CONCLUSIONS

Outcome

This study makes an attempt to integrate and analyse the important economic and natural resource sectors of five districts of the Bagmati Zone. These two major sectors were also linked additionally to some exogenous variables. The linkages between these sectors and the extraneous factors were established through different behavioural, structural, accounting, and feed-back relationships, within the framework of an adaptive policy simulation model. The adaptive simulation model provides a flexible method by which multi-commodities and multi-market interactions can be evaluated simultaneously.

Additionally, the model framework also addresses the environmental issues. The interactions between the economic and natural resource sectors, on one hand, and the influence on these sectors of the exogenous variables, on the other, result in changes in the environment. These environmental effects were viewed in terms of selected indicators and the carrying capacity of different land uses in relation to the existing load factors, the latter being primarily determined by the resource needs of the human and livestock populations. Environment, therefore, is a dynamic element, but it is dependent on the action or inaction taking place in the economy. Any action or inaction in any one sector will have repercussions on the environment.

The base model was developed on the basis of the present state of technology and information available for each district separately and was used to evaluate the economic and environmental conditions in five districts of the Bagmati Zone. Validation of the model was conducted through calibration and sensitivity analysis. This base model developed for each district then provided the basis for policy analysis. For all the districts, except for Dhading, the time frame for the simulation exercise was taken to be the Eighth Five-Year Plan Period (1993-1998). However, in the case of Dhading, the time frame was extended to 2005 A.D. This extension made it possible to examine the effects of different policies, such as improved forest management and reduced population growth, both of which have impacts beyond the five-year period considered for other districts.

The base model projects the demand and supply of major resource commodities (food, fuelwood, fodder, and others) to obtain a range of estimates of deficit to highlight the future pressure on the resource base. The forecasted demand and supply of major resources under the current trend scenario then provided a basis for evaluating the scale and timing of deficit or surplus of the major resources under alternative policy options.

Under the current trend scenario, the capacity of the districts to sustain the ever-increasing human and livestock population is decreasing over time. With the declining trend in agricultural productivity, on one hand, and deteriorating resource base on the other, the implications of a growing population for the carrying capacity of the district in terms of food, fuelwood, and fodder are already alarming. Despite the varying magnitudes of deficits or surplus that exist at present, all the districts appear to be on an unsustainable path in terms of the major resources, including food. The resulting magnitude of, say, a food deficit, will have to be met through imports. However, due to the high level of underemployment and the lack of off-farm employment opportunities and income, the purchasing power of the people is very low. Therefore, imports are not a likely substitute for domestic food deficits. Already, in most districts, agricultural lands are being over-used through increasing the intensity of production without gains in productivity. The analysis indicates that the dependence of people and the load on cultivated lands exceed the carrying capacity of such lands (Table 8.1).

The widening gap between the supply and demand of fuelwood, fodder, and timber implies that every year deficits have to be met through over-exploitation of forests, especially given the predominant practice of an open access regime in most of the areas. In any given year, exploitation may not appear to take place to a large extent but, as the excess demand continues unabated, the process of resource depletion at the margin continues, ultimately leading to deforestation and environmental degradation. Although the magnitude of the problem varies across districts, the carrying capacity in terms of fuelwood and fodder has already declined or will soon decline (Table 8.2). The marginal sufficiency in some resources observed in some districts does not in any way reflect that those districts have a relatively sustainable resource base, i.e., it is a manifestation of the problem.

Declining agricultural productivity and deforestation are perhaps the major causes of land-use changes in the districts. Declining agricultural productivity leads to food shortages and, since the existing agricultural technologies are unable to increase productivity, the pressure to expand cultivated land increases. While the intensification pressure, through increased cropping intensity under the current state of technology, has reached beyond the limit of sustainability, further expansion of marginal land, i.e., the extensification pressure, seems to be limited unless at the cost of a high level of environmental degradation. On the other hand, when deforestation occurs, land-use changes also begin to occur. Firstly, deforestation leads to an increase in shrublands, some of which are converted to marginal agricultural lands over time. As a result, the forest area required to sustain one hectare of cultivated land, given the prevailing farming system that is predominant in the hills, is declining in most of the districts. This pattern over time gives rise to a vicious cycle of resource degradation and depletion. This indicator, and other indicators of land-use changes developed in the model clearly indicate that the problems related to resource depletion are already at a critical stage in most of the districts. The results further indicate that in order to minimise land use changes and mitigate the pressure on the resource base in the districts, both agricultural productivity and productivity of the forests have to increase. Population reduction definitely plays an important role.

Table 8.1: Carrying Capacity and Load on Agricultural Land in Terms of Food (Persons/ha)

	1993	1994	1995	1996	1997	1998
Kabhrepalanchowk						
Supply as % of Demand	92	92	92	93	93	93
Carrying Capacity	5.49	5.49	5.49	5.48	5.48	5.48
Load	6.02	5.99	5.96	5.94	5.92	5.9
Sindhupalanchowk						
Supply as % of Demand	51	51	51	50	50	50
Carrying Capacity	5.43	5.43	5.43	5.42	5.42	5.42
Load	10.59	10.64	10.69	10.74	10.79	10.84
Nuwakot						
Supply as % of Demand	110	110	109	109	108	108
Carrying Capacity	5.85	5.85	5.84	5.84	5.83	5.83
Load	5.31	5.32	5.34	5.36	5.38	5.4
Dhading						
Supply as % of Demand	74	73	73	72	72	71
Carrying Capacity	5.32	5.31	5.29	5.27	5.28	5.27
Load	7.22	7.25	7.28	7.31	7.35	7.39
Rasuwa						
Supply as % of Demand	97	96	96	95	94	94
Carrying Capacity	5.2	5.2	5.2	5.2	5.2	5.2
Load	5.38	5.41	5.44	5.47	5.51	5.55

The adaptive simulation model was then used to evaluate the different policy scenarios. The policies examined dealt with population reduction, and improving the food, fuel, and fodder supplies. Policies that affected directly both the demand and supply of food and natural resources were also examined jointly and their environmental implications assessed.

Table 8.2: Carrying Capacity and Load in Terms of Fuelwood (persons per hectare)

	1993	1994	1995	1996	1997	1998
Kabhrepalanchowk						
Supply as % of Demand	85	84	83	82	81	81
Carrying Capacity	3.41	3.39	3.37	3.35	3.32	3.3
Load	4.03	4.05	4.06	4.07	4.08	4.09
Sindhupalchowk						
Supply as % of Demand	73	72	70	69	68	66
Carrying Capacity	2.21	2.18	2.15	2.12	2.09	2.06
Load	3.02	3.04	3.06	3.07	3.09	3.1
Nuwakot						
Supply as % of Demand	73	72	70	69	68	67
Carrying Capacity	3.48	3.46	3.44	3.42	3.4	3.37
Load	4.78	4.83	4.89	4.94	4.99	5.04
Dhading						
Supply as % of Demand	96	95	93	92	90	89
Carrying Capacity	2.87	2.87	2.87	2.87	2.86	2.85
Load	2.99	3.03	3.08	3.12	3.17	3.21
Rasuwa						
Supply as % of Demand	188	187	185	184	183	181
Carrying Capacity	0.91	0.91	0.91	0.91	0.91	0.91
Load	0.48	0.49	0.49	0.5	0.5	0.51

In the food sector, the aggregate demand was allowed to be influenced by the population reduction policy without curtailing the base (1991) level of per capita food need. On the supply side, irrigation development and increased fertiliser application were allowed to increase food supplies, i.e., biochemical technology. The results clearly indicated that any single policy intervention is unlikely to drive the districts towards sustainable food supply. The demand policy had a positive impact over the short term, but, unless productivity growth in the agricultural sector occurs, population reduction alone does not appear to have a sustainable impact on the districts' food supplies. This clearly implies that there is already an excess population in the districts, considering the state of agricultural technology. On the other hand, a combination of the demand and supply policies had a more sustainable impact. Clearly, the scope for mitigating the pressure on agricultural lands through the introduction of new agricultural technologies undoubtedly exists, and this should be encouraged. For example, if the paddy and maize yield rates in the five districts could be increased to the yield levels of Lalitpur or Bhaktapur, all the food deficit districts would no longer be food deficit and, at the same time, the pressure on the resource base would decline consequently.

On the resource side also, both the demand reduction and supply management policies were seen to have a more sustainable impact than a single policy option. Despite the combined policy action in the food and natural resource sectors, the districts will not be able to realise a high level of growth in real incomes or labour utilisation in a short period of time. In the short run, it is essential to improve food and forest resource supplies to mitigate the overall pressure of the districts' carrying capacity. In the long run, however, policies that emphasise high-value crops, based on the comparative advantages, should be evaluated and stressed. Furthermore, without development in the off-farm sector, it will be increasingly more difficult for the districts to increase employment opportunities and incomes and consequently improve the state of the resource base and environment to promote sustainable development.

Sustainable development is a difficult concept to operationalise and perhaps more so in a developing country like Nepal where poverty and resource-base degradation are rampant. This study makes an attempt to address the issue of sustainable development in the narrow sense of the term. Sustainable development is seen to be critically dependent on the sustainable use of a critical resource, namely, land. This resource currently is seen to determine the living standards of the people, the quality of the resource base, and, consequently, the surrounding environment. The study demonstrates clearly that the critical success factor for sustainable development in the districts will depend on how quickly the districts can improve the carrying capacity of land through the application of new technologies. Over time, as the carrying capacity improves, further assessment will be required to evaluate the new and emerging critical factors.

Further Scope of the Model

Some of the limitations of the simulation model used in the present study have already been highlighted in Chapter 1. This section will highlight further the scope of the model. In the rural districts of Nepal where food, resources, and the environmental situation are already in a critical state of balance, it is useful to evaluate the districts from a more holistic point of view. For such an evaluation, a simulation model of the type developed for this study will prove to be very useful.

The model can readily be extended to integrate other socioeconomic issues such as education, health, and drinking water and can be developed at the VDC or *illaka* level, depending on the availability of information. Carrying out such an evaluation through the Adaptive Simulation Model (ASM) has the advantages of building intersectoral linkages and evaluating the trade-offs resulting from different policy actions.

It is well known that the agricultural and forestry sectors are highly interdependent, especially in the hill and mountain regions of Nepal. In the present exercise, it has not been possible to build this interdependency more strongly, primarily due to the lack of information on variables and parameters. For example, leaf litter is a forest product which is used extensively by households to maintain soil nutrients. Thus, forests affect crop productivity directly, and this can be specified in the model. Such a specification will make it possible to identify quite easily where agricultural productivity is more seriously affected by deforestation. Policy-makers and planners can be aided in focussing plans and programmes on a more area-specific basis.

Another issue that can be addressed through the model is the question of food sufficiency versus food security. The model has built-in demand functions for food. These demand functions are dependent on the relative food prices and incomes. A high growth rate in the real income will make it possible for households to buy food even when a district may not produce enough food to meet the food requirement. It will be possible to evaluate at what level of per capita income such a situation is likely occur in a given district. Income can be increased though off-farm development activities as well as through direct intervention in agriculture. Thus, for planners, such an exercise can be useful to understand the relative merits of a food security programme versus a food sufficiency programme. This exercise will perhaps be more useful in a district that already have some surplus, e.g., Nuwakot in the Bagmati Zone.

In the natural resource sector, the model can be extended to highlight the economic costs of deforestation by applying the full cost principle. This cost (i.e., cost of policy inaction) can be compared with the cost of policy action (e.g., afforestation or other management options) to obtain an idea of the relative benefits or desirability of different policy actions. It should be noted that, because the model is interlinked, intervention in any one sector cannot be an isolated event, since secondary repercussions will also occur in other sectors.

This type of model, therefore, can be used to interlink the different, important sectors of an economy at different levels of generalisation, depending on the information and parameters available. A more global picture will thus emerge for policy-makers to assess the outcome of different policy interventions. The outcome can then be used to rank the different sectors in terms of some defined criteria or objective function and programmes, following which the resources can be directed accordingly. The cost and benefit associated with different policy actions can also be assessed, enabling policy-makers to prioritise programmes given the resource constraints. Finally, when the projects have been identified to mitigate certain problems and improve incomes in a district, such projects can be directly incorporated within the model to assess not only the direct benefits of the project, but also the resulting indirect benefits and costs. For example, if a buffalo development programme is identified as beneficial to a district, it can be developed separately outside the model and all the necessary evaluations can be made. But, when this buffalo development project is linked to the model, its impact on the food supply, share distribution of income from different sources, fodder supply in relation to forest stock, pressure on land, and so on can be evaluated also. There can be many further extensions of the model, depending on the data availability, parameters, and a suitable computer.

Data Requirements

Given the usefulness of an ASM in integrating and assessing different policy scenarios, the following section provides a list of necessary information that should be developed at the district level. Up to date land-use data are vital for identifying the direction and magnitude of interclass land transfers. A district's land-use dynamics' submodel can be developed from such a database. Similarly, an inventory of the forest stock by species' composition, maturity class, and density under different management regimes is useful. With the appropriate biomass stocking rates as well as harvest rates of different forest products, a more accurate picture of the forest products' supply situation can be developed. Information on indicators that provide a quantitative assessment of the resource base and environment have to be gathered periodically. Important environmental parameters related to rainfall, soil erosion, soil type, runoff, landslides, and so on should be developed. Qualitative indicators will prove to be useful also. Ownership of private plantations, area coverage, yields, and so on will prove useful in assessing the role of the private sector in renewing the natural resource base.

The agricultural database should be broadened and strengthened to highlight the current trends in productivity, technology, crop diversity, and marketable surplus of important crops as well as details on input use across crops. In the agricultural sector, the geographic diversity must be taken into account. In developing the database. More detailed livestock statistics on the age composition and herd size by type of animal, fodder, and feed intakes as well as livestock products are necessary to develop a better understanding of the hill farming system.

Detailed accounts of labour use in a district in the agricultural and forestry sectors, off-farm activities, and other domestic chores are required to develop a detailed labour sub-model. The volume of trade taking place in a district in terms of both imports and exports by major commodity type can greatly facilitate the trade sub-model. Periodic detailed household income and expenditure surveys that provide more accurate information on households, at least at the district level, are very important. Similarly, periodic surveys of household energy consumption and sources will be useful to assess energy consumption trends.

Information on factor and product prices through farm gate and district retail outlets is virtually non-existent in the districts. Price information has to be systematically gathered at appropriate levels, e.g., whole-sale, farm gate, and retail levels. The gathered information on product and factor prices must be comprehensive so that it can be linked with household expenditure surveys. Even though the list is not exhaustive, availability of accurate and varied information is crucial to operationalising the concept of sustainable development.