td><strong>FRACTION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.39</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.40</td>
<td>0.46</td>
<td>0.44</td>
<td>0.40</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>GROSS NATIONAL PRODUCT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>300B</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td>Agriculture</td>
<td>300B</td>
<td>900B</td>
<td>3300B</td>
<td>12200B</td>
<td>37000B</td>
</tr>
<tr>
<td><strong>PER CAPITA INCOME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td>Agriculture</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>144000</td>
<td>459000</td>
</tr>
<tr>
<td><strong>UNEMPLOYMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.062</td>
<td>0.191</td>
<td>0.075</td>
<td>-0.358</td>
<td>-0.949</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.062</td>
<td>0.191</td>
<td>0.065</td>
<td>-0.394</td>
<td>-0.949</td>
</tr>
<tr>
<td><strong>REA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.381</td>
<td>0.772</td>
<td>1.138</td>
<td>1.597</td>
<td>1.674</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.390</td>
<td>0.802</td>
<td>1.188</td>
<td>1.663</td>
<td>1.747</td>
</tr>
<tr>
<td><strong>AFS (HA)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>2.60</td>
<td>2.26</td>
<td>1.78</td>
<td>1.49</td>
<td>1.46</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2.60</td>
<td>2.24</td>
<td>1.75</td>
<td>1.45</td>
<td>1.45</td>
</tr>
<tr>
<td><strong>PCCPR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.60</td>
<td>1.618</td>
<td>1.500</td>
<td>1.513</td>
<td>1.513</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1.637</td>
<td>1.656</td>
<td>1.534</td>
<td>1.547</td>
<td>1.589</td>
</tr>
<tr>
<td><strong>PMM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.600</td>
<td>4.700</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.500</td>
<td>4.600</td>
</tr>
</tbody>
</table>
FIGURE 6.7. COMPUTER SIMULATION OF AFS
AGRICULTURE DEVELOPMENT POLICY

LEGEND:
AFS (BASE) = A
AFS (WP1) = F
this experiment as compared to the base run (Table 6.3). By the year 2020 GNP will only be 33500 Billion Pesos, about 8 per cent less than the base run GNP of 36700 in 2020 (Figure 6.9). However, per capita income is not decreased significantly in the first 30 years of simulation since the population is kept in check as revealed by the simulation figures. But by the year 2020 per capita income in the social development policy experiment would be down by 5 per cent as compared to that of the basic model, registering only 433000 per capita.

In comparison to the projected 2010 population of 84.70 in the base run, the social development experiment forecasts a population of 81.50 million. Fraction of people in the urban areas is kept under 46%. Because of the decrease in industrial investment, PMM will be equal to 4.28 in 2020, a decrease of almost 9 per cent compared to the base run.

As a consequence of the slowdown in the rate of population growth unemployment in the non-agriculture sector will only be 18% by 1990 compared to the 19% forecasted by the basic model (Figure 6.10).

Likewise, the slowdown in the growth rate of the population will stimulate an improvement in the Relative Earnings Agriculture (REA) compared to the base run forecast. By the year 2020 REA is projected to be equal to 1.840 compared to the base year forecast of 1.674. The more
Figure 6.9. Computer Simulation of GNP
Social Development Policy

Legend:
AP (Base) = 1
GMP (Base) = 2
AP (SOC.) = A
GMP (SOC.) = 6
LEGEND:
UNEMNA (BASE) = B
UNEMNA (SOC.) = U

FIGURE 6.10. COMPUTER SIMULATION OF UNEMNA
SOCIAL DEVELOPMENT POLICY
equitable distribution of wealth reflected in this experiment can be seen as the result of a smaller population competing for income. Likewise, decline in the Average Farm Size (AFS) is gradual. It is projected that by the year 2020 AFS would be equal to 1.59 hectares compared to the base run of 1.46 hectares (Figure 6.11).

6.1.4 INDUSTRIAL DEVELOPMENT POLICY

The objective of the third experiment described in this report is to simulate the effect on the system of increased industrial activity. To accomplish this, the policy variable Fraction GNP to Capital Formation (FGNPCF) is increased. The following statements were included in the program for this experiment.

\[ T \quad \text{FGNPCF}(*)=0.02575/0.17375/0.05775/0.05775 \]
\[ T \quad \text{FGNPIF}(*)=0.00875/0.00875/0.00875/0.00875/ \]
\[ X \quad 0.00875/0.00875/0.00875 \]
\[ T \quad \text{FGNPSD}(*)=0.012/0.012/0.012/0.012/ \]
\[ C \quad \text{FGNPA}=0.075 \]

Increasing government allocation to industries appears to have little effect on improving the GNP as shown in the simulation for this experiment (Figure 6.12). In fact, a slight decrease (less than 1 per cent) in GNP is forecasted for the year 2010. This may be attributed to the fact that
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL POPULATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>48.30M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td>Social</td>
<td>48.30M</td>
<td>61.40M</td>
<td>76.10M</td>
<td>81.50M</td>
<td>77.3M</td>
</tr>
<tr>
<td><strong>FRACTION URBAN POP.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.39</td>
</tr>
<tr>
<td>Social</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td><strong>GROSS NATIONAL PRODUCT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>300B</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td>Social</td>
<td>300B</td>
<td>900B</td>
<td>3200B</td>
<td>11400B</td>
<td>33500B</td>
</tr>
<tr>
<td><strong>PER CAPITA INCOME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td>Social</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>140000</td>
<td>433000</td>
</tr>
<tr>
<td><strong>UNEMPLOYMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.062</td>
<td>0.191</td>
<td>0.075</td>
<td>-0.358</td>
<td>-0.949</td>
</tr>
<tr>
<td>Social</td>
<td>0.0619</td>
<td>0.1857</td>
<td>0.0531</td>
<td>-0.3938</td>
<td>-0.8835</td>
</tr>
<tr>
<td><strong>REA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.381</td>
<td>0.772</td>
<td>1.138</td>
<td>1.597</td>
<td>1.674</td>
</tr>
<tr>
<td>Social</td>
<td>0.381</td>
<td>0.795</td>
<td>1.191</td>
<td>1.707</td>
<td>1.840</td>
</tr>
<tr>
<td><strong>AFS (HA)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>2.60</td>
<td>2.26</td>
<td>1.78</td>
<td>1.49</td>
<td>1.46</td>
</tr>
<tr>
<td>Social</td>
<td>2.60</td>
<td>2.26</td>
<td>1.80</td>
<td>1.55</td>
<td>1.59</td>
</tr>
<tr>
<td><strong>PCCPR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.60</td>
<td>1.618</td>
<td>1.500</td>
<td>1.513</td>
<td>1.513</td>
</tr>
<tr>
<td>Social</td>
<td>1.60</td>
<td>1.623</td>
<td>1.527</td>
<td>1.574</td>
<td>1.623</td>
</tr>
<tr>
<td><strong>PMM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.600</td>
<td>4.700</td>
</tr>
<tr>
<td>Social</td>
<td>1.00</td>
<td>1.00</td>
<td>1.02</td>
<td>1.49</td>
<td>4.280</td>
</tr>
</tbody>
</table>
FIGURE 6.11. COMPUTER SIMULATION OF AFS SOCIAL DEVELOPMENT POLICY

LEGEND:
AFS (BASE) = A
AFS (SOC.) = F
FIGURE 6.12. COMPUTER SIMULATION OF GNP INDUSTRIAL DEVELOPMENT POLICY
investment in both the infrastructure and agriculture sectors have been decreased to accommodate the increase of investment in industries for this particular policy experiment. Per capita income is forecasted to be about 2 per cent higher in the year 2000 but will achieve similar levels in the subsequent years of simulation.

Although population will grow in similar proportion as that of the base run, the population decline forecasted is much higher, about 6 per cent compared to the base run decrease of 5.2 per cent (Table 6.4). This may be explained by the fact that increased investment in industries would mean more industrial activity which in turn, will increase pollution generation.

Under this policy experiment, PMM is expected to increase to 4.9 by 2020, roughly 4% higher than the forecasted value for the base run. Moreover, because of increased industrial activity, the fraction of population inhabiting the urban areas will be 4 per cent higher than the base run.

Under the industrial development program, the forecasted values of the the relative earnings of agriculture indicate that the rural populace would not be given as much attention as that under the existing policy of the Philippine government. A decline of about 7 per cent in REA is incurred under this policy change. Moreover, because
of the flocking of people to the urban areas stimulated by the increased investment in industry, unemployment will achieve higher proportion. According to the simulation results, UNEMNA in 2000 would be equal to 9.8 per cent compared to the 7.5 per cent forecasted in the base run.

Table 6.4. Simulation Results of Industrial Development Policy and Basic Model

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTAL POPULATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 48.30M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td></td>
<td>Industrial 48.30M</td>
<td>61.50M</td>
<td>76.00M</td>
<td>84.30M</td>
<td>79.3M</td>
</tr>
<tr>
<td></td>
<td>FRACTION URBAN POP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Industrial 0.40</td>
<td>0.47</td>
<td>0.47</td>
<td>0.44</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>GROSS NATIONAL PRODUCT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 300B</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td></td>
<td>Industrial 300B</td>
<td>1000B</td>
<td>3300B</td>
<td>11900B</td>
<td>36500B</td>
</tr>
<tr>
<td></td>
<td>PER CAPITA INCOME</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td></td>
<td>Industrial 6000</td>
<td>16000</td>
<td>44000</td>
<td>142000</td>
<td>460000</td>
</tr>
<tr>
<td></td>
<td>UNEMNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 0.062</td>
<td>0.191</td>
<td>0.075</td>
<td>-0.358</td>
<td>-0.949</td>
</tr>
<tr>
<td></td>
<td>Social 0.062</td>
<td>0.198</td>
<td>0.098</td>
<td>-0.282</td>
<td>-0.871</td>
</tr>
<tr>
<td></td>
<td>REA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 0.381</td>
<td>0.772</td>
<td>1.138</td>
<td>1.597</td>
<td>1.674</td>
</tr>
<tr>
<td></td>
<td>Industrial 0.381</td>
<td>0.795</td>
<td>1.191</td>
<td>1.707</td>
<td>1.840</td>
</tr>
<tr>
<td></td>
<td>AFS (HA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 2.60</td>
<td>2.26</td>
<td>1.78</td>
<td>1.49</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>Social 2.60</td>
<td>2.26</td>
<td>1.80</td>
<td>1.55</td>
<td>1.59</td>
</tr>
<tr>
<td></td>
<td>PCCPR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 1.60</td>
<td>1.618</td>
<td>1.500</td>
<td>1.513</td>
<td>1.513</td>
</tr>
<tr>
<td></td>
<td>Social 1.60</td>
<td>1.623</td>
<td>1.527</td>
<td>1.574</td>
<td>1.623</td>
</tr>
<tr>
<td></td>
<td>PMM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic 1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.600</td>
<td>4.700</td>
</tr>
<tr>
<td></td>
<td>Social 1.00</td>
<td>1.00</td>
<td>1.02</td>
<td>1.49</td>
<td>4.280</td>
</tr>
</tbody>
</table>
6.1.5 INFRASTRUCTURE DEVELOPMENT POLICY

The infrastructure sector of DMP is modeled to include 8 sub-sectors namely, (1) highways, (2) railroads, (3) ports, (4) airports, (5) power and energy, (6) water supply and distribution, (7) telecommunications, and (8) sewage collection and treatment. The fourth experiment in this report investigates the effect of increasing allocation to the infrastructure sector. The policy variable used is the Fraction GNP to Infrastructure (FGNPIF). To simulate this policy change, several mathematical statements were added to the basic model:

\[ T \quad FGNPCF(*) = 0.0195/0.1675/0.0515/0.0515 \]
\[ T \quad FGNIF(*) = 0.011875/0.011875/0.011875/0.011875 \]
\[ X \quad 0.011875/0.011875/0.011875/0.011875 \]
\[ T \quad FGNSD(*) = 0.012/0.012/0.012/0.012 \]
\[ C \quad FGNPA = 0.075 \]

Based on the simulation results, Gross National Product is not improved under this program. In fact, it declines by an average of 2 per cent for the years of simulation. Per capita income also declines by about 3 per cent (Table 6.5). Population growth will follow an almost identical pattern as the base run. It must be noted though that the decline registered under this policy is only equal to 4.2 per cent, compared to the 5.2 per cent decrease forecasted
in the base run (Figure 6.13). This could be attributed to better living conditions, possibly an improvement in sewage treatment and collection which is presently virtually non-existent in most of the rural areas in the Philippines. Fraction of population in the urban areas will decline to 38% by the year 2020. Forecasted values of the unemployment rate in the non-agricultural sector indicate no significant improvement over the base run values (Figure 6.14).

The forecast also indicates an improvement in relative earnings in agriculture under this policy. By 2000 REA will increase by 3 per cent over the base run. This may be caused by an improvement in road networks, particularly to the rural areas. The average farm size will decrease by about 3 per cent over the base run as a result of the increase in rural population.

The quality of life as affected by the level of pollution is improved under this policy as shown by the simulation results of PMM. PMM is 6 per cent less than the value of the base run, possibly contributing to the more gradual decrease in population under this development program.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POPULATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>48.30M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td>Infra.</td>
<td>48.30M</td>
<td>61.60M</td>
<td>76.30M</td>
<td>85.40M</td>
<td>81.8M</td>
</tr>
<tr>
<td><strong>FRACTION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>URBAN POP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.39</td>
</tr>
<tr>
<td>Infra.</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.41</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>GROSS NATIONAL PRODUCT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>300B</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td>Infra</td>
<td>300B</td>
<td>900B</td>
<td>3200B</td>
<td>11700B</td>
<td>35600B</td>
</tr>
<tr>
<td><strong>PER CAPITA INCOME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td>Infra</td>
<td>6000</td>
<td>15000</td>
<td>42000</td>
<td>137000</td>
<td>435000</td>
</tr>
<tr>
<td><strong>UNEMMA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.062</td>
<td>0.191</td>
<td>0.075</td>
<td>-0.358</td>
<td>-0.949</td>
</tr>
<tr>
<td>Infra</td>
<td>0.062</td>
<td>0.191</td>
<td>0.074</td>
<td>-0.388</td>
<td>-0.969</td>
</tr>
<tr>
<td><strong>REA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.381</td>
<td>0.772</td>
<td>1.138</td>
<td>1.597</td>
<td>1.674</td>
</tr>
<tr>
<td>Infra</td>
<td>0.372</td>
<td>0.783</td>
<td>1.178</td>
<td>1.676</td>
<td>1.752</td>
</tr>
<tr>
<td><strong>AFS (HA)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>2.60</td>
<td>2.26</td>
<td>1.78</td>
<td>1.49</td>
<td>1.46</td>
</tr>
<tr>
<td>Infra</td>
<td>2.60</td>
<td>2.26</td>
<td>1.76</td>
<td>1.45</td>
<td>1.42</td>
</tr>
<tr>
<td><strong>PCCP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.60</td>
<td>1.618</td>
<td>1.500</td>
<td>1.513</td>
<td>1.513</td>
</tr>
<tr>
<td>Infra</td>
<td>1.562</td>
<td>1.580</td>
<td>1.462</td>
<td>1.466</td>
<td>1.496</td>
</tr>
<tr>
<td><strong>PMK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.600</td>
<td>4.700</td>
</tr>
<tr>
<td>Infra</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.500</td>
<td>4.400</td>
</tr>
<tr>
<td>Year</td>
<td>0</td>
<td>100 M</td>
<td>200 M</td>
<td>300 M</td>
<td>400 M</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>1980</td>
<td>1-2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>1-2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1-2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>1-2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>1-2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **UP (BASE) = 1**
- **RP (BASE) = 2**
- **TP (BASE) = 3**
- **UP (INFRA) = U**
- **RP (INFRA) = R**
- **TP (INFRA) = T**
LEGEND:
UNEMNA (BASE) = B
UNEMNA (INFRA.) = U

FIGURE 6.14: COMPUTER SIMULATION OF UNEMNA
INFRASTRUCTURE DEVELOPMENT POLICY
6.1.6 ENVIRONMENTAL PROTECTION POLICY

The fifth policy experiment can be thought of as investigating development-environmental trade-offs. This is achieved by increasing industrial capital-output ratio thereby decreasing Pollution-generation, UPG. Statements affecting this policy change were added to the basic model:

\[
T \text{ CORN}(\ast) = 1.90/1.90/1.90/1.90
\]

\[
T \text{ UPG}(\ast) = 0.20/0.20/0.20/0.20
\]

Under the environmental protection policy GNP and per capita income decrease by 6 per cent by the year 2000. By 2010 population will reach 86.40 million, about 2 per cent more than the forecasted value of the basic run. Forty per cent of this population will be in the urban areas. Population declines only by 1.52\% by the year 2020, compared to 5.2 per cent forecasted by the base run (Figure 6.15). Compared to the basic run, unemployment in the non-agriculture sector increases to 19.9\% in 1990 and declines to 8.2\% by 2000 (Figure 6.16).

Average farm size decreases faster under this program, a natural consequence of the population size. By the year 2010 average farm size will be 1.42 hectares compared to 1.47 hectares forecasted in the base run (Figure 6.17). Relative earnings in agriculture improves by 13 per cent by over that of the existing policy by 2010. This may be caused
by a decline in the earnings in the non-agriculture sector brought about by the decrease in industrial output.

The quality of life as measured by the Pollution Mortality Multiplier (PMM) is improved significantly under this program. According to the simulation results, PMM in 2010 will be 1.23, 23 per cent lower than the basic run level in the same year. The difference increases to 30 per cent by the year 2020. Table 6.6 summarizes the forecasted values of the environmental protection program as compared to the existing policy.

6.1.7 ZONING POLICY

The last scenario experiment seeks to investigate the the impact of the amount of land and its use on present and future housing market, employment conditions, and environmental quality. This is achieved by using policy variables Land Per Capital Normal (LPCN), Land Per Person Normal (LPPN), and Fraction Industrial Output to Infrastructure Normal (FIOIFN). Specifically, the following equations were added to the basic model to simulate this policy change.

\[ C \quad LPCN = 1.0E-8 \]
\[ C \quad LPPN = 0.0037 \]
\[ T \quad FIOIFN(*) = 0.44/.44/.44/.44 \]
### Table 6.6. Simulation Results of Environmental Protection Policy and Basic Model

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POPULATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>48.30M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>48.30M</td>
<td>61.50M</td>
<td>76.10M</td>
<td>84.70M</td>
<td>80.3M</td>
</tr>
<tr>
<td>FRACTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>URBAN POP.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.40</td>
<td>0.46</td>
<td>0.45</td>
<td>0.42</td>
<td>0.39</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>0.40</td>
<td>0.46</td>
<td>0.44</td>
<td>0.40</td>
<td>0.39</td>
</tr>
<tr>
<td>GROSS NATIONAL PRODUCT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>300B</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>300B</td>
<td>1000B</td>
<td>3300B</td>
<td>12000B</td>
<td>36700B</td>
</tr>
<tr>
<td>PER CAPITA INCOME</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>6000</td>
<td>15000</td>
<td>43000</td>
<td>142000</td>
<td>457000</td>
</tr>
<tr>
<td>UNEMNA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.062</td>
<td>0.191</td>
<td>0.075</td>
<td>-0.358</td>
<td>-0.949</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>0.062</td>
<td>0.199</td>
<td>0.082</td>
<td>-0.359</td>
<td>-0.833</td>
</tr>
<tr>
<td>REA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>0.381</td>
<td>0.772</td>
<td>1.138</td>
<td>1.597</td>
<td>1.674</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>0.413</td>
<td>0.866</td>
<td>1.290</td>
<td>1.600</td>
<td>1.885</td>
</tr>
<tr>
<td>AFS (HA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>2.60</td>
<td>2.26</td>
<td>1.78</td>
<td>1.49</td>
<td>1.46</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>2.60</td>
<td>2.25</td>
<td>1.74</td>
<td>1.42</td>
<td>1.38</td>
</tr>
<tr>
<td>PCCPR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.60</td>
<td>1.618</td>
<td>1.500</td>
<td>1.513</td>
<td>1.513</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>1.60</td>
<td>1.617</td>
<td>1.492</td>
<td>1.483</td>
<td>1.473</td>
</tr>
<tr>
<td>PMM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.600</td>
<td>4.700</td>
</tr>
<tr>
<td>Env. Pro.</td>
<td>1.00</td>
<td>1.00</td>
<td>1.01</td>
<td>1.230</td>
<td>3.270</td>
</tr>
</tbody>
</table>

Under this policy experiment, Gross National Product and per capita income are decreased by about 8 per cent compared to the base run (Figure 6.18). Population will increase to 86.30 million by 2010 and will decline to 82.90 million in 2020. Fraction of urban population will
decrease to about 36 per cent by 2020, the lowest percentage forecasted among the different policy experiments on the same year.

Simulation results indicate that the average farm size by 2020 will be 1.38 hectares, about 5 per cent smaller than the base run forecasted value. This may be seen as a natural consequence of the large portion of the populace in the rural areas. Relative earnings in agriculture will be almost double that of industrial earnings by 2020. Since Land Per Capital is decreased in this experiment, the Urban Industrial Land Required (UILR) is reduced. The reduction of UILR will retard the land conversion rate thereby preventing a drastic decline in the level of cultivated area. This can be seen as the underlying reason for the improvement in the relative earnings of the agricultural sector.

Under this program unemployment in the non-agricultural sector will attain a value of 20.1 per cent and will decline to 8.1 per cent in the year 2000 (Figure 6.19). A possible explanation for this trend will be the deceleration in industrial growth because of zoning.

Pollution Mortality Multiplier (PMM) will be about 6 per cent less than base run value in 2020. Retardation of industrial growth due to zoning limitations decrease pollution generation as indicated in the simulation results.
providing better environmental protection. Table 6.7 summarizes the results of this policy experiment.

<table>
<thead>
<tr>
<th>Table 6.7. Simulation Results of Zoning Policy and Basic Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>-------</td>
</tr>
<tr>
<td>INDIATOR</td>
</tr>
<tr>
<td>TOTAL POPULATION</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>FRACTION URBAN POP.</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>GROSS NATIONAL PRODUCT</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>PER CAPITA INCOME</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>UNEMPLOYMENT</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>R&amp;D</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>AFS (HA)</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>PCCPR</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
<tr>
<td>PMM</td>
</tr>
<tr>
<td>Basic</td>
</tr>
<tr>
<td>Zoning</td>
</tr>
</tbody>
</table>
FIGURE 6.18. COMPUTER SIMULATION OF GNP
ZONING POLICY

LEGEND:
GNP (BASE RUN) = 1
GNP (ZONING) = 6
AP (BASE RUN) = 2
AP (ZONING) = A
6.2 REGIONAL DEVELOPMENT MODEL (BUKID)

The regional model presented in this report represents the existing conditions in Impasug-ong, Bukidnon, a tiny municipality in the island of Mindanao. It is predominantly an agricultural sector involved in rice and corn farming. Based on the simulation results of the basic model, rural population in this area will increase from 18400 in the base year to 26300 in the 30th year of simulation, an average increase of 4 per cent annually (figure 6.20). Average Value of Agricultural Products (AVAGP), the measure of the productivity of the area under consideration, is forecasted to be 340.9 million pesos in the 30th year, posting the Per Capita Income (PCI) of the region at 12960 pesos by the same year. There is an indicated decrease in PCI from the 20th year of simulation to the 30th year (Figure 6.21).

The rate of unmilled crop production achieves a value of 59210 metric tons in the 30th year of simulation from 4830 metric tons during the initial year. Potential land for transfer decreases dramatically during the first ten years of simulation, declining by about 8 per cent per year (Figure 6.22).

Length of rural roads is forecasted to be equal to 167 kilometers by the 30th year, increased by 142 kilometers
over a period of 30 years (Figure 6.23). Average road density, which declines on the 10th year of simulation because of the surge in rice and corn land development, is forecasted to equal 0.1388, about 80 per cent less than the desired road density of 0.70 kilometer per square kilometer. Table 6.8 summarizes the simulation results of BUKID.

<table>
<thead>
<tr>
<th>Table 6.8. Simulation Results of BUKID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Run</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indicator</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>RURAL POPULATION</td>
<td>18.40T</td>
<td>20.34T</td>
<td>23.13T</td>
<td>26.30T</td>
</tr>
<tr>
<td>RURAL-URBAN MIGRATION</td>
<td>635.0</td>
<td>389.0</td>
<td>442</td>
<td>503</td>
</tr>
<tr>
<td>POTENTIAL LAND FOR TRANSFER (HA)</td>
<td>22000</td>
<td>3710</td>
<td>620</td>
<td>110</td>
</tr>
<tr>
<td>AVERAGE VALUE OF AGRI. PRODUCTS (Pesos)</td>
<td>7.7M</td>
<td>267.4M</td>
<td>325.1M</td>
<td>340.9M</td>
</tr>
<tr>
<td>PER CAPITA INCOME (Pesos)</td>
<td>420</td>
<td>13150</td>
<td>14060</td>
<td>12960</td>
</tr>
<tr>
<td>RURAL ROAD LENGTH (KM)</td>
<td>25</td>
<td>37.8</td>
<td>69.7</td>
<td>167</td>
</tr>
<tr>
<td>AVERAGE ROAD DENSITY (KM/SQ. KM)</td>
<td>0.0125</td>
<td>0.0023</td>
<td>0.0628</td>
<td>0.0073</td>
</tr>
<tr>
<td>UNMILLED CROP PRODUCTION RATE (TONS/YR)</td>
<td>4830</td>
<td>46960</td>
<td>56520</td>
<td>59210</td>
</tr>
</tbody>
</table>
FIGURE 6.20. POPULATION FORECAST (UKID)

FIGURE 6.21. AVERAGE VALUE OF AGRICULTURAL PRODUCTS
FIGURE 6.22. POTENTIAL LAND FOR TRANSFER

FIGURE 6.23. RURAL ROAD LENGTH
Aside from the capability of the regional model BUKID to forecast behavior of the system under scrutiny over a period of time under a established set of conditions, it can also be utilized to enable users to evaluate various strategies in agricultural development without the attendant cost of actually implementing such experiments. Specifically, BUKID can be used to perform four policy experiments, namely: (1) acceleration or deceleration of the land reform program, (2) promotion of agriculture-based industries, (3) provision of special fund for feeder road construction, and (4) provision of special credit for crop production.

Under the first experiment, two scenarios may be evaluated in view of its impact on the system's behavior. Acceleration of the land reform program may be simulated by replacing the following equation found in the base model:

\[ \text{LTR.KL} = \text{MIN}(\text{LTRD.JK}, \text{LTRP.JK}) \]

with:

\[ \text{LTR.KL} = \text{CLIP}(0, 22000, \text{TIME.K}, 1.1) \]

The effect of the substitution of the latter equation in the model is to accelerate transfer of land to the farmers within one year.

To examine the effect of deceleration of the land reform program, land reform time is extended to 10 years instead of the basic model value of 6 years.
To perform the second policy experiment, the control variable under consideration is the Market Growth in AB industries (MGAB). It can be increased to an estimated value of 10 percent.

In the third policy experiment, the strategy to be investigated is the provision of a special fund for feeder road construction over and above the allocation found in the basic model. This special fund may be invested in the following manner: 5 million pesos in the first year, 10 million pesos in the second year, and 15 million pesos in the third year. This policy experiment is achieved by introducing the following equations in the basic model:

\[
\begin{align*}
R &= R_{CB,K} = R_{F,K} \times F_{FC,K} + S_{RCF,K} \\
A &= S_{RCF,K} = \text{STEP}(S_{HF1,K}, S_{FT1}) + \text{STEP}(S_{HF2,K}, S_{FT2}) + \text{STEP}(S_{HF3,K}, S_{FT3}) + \text{STEP}(S_{HF4,K}, S_{FT4}) \\
X &= \text{STEP}(S_{HF3,K}, S_{FT3}) + \text{STEP}(S_{HF4,K}, S_{FT4}) \\
C &= S_{HF1,K} = 5E6 \\
C &= S_{HF2,K} = 5E6 \\
C &= S_{HF3,K} = 5E6 \\
C &= S_{HF4,K} = 5E6 \\
C &= S_{FT1,K} = 0 \\
C &= S_{FT2,K} = 1 \\
C &= S_{FT3,K} = 2 \\
C &= S_{FT4,K} = 3
\end{align*}
\]

The above equations shall replace the following equation:
A \quad RCB.K=RF.K*FFC.K

The objective of the fourth experiment recommended in this report is to evaluate the impact of additional capital spending in crop production. This policy experiment may be used to examine whether the increase in agricultural productivity would justify a 5 million peso additional investment in credit allocation for crop production. This policy change may be simulated by replacing the basic model equation below:

A \quad CCP.K=FCCP*ASTAC.K

with the following equations:

A \quad CCP.K=FCCP*ASTAC.K+SCPC.K
A \quad SCPC.K=SCPCI*CLIP(0,1,TIME.K,4.1)
C \quad SCPCI=5E6
CHAPTER 7

CONCLUSIONS AND RECOMMENDATION

7.1 SUMMARY

Based on the simulation results of DMP, including the base run, the following conclusions may be drawn regarding the dynamic behavior of the Philippine economy:

1) By the year 2020, Gross National Product is forecasted to increase to 36700 Billion Pesos.

2) Unemployment will peak in 1990 and will decline continuously but the Philippines would still be plagued by high unemployment rate until the middle of the 2000s.

3) The orientation of government policies undertaken by the Aquino Administration may bear fruits by 2000 as deduced from the value of the Relative Earnings in Agriculture (REA) which is forecasted to attain a value of 1 between 1990 and 2000.

4) Population will continuously grow to 84.70 million in 2010, after which it will decline.

Comparing the results of the policy experiments and the base run, the following patterns were observed:

1) Based on Gross National Product (GNP) projection, the agricultural development policy forecasts an improvement over the base run after 30 years of simulation.
2) Under the industrial development policy, Per Capita Income is seen to improve better for the first 30 years of simulation.

3) Relative Earnings in Agriculture (REA), the indicator for distribution of wealth, is forecasted to be of higher value under the environmental protection policy.

4) Unemployment in the non-agriculture sector is contained under the social development policy. This may be attributed to the smaller population size forecasted in this experiment run.

It is evident that each policy experiment has merits and demerits. It would seem that for equitable development to occur, more than one of these policies will have to be implemented.

Computer simulation results of BUKID indicate that the average value of agricultural products will increase from 7.7 million pesos in the initial year to 340.9 million pesos during the 30th year. Furthermore, per capita income is seen to peak during the 20th year (14060 Pesos) and then decline to 12960 pesos during the 30th year.

Rural roads length will increase to 167 kilometers at the end of the simulation period. But it is apparent that the augmentation in the length of the rural roads will not stimulate a corresponding increase in the average road
density. This is due to the surge in the development of rice and corn land under the land reform program.

7.2 MODEL USEFULNESS AND LIMITATIONS

The utility of these models for decision-makers lie in their ability to (1) forecast the system's behavior over a period of time, (2) provide conditional projections of government actions and refusal to act, (3) conduct sensitivity analysis to establish research and data gathering priorities, (4) identify constraints that may influence system behavior, and (5) provide a tool of communication among specialists.

Information about the future obtained from these models will be in the form of conditional projections of the dynamic behavior of the system, a pattern rather than exact values.

In the question of validity, most system dynamists contend that it is dependent on the suitability and consistency of the model. Suitability may be tested by inquiring into the structural suitability of the model in terms of dimensional consistency. It is important that the dimensions of the variables in every equation of the model agree with the computation. Moreover, the modeler must continually test each equation thus to ensure that is
meaningful. As such, model validation is also a subjective endeavor. It is not a static process. The model is open to criticisms and improvement. It is a continuous exercise of model building, model testing, verification of the model's consistency with the slice of reality it tries to capture, and reconsideration of structure.

7.3 CONCLUSIONS AND RECOMMENDATIONS

What has been described in the pages of this report are initial models built using limited access to data, both on the national and regional level. For extension of this study, the following recommendations are made:

1) Further disaggregation for DMP to enable users to experiment with more policy changes.

2) Extension of data gathering to verify and strengthen the underlying structures and stated parameters in both models.

3) Further performance of sensitivity analysis through computer simulation.

4) Exploration of the impact of shortening simulation period to 30 years.

This study presents initial models that may be utilized for national and regional planning. The utility of these
models lie in their ability to forecast behavior of the system in a future time thus providing policy makers with a dynamic tool for evaluating alternative policies. The policy experiments performed were intended to exhibit the potential capacity of these models in aiding economic planning.
REFERENCES:


APPENDICES
APPENDIX A

DEVELOPMENT MODEL OF THE PHILIPPINES PROGRAM EQUATIONS

NOTE ********************************************
NOTE DEVELOPMENT MODEL OF THE PHILIPPINES
NOTE ********************************************
NOTE INDUSTRIAL SECTOR
NOTE
FOR A=1,4=Mining, Manufacturing, Constr,BusIn
NOTE FOR - COMPUTES SUBSCRIBED EQUATIONS A
L IC.K(A)=IC.J(A)+(DT)((CF.JK(A)*(1+AR01*dt))-CD.JK(A))
NOTE IC - INDUSTRIAL CAPITAL (PESOS)
L IC(A)=ICM(A)
T ICM(*)=70E9/570E9/180E9/180E9
NOTE ICM - INITIAL VALUE OF INDUSTRIAL CAPITAL (PESOS)
C ARO1=.21
NOTE ARO1 - ANNUAL RATE OF INFLATION
A TIC.K=SUM(IC.K)
NOTE TIC - TOTAL INDUSTRIAL CAPITAL (PESOS)
A TICM.K=SUM(ICM)
NOTE TICM - TOTAL INDUSTRIAL CAPITAL INITIALLY (PESOS)
R CD.KL(A)=IC.K(A)/LIC(A)
NOTE CD - CAPITAL DEPRECIATION (PESOS/TR)
T LIC(*)=50/50/50/50
NOTE LIC - LIFETIME INDUSTRIAL CAPITAL (TR)
R CT.KL(A)=GNP.K*FGHPCF(A)
NOTE CF - CAPITAL FORMATION (PESOS/TR)
T FGHPCF(8)=.2/.27/.2/.02/.02
NOTE FGHPCF - FRACT GNP CAPITAL FORMATION (DIM)
A IP.K(A)=IO.K(A)*(1-FI01.K(A))
NOTE IP - INDUSTRIAL PRODUCT (PESOS/TR)
A GNP.K=SUM(IP.K)+AP.K
NOTE GNP - GROSS NATIONAL PRODUCT
A IO.K(A)=IC.K(A)/COR.K(A)
NOTE IO - INDUSTRIAL OUTPUT (PESOS/TR)
A FI01.K(A)=FIORM(A)+FI0IF.K(A)
NOTE FI01 - FRACT INDUSTRIAL OUTPUT TO INPUTS (DIM)
T FIORM(*)=.2/.2/.2/.2
NOTE FIORM - FRACT INDUS OUTPUT TO RAW MATERIALS (DIM)
A FI0IF.K(A)=FI0IFM(A)*FI0IFM.K(A)
NOTE FI0IF - FRACT INDUS OUTPUT TO INFRASTRUCTURE (DIM)
T FI0IFM(*)=.4/.4/.4/.4
NOTE FI0IFM - FRACT INDUS OUTPUT TO INFRA NORMAL (DIM)
A FI0IFM.K(A)=TAR1(FI01FT,(TICCI.K/TICCI.K)/(TICM.K/TIFN.K),0,2,.5)
NOTE FI01FT - TABLE VALUES FOR FI01FM (DIM)
T FI01FT=.5/.6/1/1
NOTE FI01FT - TABLE VALUES FOR FI01FM (DIM)

211
A TICI.K=SUM(TICI.K)

NOTE TICI - TOTAL INDUSTRIAL CAPITAL CORRECTED FOR INFLATION (PESOS)

L TICI.K(A)=TICI.J(A)+(DT)((F.JK(A)-CD.JK(A))
N TICI(A)=ICM(A)

NOTE TICI - INDUSTRIAL CAPITAL CORRECTED FOR INFLATION (PESOS)

A COR.K(A)=COR(A)*CORM.K(A)

NOTE COR - CAPITAL OUTPUT RATIO (YR)

T CORM(*)=1.75/1.75/1.75

NOTE CORM - CAPITAL OUTPUT RATIO NORMAL (YR)

A CORM.K(A)=TABXT(CORM(*,A),POLR.K,1,1.1,4,10.4)

NOTE CORM - CAPITAL OUTPUT RATIO MULTIPLIER (DIM)

T CORM(*,MINING)=1.0/1.0
T CORM(*,MANUF)=1.0/1.0
T CORM(*,CONSTR)=1.0/1.0
T CORM(*,BUSIN)=1.0/1.0

NOTE CORM - CORM TABLE VALUES (DIM)

A PCI.K=GNP.K/TP.K

NOTE PCI - PER CAPITA INCOME (PESOS/YR-PERSON)

A PCIM.K=GNPN.K/TPN

NOTE PCIM - INITIAL PER CAPITA INCOME (PESOS/YR-PERSON)

A GNPN.K=(TICM.K*(1-APR01.RM.K-APO1.RM.K)/ACORN.K)+WEAN*EPN*RPF

NOTE GNPN - GROSS NATIONAL PRODUCT NORMAL (PESOS/YR)

A ACORN.K=SUM(FORM/4)

NOTE AFORN - AVER FRAC INDUS OUTPUT TO RAW MATERIALS (DIM)

A AFORK.K=SUM(FYOGF)

NOTE AFORF - AVER FRAC INDUS OUTPUT TO INFRA NORMAL (DIM)

A ACORN.K=SUM(CORM)/4

NOTE ACORN - AVER CAPITAL OUTPUT RATIO NORMAL (YR)

NOTE ENVIRONMENTAL SECTOR

L POL.K(A)=POL.J(A)+(DT)((POLG.JK(A)/(1+AROI*BT))-POLA.JK(A))

NOTE POL - POLLUTION (GRAM)

M POL(A)=POLN(A)
N POLN(A)=ICM(A)

NOTE POLN - POLLUTION INITIAL VALUE (GRAM)

E POLA.KL(A)=POL.K(A)/POLAT.K(A)

NOTE POLA - POLLUTION ABSORPTION (GRAM/YR)

A POLAT.K(A)=((POLATM(A)*TABXT((POLATM(*,A),POLR.K,0,10,1)))

NOTE POLAT - POLLUTION ABSORPTION TIME (YR)

T POLATM(*)=5/5/5/5

NOTE POLATM - POLLUTION ABSORPTION TIME NORMAL (YR)

T POLATM(*,MINING)=1/1.19/1.32/1.41/1.5/1.63/1.68/1.73/1.78
T POLATM(*,MANUF)=1/1.19/1.32/1.41/1.5/1.63/1.68/1.73/1.78
T POLATM(*,CONSTR)=1/1.19/1.32/1.41/1.5/1.63/1.68/1.73/1.78
T POLATM(*,BUSIN)=1/1.19/1.32/1.41/1.5/1.63/1.68/1.73/1.78

NOTE POLATM - TABLE VALUES FOR POL ABSORPTION TIME MULT (DIM)

EPOKL.K(A)=IK.K(A)*UPG(A)

NOTE POKL - POLLUTION GENERATION (GRAM/YR)


212
NOTE UPG - UNIT POLLUTION GENERATION (GRAM/PESO)
A POLR.K=SUM(POLK)/SUM(POLN)
NOTE POLR - POLLUTION RATIO (DIM)
NOTE INFRASTRUCTURE SECTOR
NOTE FOR B=1,8=HIWAY,RAIL,PORTS,AIRPORT,POWER,WATER,TELECOM,SEWER
NOTE FOR - COMPUTES SUBSCRIBED EQUATIONS B
L I.F(IKJK(IKJK)(DT)(IFKJK(IKJK)(1+ARO(IKJK))))
NOTE IF - INFRASTRUCTURE (PESOS)
N IFK(IKJK)=IFN(IKJK)
T IFN(#)=87.5E9/87.5E9/87.5E9/87.5E9/87.5E9/87.5E9/87.5E9/87.5E9/87.5E9
NOTE IFN - INITIAL VALUES OF INFRASTRUCTURE (PESOS)
A TIFN.K=SUM(IFN.K)
NOTE TIF - TOTAL INFRASTRUCTURE (PESOS)
A TIFN.K=SUM(IFN.K)
NOTE TIFN - TOTAL INFRASTRUCTURE INITIALLY (PESOS)
R IFD.KL(IKJK)=IFK(IKJK)/LIF(IKJK)
NOTE IFD - INFRASTRUCTURE DEPRECIATION (PESOS/YR)
T LIF(IKJK)=50/50/50/50/50/50
NOTE LIF - LIFETIME INFRASTRUCTURE (YR)
R IFK(IKJK)=GNP.IKIFWIPF(IKJK)
NOTE IFI - INFRASTRUCTURE INVESTMENT (PESOS/YR)
T FGWPFI(IKJK)=.01/.01/.01/.01/.01/.01/.01
NOTE FGWPFI - FRACT GNP TO INFRASTRUCTURE (DIM)
S IFCCF(IKJK)=(1/IIFC.IKTP)/TIFK.IKTP)
NOTE IFCCFR - INFRA CAPITAL PER CAPITA RATIO (DIM)
L IFCI.IKJK=IFIJK(IKJK)(DT)((IFIFKJK(IKJK)(1+ARO(IKJK)))-IFD.IKJK(IKJK))
N IFCI(IKJK)=IFN(IKJK)
NOTE IFC1 - INFRASTRUCTURE CORRECTED FOR INFLATION (PESOS)
A TIFCU.K=SUM(IFCU.K)
NOTE TIFCU - TOTAL INFRASTRUCTURE CORRECTED FOR INFLATION (PESOS)
NOTE SOCIAL DEVELOPMENT SECTOR
NOTE FOR C=1,5=HEALTH,EDUCA,HOUSING,FAMPLW,WELFARE
NOTE FOR - COMPUTES SUBSCRIBED EQUATIONS C
L SDC.K=(SDC.JK(IKJK)(DT)(SCIJK(IKJK)-SDJC.IKJK(IKJK))
NOTE SDC - SOCIAL DEVELOPMENT CAPITAL (PESOS)
N SDC(IKJK)=SDC(IKJK)
T SDCM(IKJK)=95E9/95E9/95E9/95E9/95E9/95E9/95E9/95E9/95E9
NOTE SDCM - SOCIAL DEVELOPMENT CAPITAL INITIAL (PESOS)
A TSDCM.K=SUM(SDCM.K)
NOTE TSDC - TOTAL SOCIAL DEVELOPMENT CAPITAL (PESOS)
A TSDCM.K=SUM(SDCM.K)
NOTE TSDCM - TOTAL SOCIAL DEVELOPMENT CAPITAL INITIALLY (PESOS)
R SDC.KL(IKJK)=SDC.IKJK(IKJK)/LSDC(IKJK)
NOTE SCD - SOCIAL DEVELOPMENT CAPITAL DEPRECIATION (PESOS/YR)
T LSDC(IKJK)=50/50/50/50/50/50
SCI.KL(C)=GNP.K*FGNPSD(C)
NOTE SCI - SOCIAL DEVELOPMENT CAPITAL INVESTMENT (PESOS/YR)
T FGNPSD(*)=.012/.012/.012/.012/.012
NOTE FGNPSD - FRACT GNP TO SOCIAL DEVELOPMENT (DIM)
A SDCPCR.K=((TSDCCI.K/TP.K)/(TSDCM.K/TPN))
NOTE SDCPCR - SOCIAL DEVELOPMENT CAPITAL PER CAPITAL RATIO (DIM)
L SDCCI.K(C)=SDCCI.J(C)*((DT)((SCI.JK(C)/(1+AROI*DT)))-SCD.JK(C))
N SDDCI(C)=SDCM(C)
NOTE SDCCI - SOCIAL DEV. CAPITAL CORRECTED FOR INFLATION (PESOS)
A TSDCCI.K=SUM(SDCCI.K)
NOTE TSDCCI - TOTAL SOCIAL DEV. CAPITAL CORRECTED FOR INFLATION (PESOS)
NOTE
NOTE DEMOGRAPHIC SECTOR
NOTE
A TP.K=UP.K*RP.K
NOTE TP - TOTAL POPULATION (PERSONS)
W TPM=UPM+RPN
NOTE TPN - TOTAL POPULATION NORMAL (PERSONS)
NOTE UP - URBAN POPULATION
C UPM=19.32E6
NOTE UPN - URBAN POPULATION INITIAL VALUE
R UB.KL=UP.K*UP.E
NOTE UB - URBAN BIRTHS
A UF.K=UFM*UPM.K
NOTE UF - URBAN FERTILITY (FRAC/yr)
C UFM=.0355
NOTE UFN - URBAN FERTILITY NORMAL (FRACT/YR)
A UFM.K=TABXT(UFMT,SDCPCR.K,.5,.5)
NOTE UFMT - URBAN FERTILITY MULTI. TABLE VALUES
I UD.KL=UP.K*UM.K
NOTE UD - URBAN DEATHS (PERSONS/YR)
A UM.K=PMN.K*ULEM.K/ULEN
NOTE ULE - URBAN MORTALITY (FRACT/YR)
C ULEM=63
NOTE ULEM - URBAN LIFE EXPECTANCY NORMAL (YRS)
A ULEM.K=TABLE(ULEMT,SDCPCR.K,.5,.5)
NOTE ULEMT - URBAN LIFE EXPECTANCY MULTIPLIER
A PMN.K=TABLE(PMNT,POLR.K,0,10,1)
NOTE PMN - POLLUTION MORTALITY MULTIPLIER (DIM)
T PMNT=1/1/1.005/1.013/1.025/1.043/1.07/1.11/1.16/1.22/1.29
NOTE PMNT - POLLUTION MORTALITY MULTIPLIER TABLE VALUES
R ER.KL=UP.K*EF*EM.K
NOTE ER - EMIGRATION RATE (PERSONS/YR)
C TF=.001
NOTE EF - EMIGRATION FACTOR
A EM.K=TABLE(ENT,PCI.K/PCIM.K,0,2,.25)
NOTE PCIM - EMIGRATION MULTIPLIER

214
T  EMT=20/8/4/2/1/.85/.8/.8/.8
NOTE EMT - EMIGRATION MULTIPLIER TABLE VALUES
R  IM.KL=CLIP(FRES,0,TIME.K,1992)-CLIP(FRES,0,TIME.K,1997)+NIM
NOTE IM - IMMIGRATION (PERSONS/yr)
C  FRES = 100
NOTE FRES - FOREIGN RESIDENTS (PERSONS/yr)
C  NIM=1000
NOTE NIM - NORMAL IMMIGRATION (PERSONS/yr)
L  RP.K=RP.J+(DT)(RK.JK-RD.JK-RUM.JK)
M  RP=RPN
NOTE RP - RURAL POPULATION (PERSONS)
C  RPN=29E6
NOTE RPN - RURAL POPULATION INITIAL (PERSONS)
R  RB.KL=RP.K*RF.K
NOTE RB - RURAL BIRTHS
A  RF.K=RFN*RFM.K
NOTE RF - RURAL FERTILITY (FRAC/yr)
C  RFM=.045
NOTE RFN - RURAL FERTILITY NORMAL (FRAC/yr)
A  RFN.K=TBXT(RFM,SDCPR.K,.5,6,.5)
NOTE RFMT - RURAL FERTILITY MULT. TABLE VALUES
R  RD.KL=RP.K*RM.K
NOTE RD - RURAL DEATHS (PERSONS/yr)
A  RM.K=RLEN.K/RLEN
NOTE RM - RURAL MORTALITY (FRAC/yr)
C  RLEN=64
NOTE RLEN - RURAL LIFE EXPECTANCY NORMAL (YR)
A  RLEN.K=TBXT(RLEN,SDCPR.K,.5,6,.5)
NOTE RLEN - RURAL LIFE EXPECTANCY MULT. TABLE VALUES
S  FPU.K=UP.K/TP.K
NOTE FPU - FRAC POPULATION URBAN (DIM)
S  PD.K=TP.K/AREA
NOTE PD - POPULATION DENSITY (PERSONS/SQ. KM.)
C  AREA=300000
NOTE AREA - AREA OF THE PHILIPPINES (SQ. KM.)
NOTE
NOTE AGRICULTURE SECTOR
NOTE
R  RUN.KL=MRPG.K*RUMM.K
NOTE RUN - RURAL-URBAN MIGRATION (PERSONS/yr)
A  MRPG.K=RJ.K-RD.JK
NOTE MRPG - NATURAL RURAL POPULATION GROWTH (PERSONS/yr)
A  RUMM.K=TBXT(RUMMT,REA.K/RK,0,2,.5)
T  RUMMT=2/1.4/1/.75/6
NOTE RUMMT - TABLE VALUES FOR RURAL URBAN MIGRATION MULT
N  REAN=WENAN
NOTE REAN - RELATIVE EARNINGS AGRICULTURAL NORMAL (DIM)
A  WENAN.K=(GMPH.K-WEN*RPN*RIPF)/LFMAN

215
NOTE WENAM - WORKER EARNINGS NON-AGRICULTURE NORMAL (PESOS/WORKER-YR)
N  LFANAM=UPM*ULPF
NOTE LFANAM - LABOR FORCE NON-AGRICULTURE NORMAL (WORKERS)
A  REA.A=WEN.A/WENA.K
NOTE REA - RELATIVE EARNINGS IN AGRICULTURE (DIM)
A  WENA.K=SUM(IP.K)/JOBSMA.K
NOTE WENA - WORKER EARNINGS NON-AGRICULTURAL (PESOS/WORKER-YR)
A  WEA.K=WEAN*(CROPA.K/CROPAN)*(ADI.K/ADIN)
X  *((1+AR0I*DT)**(TIME.K-1980))
NOTE WEA - WORKER EARNINGS AGRICULTURE (PESOS/WORKER)
C  WEAN=2500
NOTE WEAN - WORKER EARNINGS AGRICULTURE NORMAL (PESOS/WORKER-YR)
C  ADIN=10
NOTE ADIN - AGRICULTURAL DIVERSITY INDEX NORMAL (DIM)
A  ADI.K=TEXT(ADI.K,TIME.K,1980,2050,10)
NOTE ADI - AGRICULTURAL DIVERSITY INDEX (DIM)
T  ADIT=10/11.4/11.9/12.7/12.2/13.6/14/14.3
NOTE ADIT - TABLE VALUES FOR ADI
A  CROPA.K=CULTL.K*MCI.K
NOTE CROPA - CROP AREA (HA)
N  CROPAN=CULTLN*MCI
NOTE CROPAN - CROP AREA NORMAL (HA)
C  MCI=2.0
NOTE MCI - MULTIPLE CROPPING INDEX (DIM)
A  MCI.K=TEXT(MCIM,K,TIME.K,1980,2050,10)
X  TABXT(MCIM,TIME.K,1980,2050,10)
NOTE MCIM - TABLE VALUES FOR MCI MULT.
S  PCCPR.K=([CROPA.K]/[CROPAN/TPN])
NOTE PCCPR - PER CAPITA CROP PRODUCTION RATIO
A  LFA.K=RF.K*ELPF
NOTE LFA - LABOR FORCE AGRICULTURE (WORKERS)
C  ELPF=.36
NOTE ELPF - RURAL LABOR PARTICIPATION FACTOR (DIM)
L  CULTL.K=CULTL.J-(DT)(LCR.JK)
N  CULTLN=CULTLN
NOTE CULTLN - CULTIVATED LAND (HA)
C  CULTLN=12.0X6
NOTE CULTLN - CULTIVATED LAND INITIALLY (HA)
L  UIL.K=UIL.J+(DT)(LCR.JK)
N  UIL=UILN
M  UILN=1((ICN(1)+ICN(2)+ICN(3)+ICN(4))+(IFN(1)+IFN(2)+IFN(3)+IFN(4)
X  +IFN(5)+IFN(6)+IFN(7)+IFN(8))(SDCN(1)+SDCN(2)+SDCN(3)+
X  SDCN(4)+SDCN(5)))*LPCN*UP.K*LPPN
NOTE UILN - URBAN INDUSTRIAL LAND INITIALLY (HA)
C  LPCN=1.2-8
NOTE LPCN - LAND PER CAPITAL NORMAL (HA/PESO)
NOTE LPPM - LAND PER PERSON NORMAL (HA/PERSON)
A LPPM.K=LPCM*K/LPCM.K
NOTE LPC - LAND PER CAPITAL (HA/PESO)
A LPP.K=LPPM*NK/LPPM.K
NOTE LPP - LAND PER PERSON (HA/PERSON)
A LPCM.K=Tab(LPCM,ULR.K/ULW,0.5,1)
T LPCM=1.2/1.0/.95/.9/.82/.8
NOTE LPCM - LAND PER CAPITA MULTIPLIER (DIM)
A LPCM.K=Tab(LPPMT,ULR.K/ULW,0.5,1)
T LPPMT=1.2/1.0/.95/.9/.82/.8
NOTE LPPMT - LAND PER PERSON MULT. TABLE VALUES (DIM)
R LCR.K=ULR.K/LKT
NOTE LCR - LAND CONVERSION RATE (YR)
C LCT=5
NOTE LCT - LAND CONVERSION TIME (YR)
A ULR.K=(TIC.K*YIF.K*TS.D.K)*LPC.K*UP.K*LPP.K
NOTE UIER - URBAN INDUSTRIAL LAND REQUIRED (HA)
A AP.K=WKA.K*LFA.K
NOTE AP - AGRICULTURAL PRODUCT (PESOS/YR)
C FGMPA=.08
NOTE FGMPA - FRACT GNP TO AGRICULTURE (DIM)
C FGMPAM=.08
NOTE FGMPAM - FRACT GNP TO AGRICULTURE NORMAL (DIM)
S AF.S=(CULTL.K/CULTLN)*CRF.RP.K*AFS
NOTE AFS - AVERAGE FARM SIZE (HA)
C AFSN=2.6
NOTE AFSN - AVERAGE FARM SIZE IN 1980 (HA)
S PPF.K=TP.K/LFA.K
NOTE PPF - POPULATION PER FARMER (DIM)
NOTE
NOTE EMPLOYMENT SECTOR
NOTE
A JII.K(A)=IIC.K(A)/ICLR.K(A)
NOTE JII - JOBS IN INDUSTRY (PERSONS)
A ICLR.K(A)=ICLRN(A)*ICLRK.K(A)
NOTE ICLR - INDUS CAPITAL-LABOR RATIO (PESOS/PERSON)
NOTE ICLRN - INDUSTRIAL CAPITAL--=LABOR RATIO NORMAL (PESOS/PERSON)
A ICLRN.K(A)=Tab(tc1ET(*,A),IVC.K(A)/ICN(A),1,1,1)
NOTE ICLRN - INDUS CAPITAL-LABOR RATIO MULTIPLIER (DIM)
T TC1ET(*,1)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66
T TC1ET(*,2)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66
T TC1ET(*,3)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66
T TC1ET(*,4)=1/1.50/1.96/2.38/2.76/3.10/3.40/3.66
NOTE ICLRN - TABLE VALUES FOR ICLRN
A JJIF.K(B)=IFI.K(B)/IFCLR.K(B)
NOTE JJIF - JOBS IN INFRASTRUCTURE (PERSONS)
A IFCLR.K(B)=IFCLRN(B)*IFCLRN.K(B)
NOTE IFCLR - INFRASTRUCTURE CAPITAL-LABOR RATIO (PESOS/PERSON)
NOTE IFCLRM - INFRA CAPITAL-LABOR RATIO NORMAL (PESOS/PERSON)
T IFCLRM[*1]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*2]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*3]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*4]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*5]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*6]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*7]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T IFCLRM[*8]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
NOTE IFCLRT - TABLE VALUES FOR IFCLRM
A JISD.K(C)=SDCCI.K(C)/SDCLR.K(C)
NOTE JISD - JOBS IN SOCIAL DEVELOPMENT (PERSONS)
A SDCLR.K(C)=SDCLRN(C)*SDCLRM.K(C)
NOTE SDCLR - SOCIAL DEVELOPMENT CAPITAL-LABOR RATIO (PESOS/PERSON)
T SDCLR=[0.2066/0.2066/0.2066/0.2066/0.2066/0.2066]
NOTE SDCLRM - SOCIAL DEVEL CAPITAL-LABOR RATIO NORMAL (PESOS/PERSON)
A SDCLRM.K(C)=TABIX(SDCLR(*,C),SDCCI.K(C)/SDCM(C),1,6,1)
NOTE SDCLRT - TABLE DEVEL CAPITAL-LABOR RATIO MULTIPLIER (DIM)
T SDCLRT[*1]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T SDCLRT[*2]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T SDCLRT[*3]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T SDCLRT[*4]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
T SDCLRT[*5]=1.50/1.96/2.38/2.76/3.10/3.40/3.66
NOTE SDCLRT - TABLE VALUES FOR SDCLRT
S LF.K=LFNA.K*LFA.K
NOTE LF - LABOR FORCE (PERSONS)
A LFNA.K=UP.K*ULPF
NOTE LFNA - LABOR FORCE NON-AGRICULTURE (PERSONS)
C ULPF=0.60
NOTE ULPF - URBAN LABOR FORCE PARTICIPATION FRACT (DIM)
A JOBSNA.K=TIJII.K+TIJIF.K+TJISD.K
NOTE JOBSMA - JOBS NON-AGRICULTURE (PERSONS)
A TJII.K=SUM(TIJI.K)
NOTE TJII - TOTAL JOBS IN INDUSTRY (PERSONS)
A TIJIF.K=SUM(TIJIF.K)
NOTE TIJIF - TOTAL JOBS IN INFRASTRUCTURE (PERSONS)
A TJISD.K=SUM(TJISD.K)
NOTE TJISD - TOTAL JOBS IN SOCIAL DEVELOPMENT (PERSONS)
S UNENMA.K=(LFNA.K-JOBSMA.K)/LFNA.K
NOTE UNENMA - UNEMPLOYMENT NON-AGRICULTURE (DIM)
NOTE
NOTE CONTROL STATEMENT
NOTE
C DT=0.50
N TIME=1980
C LENGTH=2050
C PLTAPER=1
C PRTAPER=10
PLOT UP=U,RP=R,TP=T
```
OPTION PLOTS=OFF;

DATA A; SET WORK.A;
  KEEP Y X; RUN;
```

NOTE SOCIAL DEVELOPMENT POLICY

RUN S
T  FGMPF(*)=0.02575/0.17375/.05775/.05775
T  FGWIF(*)=.00875/.00875/.00875/.00875/.00875/.00875/
X  .00875
T  FGMPSD(*)=0.012/0.012/0.012/0.012/0.012
C  FGMPA=0.075

NOTE INDUSTRIAL DEVELOPMENT POLICY

RUN I
T  FGNCF(*)=0.0195/.1675/.0515/.0515
T  FGMPIF(*)=.011875/.011875/.011875/.011875/.011875/
X  .011875/.011875
T  FGMPSD(*)=0.012/0.012/0.012/0.012/0.012
C  FGMPA=0.075

NOTE INFRASTRUCTURE DEVELOPMENT POLICY

RUN F
T  CORN(*)=1.90/1.90/1.90/1.90
T  UPG(*)=.20/.20/.20/.20

NOTE ENVIRONMENTAL PROTECTION POLICY

RUN E
C  LPCN=1.0E-8
C  LPPW=0.0037
T  FIOIFN(*)=0.44/0.44/0.44/0.44

NOTE ZONING POLICY

RUN Z
QUIT

**************************************************END OF PROGRAM**************************************************
APPENDIX B

BUKID PROGRAM EQUATIONS

NOTE:  *************************************************************************************************************
NOTE:  RURAL REGIONAL DEVELOPMENT MODEL
NOTE:  *************************************************************************************************************
NOTE:  RURAL REGION
NOTE:  *************************************************************************************************************
NOTE:  DEMOGRAPHIC SUB-SECTOR
NOTE:  *************************************************************************************************************

L  RP.K=RP.J*(DT)*(RB.JK-RD.JK-RUM.JK)
NOTE RP - RURAL POPULATION (PERSONS/yr)
N  RP=18398
E  RB.KL=RP.K*RBRN
NOTE RB - RURAL BIRTHS (PERSONS/yr)
C  RBRN=0.04
R  RD.KL=RP.K*RDRN
NOTE RD - RURAL DEATHS (PERSONS/yr)
C  RDRN=0.008
E  RUM.KL=NRPG.K*RUMM.K
NOTE RUM - RURAL-URBAN MIGRATION (PERSONS/yr)
A  NRGP.K=RB.JK-RD.JK
NOTE NRPG - NATURAL RURAL POPULATION GROWTH
A  RUMM.K=TABLEL(RUMNT,URUR.K,,0,2,.5)
T  RUMNT=2/1.4/1/.75/.6
A  URUR.K=UUR.K/RUR.K
NOTE URUR - URBAN-RURAL UNEMPLOYMENT RATIO
NOTE:  *************************************************************************************************************
NOTE:  RURAL LABOR FORCE
NOTE:  *************************************************************************************************************
A  RLF.K=RP.K*RPFF
C  RPFF=0.30
NOTE RPFF - RURAL POPULATION PARTICIPATION FACTOR
L  RCF.K=RCF.J*(DT)*(WF.JK-FLR.JK)
NOTE RCF - RICE AND CORN FARMERS
N  RCF=2150
E  WF.KL=DNF.K*RUMM.K
NOTE WF - NEW FARMERS
A  DNF.K=CTLA.K/DLPF
NOTE DNF - DESIRED NO. OF FARMERS
C  DLPF=4
NOTE DLPF - DESIRED LAND PER FARMER (HA/FARMER)
A  RUMM.K=TABLEL(RUMNT,RUM.K/NUR,0,1,1)
NOTE RUMM - RURAL UNEMPLOYMENT RATE MULTIPLIER
T  RUMNT=.1/.1/.2/.5/.8/1/1.2/1.4/1.5/.8/2
C  NUR=0.06
NOTE NUR - NATIONAL UNEMPLOYMENT RATE
E  FLR.KL=RCF.K*FLM*FLM.K
NOTE FLR - FARMER LEAVING RATE
C FLN=0.001
A FLN.K=TABHL(FLMT,FTNIR.K,0,2,2)
T FLMT=2/1.9/1.8/1.6/1.2/1.58/1.3/2/1.1
A FTNIR.K=APPF.K/AMI

NOTE FTNIR - FARMER TO NATIONAL INCOME RATIO
C AMI=30000

NOTE AMI - AVERAGE NATIONAL INCOME (Pesos/yr)
A APPF.K=PPH.K*LPF

NOTE LPF - AVERAGE PROFIT PER FARMER (P/yr)
C LPF=2

NOTE LPF - LAND PER FARMER (HA/FARMER)

NOTE
NOTE AGRARIAN REFORM AND COMPACT FARMING DEVELOPMENT
NOTE
L PLT.K=PLT.J-(DT)(LRT.JK)

NOTE PLT - POTENTIAL RICE AND CORN LAND FOR TRANSFER
N PLT=22000
R LTR.KL=MIN(LTRD.JK,LTRP.JK)
R LTRP.KL=LRBA.K/LRC

NOTE LTRP - LAND TRANSFER RATE POSSIBLE (HA/yr)
C LEC=20000

NOTE LRC - LAND REFORM COST (Pesos/ha)
L LRBA.K=LRBA.J+(DT)(LRFR.JK)

NOTE LRBA - LAND REFORM BUDGET ALLOCATION (Pesos/yr)
N LRBA=2026
R LRFR.K=LRBA.K*LRFR

NOTE LRFR - LAND REFORM FUNDING RATE (1000 Pesos/yr)
C LRFRM=0.10
R LRFR.K=LRBA.K/LRFR

NOTE LTRD - LAND TRANSFER RATE DESIRED (HA/yr)
C LRT=6

NOTE LRT - LAND REFORM TIME (yr)
L NCF.K=NCF.J+(DT)(CFCR.JK)

NOTE NCF - NUMBER OF COMPACT FARMS
N NCF=80
R CFCR.JK=MIN(CFCRP.JK,CFCRD.JK)

NOTE CFCR - COMPACT FARM CONVERSION RATE
R CFCRD.KL=(DMCF - NCF.K)/CFCT

NOTE CFCRD - COMPACT FARM CONVERSION RATE DESIRED
C DMCF=880

NOTE DMCF - DESIRED NO. OF COMPACT FARMS
C CFCT=6

NOTE CFCT - COMPACT FARM CONVERSION TIME (yr)
R CFCRP.KL=AT.K*CFCHFT*RLCM.K

NOTE CFCRP - COMPACT FARM CONVERSION RATE POSSIBLE (HA/yr)
C CFCHFT=14

NOTE CFCHFT - COMPACT FARMS HANDLED BY AGRI. TECH
A RLCM.K=TABEL(RLCMT,PPH.K/EPPH,0.2,2)

NOTE RLCM - RICE & CORN LAND CONVERSION MULT
NOTE EPPH - EXPECTED PROFIT PER HECTARE (1000/P/HA)
A CFLA.K=25*NCF.K
NOTE CFLA - COMPACT FARM LAND AREA (HA)
NOTE
NOTE AGRIC. - TECHNICIAN AVAILABILITY
NOTE
L AT.K=AT.J+(DT)(ATT.JK - ATL.JK)
N AT=10
R ATT.KL=(AT.K*ATLN)/TRT
NOTE ATT - AGRIC. - TECHNICIAN TRAINING RATE (TECHNICIANS/YR)
C ATTN=0.06
C TRT=0.25
NOTE TRT - TECHNICIAN TRAINING TIME (YRS)
R ATL.KL=AT.K*ATLN
NOTE ATL - AGRIC. TECH LEAVING RATE (TECHNICIANS/YR)
C ATLN=0.05
A ATTTR.K=AT.K/BCF.K
NOTE ATTTR - AGRIC. TECHNICIAN TO FARMER RATIO
NOTE
NOTE FARM PRODUCTIVITY
NOTE
A TPH.K=THP*FMM.K*FUM.K*ATN.K*CAFPM.K
NOTE YPH - YIELD PER HECTARE
N TPH=2
A FMM.K=TMH/AMU.K*AMU.K*AMU.K*AMU.K*AMU.K*AMU.K
NOTE FMM - FARM MECHANIZATION MULTIPLIER
I FMNT=1/1.02/1.04/1.06/1.075/1.09/1.1
A AMU.K=MHU.K/CFLA.K
NOTE AMU - AVE. MACHINERY USAGE (HP/HA)
L MUJ.K=MHU.K+(DT)(MHIJ.K-MHJR.K)
NOTE MHU - MACHINERY HP USAGE
N MHU=65
R MHJR.KL=MHU.K/AMU
NOTE MHJR - MACHINERY HP DEPLETION RATE (HP/YR)
C AMU=8
NOTE AMU - AVERAGE MACHINE LIFETIME (YRS)
R DMHJR.KL=(DMUI - AMU.K)(CFLA.K)/CFMIT
NOTE DMHJR - DESIRED MACHINERY HP INCREASE RATE (HP/YR)
C DMUI=2.78
NOTE DMUI - DESIRED MACHINERY USAGE INTENSITY (HP/TE)
C CFMIT=16
NOTE CFMIT - COMPACT FARM MECHANIZATION IMPLEMENTATION TIME
R MPHMJR.KL=CFM.K/UCFM
NOTE PPHMR - POSSIBLE MACHINERY HP INC. RATE (HP/YR)
C UCFM=2.5
NOTE UCFM - UNIT COST OF FARM MACHINERY (1000/P/YR)
R MHJR.KL-MIN(PHMJR.K, DMHJR.K)+FAN.K
NOTE MHJR - HP INCREASE RATE (HP/YR)
A \quad \text{FAM.K} = \text{TABHL(FAMT, AWPH.K, 5, 2, 5)}

\text{NOTE FAM - FARMER AVAILABILITY MULTIPLIER}

T \quad \text{FAMT} = \text{1.2/8.7/6}

A \quad \text{AWPH.K} = \text{RLF.K/CFLA.K}

\text{NOTE AWPH - AGRICULTURAL WORKER PER HECTARE}

A \quad \text{FUM.K} = \text{TABHL(FUMT, FAL.K, 0, 1, .02)}

\text{NOTE FUM - FERTILIZER USE MULTIPLIER}

T \quad \text{FUMT} = \text{1/1.02/1.04/1.06/1.08/1.1}

L \quad \text{FAL.K} = \text{FAL.I + (DT)(FALIR.JK)}

\text{NOTE FAL - FERTILIZER APPLICATION LEVEL (MT/HA/YR)}

C \quad \text{FAL} = 0

R \quad \text{FALIR.KL} = \text{(DFAL - FAL.K)/FALAT(CAFAM.K)}

\text{NOTE FALAT - FERTILIZER APPLICATION LEVEL ATTAINMENT}

A \quad \text{CAFAM.K} = \text{TABHL(CAFAM, CARCFP.K, 0, 1, .2)}

\text{NOTE CAFAM - CAPITAL AVAILABILITY-FERTILIZER APP. MULT.}

T \quad \text{CAFAMT} = \text{1/1.05/1.1/1.2/1.3/1.35}

A \quad \text{CARCFP.K} = \text{CCP.K/((CFCRN)(CFLA.K))}

\text{NOTE CARCFP - CAPITAL AVAILABLE RATIO}

C \quad \text{CFCRN} = 2

\text{NOTE CFCRN - COMPACT FARM CONVERSION RATE NORMAL}

A \quad \text{ATM.K} = \text{TABHL(ATMT, ATTFR.K, 0, .005, .001)}

\text{NOTE ATM - AGRI. TECHNICIAN MULTIPLIER}

T \quad \text{ATMT} = \text{1/1.04/1.06/1.08/1.09/1.1}

A \quad \text{CACFPMT} = \text{TABHL(CACFPMT, CARCFP.K, 0, 1, 2)}

T \quad \text{CACFPMT} = \text{0.70/0.75/0.8/0.9/1.1}

\text{NOTE}

\text{NOTE AFTER PRODUCTION LOSS LEVEL}

\text{NOTE}

L \quad \text{UMCL.K} = \text{UMCL.J + (DT)(UMCPR.JK - UMCTR.JK)}

\text{NOTE UMCL - UNMILLED CROP LOSS (MT/YR)}

W \quad \text{UMCLN} = 0.12

R \quad \text{UMCPR.KL} = \text{YPH.K*MIN(CFLA.K, FLA)}

\text{NOTE UMCPR - UNMILLED CROP PRODUCTION RATE (MT/YR)}

C \quad \text{FLA} = 35000

\text{NOTE FLA - FARM LAND AREA (HA)}

\text{NOTE}

\text{NOTE COST OF FARMING PER HECTARE}

\text{NOTE}

A \quad \text{CPH.K} = \text{(RCH.K + MLCH + WMICH + (FAL.K*COF)}}

X \quad + \text{((FCOT.K*YPH.K)}}

A \quad \text{RCH.K} = \text{CLIP(0, RCHN, TIME.X, 15)}

C \quad \text{RCHN} = 400

\text{NOTE NRCH - NORMAL RENTAL COST PER HECTARE}

C \quad \text{MLCH} = 2000

\text{NOTE MLCH - NORMAL LABOR COST PER HECTARE}

C \quad \text{WMICH} = 2700

224
NOTE WHICH - NORMAL MECHANICAL INPUT COST PER HECTARE
C COF=180
NOTE COF - COST OF FERTILIZER (P/KG)
NOTE
NOTE PROFIT PER HECTARE
NOTE
A PPH.K=(TPH.K*SPT)-CPH.K
C SPT=6000
NOTE SPT - SELLING PRICE OF UNMILLED CROP/TON
NOTE
NOTE ASRO-BASED INDUSTRIES
NOTE
L CAB.K=CAB.J+(DT)(CARAB.JK-CDAB.JK)
NOTE CAB - CAPITAL IN ASRO-BASED INDUSTRIES (1000P/yr)
N CAB= 1E5
R CARAB.KL=DELAY3(CAAB.JK,DCARAB)
NOTE CARAB - CAPITAL ADD REALIZED IN ASRO-BASED IND.
C DCARAB=2
NOTE DCARAB - DELAY IN CAPITAL ADD REALIZED IN AB IND.
R CDAB.KL=CDRAB*CAB.K
NOTE CDAB - CAPITAL DISCARD IN AB INDUSTRIES
C CDAB=0.05
NOTE CDRAB - CAPITAL DISCARD RATIO IN AB IND.
R CAAB.KL=CANAB+CAL.K*CANAB.K
NOTE CAAB - CAPITAL ADD IN AB INDUSTRIES
C CANAB=0.1
NOTE CANAB - CAPITAL ADD NORMAL IN AB IND.
A CANAB.K=TABRL(CANTAB,DPRAB.K,.5,.2,.5)
NOTE CAMAB - CAPITAL ADD MULT. IN AB IND.
T CANTAB=0.5/1/1.2/1.4
A DPRAB.K=DMFAB.K/PAB.K
NOTE DPRAB - DEMAND-PRODUCTION RATIO IN AB IND.
A PAB.K=MIN(DMFAB.K, PCAB.K)
NOTE PAB - PRODUCTION IN AB IND. (P/yr)
L DMFAB.K=DMFAB.J+(DT/DMFAB)(DMAB.J-DMFAB.J)
NOTE DMFAB - DEMAND PERCEIVED IN AB INDUSTRIES
N DMFAB=325
C DDMFAB=0.75
NOTE DDMFAB - DELAY IN DEMAND PERCEPTION IN AB INDUSTRIES
A DMAB.K=EDMAB.K*LDMAB.K
NOTE DMAB - DEMAND IN AB INDUSTRIES
A LDMAB.K=(RP.K)(DMFAB*PCI.K)
C DMFAB=0.05
NOTE DMFAB - DEMAND FACTOR IN AB IND. (P/yr/PERSON)
L EDMAB.K=EDMAB.J+(DT)(CEDMAB.JK)
NOTE EDMAB - EXPORT DEMAND IN AB INDUSTRIES (1000 P/yr)
N EDMAB=2.5E5
R CEDMAB.KL=ENGAB.K*EDMAB.K
NOTE CEDMAB - CHANGE IN EXPORT DEMAND IN AB (1000P/yr/yr)
A ENGAB.K=MSAB*(1+(CEAB)(1-RCIAB.K))

225
NOTE EMGAB - EXPORT MARKET GROWTH IN AB IND.
C C0AB=0.045

NOTE MGAB - MARKET GROWTH IN AB INDUSTRIES
C C0AB=0.4

NOTE CEAB - COST ELASTICITY IN AB INDUSTRIES
A BC1AB.K=WCUPAB+WMAAB/RMAAB.K+WMAAB/MAAB.K+
X WLCAB*RW.K

NOTE RC1AB - RELATIVE COST INDEX IN AB INDUSTRIES
C WCUPAB=0.763

NOTE WCUPAB - WEIGHTAGE OF CONSTANT COST OF PRODUCTION IN AB
C WMAAB=0.023

NOTE WMAAB - WEIGHTAGE OF RAW MATERIAL ACCESSIBILITY IN AB
C WMAAB=0.016

NOTE WMAAB - WEIGHTAGE OF MARKET ACCESSIBILITY IN AB IND.
C WLCAB=0.198

NOTE WLCAB - WEIGHTAGE OF LABOR COST IN AB IND.
A RMAAB.K=TNRAB,AR.D.K,0.1,5

NOTE RMAAB - RAW MATERIAL ACCESSIBILITY IN AB IND.
T RMAAB.K=0.01/1.5
A RMAAB.K=TNRAB,AR.D.K,0.1,5

NOTE MAAB - MARKET ACCESSIBILITY IN AB INDUSTRIES
T MAABT=0.01/1.5
A PCAB.K=CA.K/COAB.K

NOTE PCAB - PRODUCTION CAPACITY IN AB INDUSTRIES (PESOS/TR)
L COAB.K=COAB.J+(DT)(CCOAB.KK)

NOTE COAB - CAPITAL OUTPUT FACTOR IN AB INDUSTRIES (YR)
W COAB=0.35
R CCOAB.KL=CCOAB*COAB.K

NOTE CCOAB - CHANGE IN CAPITAL OUTPUT IN AB INDUSTRIES
C CCOAB=0.015

NOTE CCOAB - CHANGE IN CAPITAL OUTPUT RATIO IN AB IND.
A ABP.K=AB.K*PEPAB

NOTE ABP - AGRICULTURAL INDUSTRIES PRODUCTION (MT/YR)
C PEPAB=20000

NOTE PEAB - PER EMPLOYEE PRODUCTION IN AB IND. (MT/YR)
A PEAB.P=PEB.K/LOFAB.K

NOTE PEAB - EMPLOYMENT IN AB INDUSTRIES
L LOFAB.K=LOFAB.J+(DT)(CLOFAB.KK)

NOTE LOFAB - LABOR OUTPUT FACTOR IN AB INDUSTRIES
W LOFAB=50000
R CLOFAB.KL=CLOFAB*LOFAB.K

NOTE CLOFAB - CHANGE IN LABOR OUTPUT FACTOR IN AB IND.
C CLOFAB=

NOTE CLOFAB - CHANGE IN LABOR OUTPUT FACTOR RATIO IN AB
L RW.K=RW.J+(DT)(TRW-RW.J)/RWAT

NOTE RW - RELATIVE WAGE (DIN)
W RW=0.80
C RWAT=5

NOTE RWAT - RELATIVE WAGE ADJUSTMENT TIME (YR)
C TRW=1.2
NOTE TRW - TARGET RELATIVE WAGE (D)
NOTE RURAL UNEMPLOYMENT RATE
NOTE A RUR.K=(RLF.K-(AJ.K+JFRC.K+EAB.K))/RLF.K
NOTE AJ = AGRICULTURAL JOBS
NOTE A JFRC.K=(RCR.K*JFRR)
NOTE JFRR = JOBS FROM ROAD CONSTRUCTION (PERSONS/HR)
NOTE RCR = JOBS PER KILOMETER ROAD (PERSONS/KM)
NOTE TRANSPORTATION SECTOR
NOTE RURAL ROAD LENGTH
NOTE L RRL.K=RRL.J+(DT)(RCR.JK)
NOTE RRL = RURAL ROAD LENGTH (KM)
NOTE RRL = 25
NOTE RCR.K=MIN(DFR.K,RCB.K/RCC)*RELAM.K/RCT
NOTE RCT = ROAD CONSTRUCTION TIME (HR)
NOTE RCC = 100E3
NOTE RCC = ROAD CONSTRUCTION COST (P/KM)
NOTE DFR = DEMAND FOR ROAD
NOTE DRL.K=(DDR*CFLA.K)*100
NOTE DRL = DESIRED ROAD LENGTH (KM)
NOTE DDE = 0.70
NOTE DDR = DESIRED ROAD DENSITY (KM/SQ. KM)
NOTE ARD = ACTUAL ROAD DENSITY
NOTE RRLAM.K=TABRL(RRLAMT, RDLFO.K,0,1,2)
NOTE RRLAM = RURAL ROAD LAND AVAILABILITY MULT.
NOTE RRLAM = 1/1.3/1.45/1.3/0.5/0
NOTE RDLFO.K=(RRL.K*AROW)/RDLA
NOTE AROW = AVERAGE ROAD LENGTH (KM)
NOTE RDLA = 250
NOTE EEKL.K=ERRL.K+(DT)(RCR.JK-RRD.JK)
NOTE EEKL = EFFECTIVE RURAL ROAD LENGTH (KM)
NOTE RRD = ROAD DETERIORATION RATE (KM/HR)
NOTE ARD = AVERAGE ROAD USEFUL LIFE (HR)
NOTE RRD = ROAD MAINTENANCE MULTIPLIER
NOTE RRD = 1/1.4/1.65/1.8/1.5/2
NOTE MFPK.K = RMB.K / RRL.K
NOTE MFPK - MAINTENANCE FUND PER KILOMETER
C MCFK=17104
NOTE MCPT - MAINTENANCE COST PER KILOMETER (PESOS/KM)
A TTM.K = TABHL(TTMT, (TT.K/300)/DADT, 0, 2, .2)
NOTE TTM - TRUCK TRAFFIC MULTIPLIER
T TTMT=2.2/1.8/1.6/1.4/1.2/1.0/1.4/.8/.5/.3/.2
C DADT=190
NOTE DADT - DESIGN AVE. DAILY TRAFFIC (TT/DAY)
A ETARR.K = ERRK.K / RRL.K
NOTE NOTE
NOTE RURAL ROAD FUND
NOTE NOTE
L RF.K = RF.R + (DT)(RF.R.K)
W RF=1000000
R RF.R.K = RF.K * RFK
NOTE RFK - ROAD FUNDING RATE (K/yr)
C RFK=0.10
A RCB.K = RF.K * FCC.K
NOTE RCB - ROAD CONSTRUCTION BUDGET
A FCC.K = FCCN * DFHM.K * ETARM.K
C FCCN=0.60
A DFHM.K = TABHL(DFHM.T, ARD.K / DRD, 0, 1, .1)
NOTE DFHM - DEMAND FOR ROAD MULTIPLIER
A RMB.K = RF.K * (1 - FCC.K)
A ETARM.K = TABHL(ETARM.T, ETARR.E, 0, 1, .1)
NOTE ETARM - EFFECTIVE TO ACTUAL ROAD RATIO MULTI.
T ETARM=0/.1/.2/.3/.4/.5/.6/.7/.8/.9/.95/1
NOTE NOTE
NOTE ROAD TRANSPORT CAPACITY
NOTE NOTE
R UMHRK.K = MIN(RTC.K, UMCFT.JK)
NOTE UMHRK - UNMILLED CROP TRANSPORT RATE (MT/HR)
A RTC.K = TRUCK.K * TTPD.K * HPP * PLPT
NOTE RTC - ROAD TRANSPORT CAPACITY (TOMS/HR)
C HPP=60
NOTE HPP - HARVEST PEAK PERIODS (DAYS)
C PLPT=7
NOTE PLPT - PAYLOAD PER TRUCK (TOMS/TRUCK)
A TT.K = (UMHRK.JK / PLPT) * 2
NOTE TT - TRUCK TRIPS (TRIPS/DAY)
L TRUCK.K = TRUCK.J + (DT)(TPR.JK - TBR.JK)
K TRUCK=20
R TPR.K = MAX(DNT.K - TRUCK.K, 0) / DIP
NOTE TPR - TRUCK PURCHASE RATE (TRUCKS/TRUCK)
C DIP=2
NOTE DIP - DELAY IN TRUCK PURCHASE (YR)
A DNT.K = (((UMCFR.JK / HPP) + (ABP.E * FABPM)) / (PLPT * TTPD.K))
NOTE DNT - DESIRED NO. OF TRUCKS
C  FABPM=0.95
NOTE FABPM - FRACT AB PRODUCT FOR MARKETING (DIM)
R  TDR.KL=TRUCK.K*TDN*TDRM.K
C  TDN=0.10
A  TDRM.K=TAHNL(TDRMT,ETARR.K,0,1,1)
T  TDRMT=1.9/1.75/1.7/1.65/1.55/1.5/1.4/1.2/1.1/1
A  TTPD.K=AWHD/ETT.K
NOTE TTPD - TRUCK TRIPS PER DAY
C  AWHD=8
NOTE AWHD - AVE. NO. OF WORKING HOURS PER DAY
A  ETT.K=(IGD/ATS)*ERDM.X
C  IGD=25
NOTE IGD - INITIAL GRID DISTANCE (KM)
C  ATS=15
NOTE ATS - AVE. TRAVEL SPEED (KM/HR)
A  ERDM.X=TAHNL(ERDM.T,ETARR.K,0,1,1)
NOTE ERDM - EFFECTIVE ROAD DETERIORATION MULT.
T  ERDM.T=2/2/2/1.9/1.8/1.7/1.5/1.2/1.1/1
NOTE NOTE
NOTE FARMING COST OF TRANSPORT
NOTE
A  FCOT.K=FTCN*ARTCM.K
C  FTCN=150
A  ARTCM.K=TAHNL(ARTCM.T,ARTD.K,DEP,0,1,1)
NOTE ARTCM - ACTUAL ROAD TRANSPORT COST MULT.
T  ARTCM.T=1.5/1.45/1.4/1.35/1.3/1.2/1.1/1/1/1.9/1.8/85/1.8
NOTE NOTE
NOTE AGRICULTURAL LOANS AVAILABLE
NOTE
L  AOMTL.X=AOMTL.X+(DT)/(AMTLR.RJ-AMTLPR.RJ)
NOTE AOMTL - AGRI. OUTSTANDING MEDIUM-TERM LOAN
N  AOMTL=0
R  AMTLRPR.KL=AMTLR.X/MTLRT
NOTE AMTLRPR - AGRI MEDIUM-TERM LOAN REPAYMENT RATE
C  MTLRT=4
NOTE MTLRT - MEDIUM-TERM LOAN REPAYMENT TIME
R  AMTLR.X=AMTLRN*AMTLR.X
NOTE AMTLRN - AGRI MEDIUM-TERM LOAN REPAYMENT RATE
C  AMTLRN=4500
NOTE AMTLRN - AGRI MEDIUM-TERM LOAN REPAYMENT NORMAL
A  TAMTLR.K=TAHNL(TAMTLR.T,TIME.X,0,6,1)
NOTE TAMTLR - TREND IN AGRI MEDIUM-TERM LOAN RECEIVE RATE
T  TAMTLR.T=1/1.2/1.5/1.07/1.16/1.35
A  AMTAC.K=AMTLR.RJ
NOTE AMTAC - AGRI MEDIUM-TERM AVAILABLE CREDIT
A  CFM.X=(FCFM)(AMTAC.K)
C  FCFM=0.60
L  AOSTL.X=AOSTL.X+(DT)(ASTLRR.RJ-ASTLPR.RJ)
NOTE AOSTL - AGRI OUTSTANDING SHORT-TERM LOAN
N  AOSTL=0

229
R  ASSLRPR.KL=(AGSTL.K/STLRT)*ASTLRF
NOTE ASSLRPR = AGRI SHORT-TERM LOAN REPAYMENT RATE
C  STLRT=1
NOTE STLRT = SHORT-TERM LOAN REPAYMENT TIME
C  ASTLRF=.2
NOTE ASTLRF = AGRI. SHORT-TERM LOAN REPAYMENT FRACT.
R  ASTLRR.KL=ASTLRRN*TASTLRT.K
NOTE ASTLRR = AGRI. SHORT-TERM LOAN REPAYMENT RATE
C  ASTLRRN=50000
NOTE ASTLRRN = AGRI SHORT-TERM LOAN REPAYMENT RATE NORMAL
A  TASTLRT=TABHL(TASTLRT,TIMN.K,0,6,1)
NOTE TASTLRT = TREND OF AGRI SHORT-TERM LOAN RECEIVE RATE
T  TASTLRT=1/2.18/3.18/3.64/4.35/4.34)
A  ASTAC.K=ASTLRR.JX+AGSAVRI.K
NOTE ASTAC = AGRI. SHORT-TERM AVAIL. CREDIT
A  CCP.K = (FCCP)(ASTAC.K)
NOTE CCP = CREDIT CROP PRODUCTION (1000P/yr)
C  FCCP =.60
NOTE FCCP = FRACTION OF CREDIT FOR CROP PROD. (D)
A  AGSAVRI.K=FSAGI*AGSAV.K
NOTE AGSAVRI = AGRI. SAVING RE-INVESTMENT (1000P/yr)
C  FSAGI=.35
NOTE FSAGI = FRACTION OF AGRI. SAVINGS FOR RE-INVESTMENT
A  AGSAV.K=AGSAVF.K*AVAGP.K
NOTE AGSAV = AGRI. SAVINGS (1000P/yr)
A  AGSAVF.K=TABHL(AGSAVF,PCI.K,500,2500,500)
NOTE AGSAVF = AGRICULTURAL SAVING FRACTION
T  AGSAVF=.0/0.05/0.10/0.15/.2
A  AVAGP.K=(TPH.K*CPFA.K)+PAB.K
NOTE AVAGP = AVERAGE VALUE OF AGRICULTURAL PRODUCTS
A  PCI.K=AVAGP.K/RP.K
NOTE PCI = PER CAPITA INCOME
NOTE
NOTE RURAL HOUSING

NOTE
L  RH.K=RH.J+(D1)(RHC.JK-RHD.JK)
N  R=150
R  RHC.KL=RH.K*RHCN*RHCN.K
NOTE RHC = RURAL HOUSING CONSTRUCTION RATE (HOUSES/YEAR)
C  RHCN=.017
R  RHD.KL=RH.K*RHDN
NOTE RHD = RURAL HOUSING DETERIORATION RATE (HOUSES/YEAR)
C  RHDN=.001
A  RHCN=TABHL(RHCN,RHHR.K,0,2,.2)
T  RHCMT=.2/.25/.35/.7/1/1.35/1.6/1.8/1.95/2
A  RHHR.K=RP.K/(RH.K*NPH)
NOTE RHHR = RURAL HOUSEHOLDS TO HOUSES RATIO
C  NPH=7
NOTE NPH = NUMBER OF PERSONS/HOUSEHOLD

230
NOTE URBAN REGION

NOTE
L
UP.K=UP.J+(DT)(UBR.JK+RUM.JK-UDR.JK-UOM.JK)
N
UP=200000
R
UBR.KL=UP.K*UBRN
C
UBRN=0.03
R
UDR.KL=UP.K*UDRN
C
UDRN=0.006
R
UCM.KL=UP.K*UCMN
NOTE UOM - URBAN OUTMIGRATION
C
UOMN=0.001

NOTE URBAN HOUSING

NOTE
L
UH.K=UH.J+(DT)(UHC.JK-UHD.JK)
N
UH=2000
R
UHC.KL=UH.K*UHCN*UHDN.K*ULAM.K
C
UHCN=0.019
A
UHDN.K=TABLE(UHDMT,UHHR.K,0,2,.2)
NOTE UHDM - URBAN HOUSING DEMAND MULTIPLIER
T
UHDMT=.1/.2/.35/.5/.71/1/1.6/1.8/1.9/1.95/2
A
UHHR.K=UP.K/(UH.K*PH)
NOTE UHHR - URBAN HOUSEHOLDS TO HOUSING RATIO
C
PH=6
NOTE PH - PERSONS/HOUSEHOLD
R
UHD.KL=UH.K*UHDN
C
UHDN=0.001
A
ULAM.K=TABLE(ULAMT,ULF0.K,0,1,.1)
NOTE ULAM - URBAN LAND AVAILABILITY MULTIPLIER
T
ULAMT=1/1.25/1.5/1.25/.75/0
A
ULF0.K=(UH.K*LUH+UBS.K*LBS+USS.K*LSS)/ULAM
NOTE ULF0 - URBAN LAND FRACTION OCCUPIED (DIM)
C
LBS=4
NOTE LBS - LAND REQUIRED FOR BUSINESS STRUCTURE (HA)
C
LSS=0.80
NOTE LSS - LAND REQUIRED FOR SERVICE STRUCTURE (HA)
C
LUH=0.050
NOTE LUH - LAND REQUIRED FOR URBAN HOUSE (HA)
C
ULAM=500000

NOTE URBAN BUSINESS SECTOR

NOTE
L
UBS.K=UBS.J+(DT)(UBSC.JK-UBSD.JK)
N
UBS=300
R
UBSC.KL=UBS.K*UBSCN*ULFAM.K*ULAM.K
C
UBSCN=0.015
R
UBSD.KL=UBS.K*UBSDN
C
UBSDN=0.001
NOTE
NOTE URBAN SERVICE SECTOR
NOTE
L  USS.K=USS.J+(DT)*(USC.JK-USSD.JK)
M  USS=200
R  USCC.KL=USS.K*USCM*ULFAM.K*ULAM.K
C  USCM=0.015
R  USSD.ZL=USS.K*USSDN
C  USSDL=6.001
A  UJ.K=UBS.K*JBS+USS.K*JSS
C  JBS=60
NOTE JBS - JOBS AVAILABLE PER BUSINESS STRUCTURE (PERSONS)
C  JSS=40
NOTE JSS - JOBS AVAILABLE PER SERVICE STRUCTURE (PERSONS)
NOTE
NOTE URBAN LABOR FORCE
NOTE
A  ULF.K=UP.K*ULPF
C  ULPF=0.60
NOTE ULPF - URBAN LABOR PARTICIPATION FACTOR (D)
A  UUR.K=ULF.K-UJ.K)/ULF.K
NOTE UUR - URBAN UNEMPLOYMENT RATE
A  ULFAM.K=TABLEL(ULFANT,ULFJR.K,0.2,2)
NOTE ULFAM - URBAN LABOR FORCE AVAILABILITY MULTIPLIER
T  ULFANT=.1/.15/.2/.3/.5/1.0/1.3/1.5/1.7/1.9/.2
A  ULFJR.K=ULF.K/UJ.K
NOTE ULFJR - URBAN LABOR FORCE TO JOBS RATIO
NOTE
NOTE CONTROL STATEMENTS
NOTE
C  DT=0.25
C  LENGTH=30
C  PLTPER=1
C  FRTPER=10
PRINT PLT,NCF,AMH,AWPH,UMCL
PRINT AVAGP,PCC,FPN
PRINT RRL,ERL,ARD
PRINT UP,RP,RUM,RLF,UR
PRINT CARCFF,CAP,CACFP2
PRINT ASTAC,UMCP,UMCTR
PLOT PLT=F,FCPLA=F/MCF=F
PLOT PCI=I/AVAG=P
PLOT RRL=R,ERL=E
PLOT RUR=R/UUR=R
RUN
QUIT
***************************************************************************END OF PROGRAM***************************************************************************
VITA

Maria Sheilah A. Gaabucayan was born in the 15th day of April, 1965. The eldest daughter of Castor P. Gaabucayan, Jr. and Minda A. Gaabucayan, Sheilah earned her Bachelor's Degree in Civil Engineering from Xavier University (Philippines) in 1986.

Sheilah is currently on a study leave from the College of Engineering of Xavier University where she is a member of the faculty. She will resume her teaching duties in June 1993.

Her objective is to continue in the teaching profession and undertake research in transportation planning pertinent to her country's needs.