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Blending planning and learning for national development

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Abstract

National development planning is a decision process at the central government level that defines the strategic plan for a country's long-term development. The System Dynamics Group at the University of Bergen in collaboration with Millennium Institute and the University of Iowa is developing an interactive learning environment for national development planning. BLEND is the acronym for Bergen Learning Environment for National Development. BLEND is a networked computer learning environment that constitutes a microcosm for real planning settings where policy makers play roles in a simulated government. The simulation model underlying BLEND is based on Millennium Institute's Threshold 21 model (T21) which has so far been applied in over 20 countries. T21 is a rather large model with a high level of detail. There is, however, ample evidence that learning environments are more effective when the models are simplified. The purpose of this paper is therefore to identify the key learning goals that BLEND has to address. Based on these we develop a simplified version of T21 that exhibits a lower level of detail and eliminates non-fundamental structural components.

1 Introduction

Developing countries face the challenge of managing a socioeconomic transformation process towards a number of development goals. This transformation process is usually accompanied by a number of persistent development problems that manifest themselves in conditions such as food shortage, poverty, poor social services and human development infrastructure, technological backwardness, low productivity, resource depletion, environmental degradation, and poor governance.

The starting point for suggested solutions to development problems is usually the acceptance of a snapshot of the existing conditions. A developmental policy is then constructed as a well-intended measure that should improve existing conditions. Experience shows, however, that policies implemented with such a perspective not only give unreliable performance, they also create unexpected results. This happens because the causes leading to the existing conditions and their future projections are not adequately understood. The well intentioned policies addressing problem symptoms only create short term benefits that are often overcome by the system's reactions in the long term (Saeed 2003).

Table 1 reports on three development problems – food security, poverty, and social unrest – and the broad policies implemented over the past several decades to address them. These problems have, however, continued to persist or even become worse. Because they were taken as given, the natural response for overcoming them was to facilitate intensive agriculture so more food could be produced, foster economic growth so aggregate income could be increased, and strengthen internal security and defense infrastructure so the public could be protected from social unrest. The common denominator of those policies was that they attributed the existing conditions to outside factors. They also assumed that the system in which they appeared is static and not self-regulating. Thus, it was expected that directly attacking symptoms would help alleviate them. Saeed (1998) demonstrates with the use of a quantitative simulation model that attacking symptoms of the food security problem without knowing how these were created is rarely likely to lead to a fundamental and desired change in the behavior of the system. In addition, policies are usually formulated by individual government agencies that focus on their own priorities and on a short time horizon, rarely considering the impact on, or needs of the other policy sectors.

Table 1: Development problems, policies implemented to address them, and subsequent problems experienced (Saeed 2003: 411)

Initially perceived problems	Policies implemented	Subsequently experienced problems
Food security	Intensive agriculture	Land degradation
	Land development	Depletion of water aquifers
	Irrigation	Vulnerability to crop failure
	Fertilizer application	Population growth
	Use of new seeds	Continuing/ increased vulnerability to food shortage

Poverty	Economic growth Capital formation Sectoral development Technology transfer External trade	Low productivity Indebtedness Natural resources depletion Environmental degradation Continuing/ increased poverty
Social unrest	Spending on internal security and defense infrastructure Limiting civil rights	Poor social services Poor economic performance Authoritarian governance Insurgence Continuing/ increased social unrest

From a systemic perspective, the source of formulating ineffective strategies and of policy failure is often to be found in the limited cognitive skills and capabilities of individuals compared to the complexity of the systems they are supposed to manage. A vast body of experimental work demonstrates that individuals make significant, systematic errors in diverse problems of judgment and choice (e.g. Kahneman et al. 1982). Dynamic decision making is particularly difficult, especially when decisions have indirect, delayed, nonlinear, and multiple feedback effects (e.g. Brehmer 1992, Dörner 1996, Moxnes 1998, Moxnes 2004, Sterman 1989). Empirical studies show that performance deteriorates markedly as the time delays grow longer and the feedbacks grow more powerful (Diehl and Sterman 1995). Experience and training do not solve the problem. Professional economists, for example, create depressions in simple economic models (Sterman 1989) and government officials playing an economic development game often impoverish their simulated nations through foreign debt, poison their environments, and starve their population (Meadows 1989).

Development planning is a decisional process at the central government level that defines the strategic plan for a country's long-term development. The planning process, including the timing and calibration of implementations requires a comprehensive understanding of the complex relationships formed through the interaction of the economic, social and ecological subsystems concerned. National development planning is a dynamic decision making task where decisions have indirect, delayed, nonlinear, and multiple feedback effects and where the involved policy makers struggle both with misperception of feedback structure and feedback dynamics. Replacing reductionist, partial, and short-termed views of the development process with a holistic, broad, long-term and dynamic view constitutes a double-loop learning process (Argyris 1985). This learning process ultimately enables decision makers to redesign their policies (decision rules) and institutions accordingly. Effective learning involves continuous experimentation in both virtual and real worlds with feedback from both that informs development of the mental models, the formal models and the design of experiments. In systems with significant dynamic complexity, computer simulation will typically be needed to support the virtual worlds (Sterman 1994).

The System Dynamics Group at the University of Bergen in collaboration with Millennium Institute and the University of Iowa develops such a virtual world. BLEND is the acronym for *B*ergen *L*earning *E*nvironment for *N*ational *D*evelopment. BLEND is a primarily computer and network based learning environment that constitutes a microcosm for real planning settings where policy makers play roles in a simulated government. As an aircraft simulator allows pilots to try new maneuvers and experience extreme conditions without risk, so too a learning laboratory provides a flight simulator for government officials. A learning laboratory compresses time and space, allowing policy makers to experience the long-term, system-wide consequences of their decisions (Alessi 2000b, Davidsen 1996, Grössler et al. 2000, Senge and Sterman 1994). The learning environment approach cannot address all important issues in national development planning. However, we argue that it is helpful in overcoming some of the persistent difficulties facing policy makers in complex organizations such as national governments. As these difficulties are growing more severe in the rapidly changing global environment we highlight the development of a learning environment as one important learning tool.

BLEND is based on a system dynamics model that provides a means for better understanding the impact of alternative policies and their implementation in the form of decisions. The simulation model itself is a simplification of an existing, detailed system dynamics model used to inform the national development planning process. This paper describes this simplification process. It starts with identifying the development issues that the simulation model has to be able to address and the characteristics of the development policies that have to be transferred in the context of a learning environment. Based on these learning goals the simplification steps are described. We test the simplified model as to whether it remains capable of describing the development issues and of testing effective development policies. We conclude the paper with reflections on a research program concerned with the design, implementation and assessment of a series of learning tools for national development planning that complement BLEND.

2 Learning goals

Various system dynamics models have been built in order to support national planning in developing countries (for an overview see Pedercini and Kopainsky 2007). These models differ from each other in several respects (Table 2) and they generate a variety of outcomes and insights.

Table 2: Characteristics of system dynamics models for national planning

Model name	Model purpose	Scope	Implementation	Size	References
Threshold 21	Comprehensive cross-sector analysis	Country-specific Based on generic framework	Direct involvement of stakeholders	Large	Barney 2002 Barney Pedercini 2003
Population Development Environment	Demographics, natural resource management	Country-specific Based on generic framework	Without direct involvement of stakeholders	Medium-large	IIASA 2001
Saeed's sustainable development models	Case studies sustainable development	Country-specific Problem specific	Without direct involvement of stakeholders	Small-medium	Saeed 1998
	Generic models sustainable development	Generic structure with respect to countries Problem specific	Without direct involvement of stakeholders	Small-medium	Saeed 1994, 1998
Dangerfield's Sarawak model	Transition to knowledge economy	Country-specific Problem specific	Direct involvement of stakeholders	Medium-large	Dangerfield 2005

Threshold 21 (T21), for example, integrates economic, social, and environmental factors in its analysis, thereby providing insight into the potential impact of development poli-

cies across a wide range of sectors, and revealing how different strategies interact to achieve desired goals and objectives. Based on country-driven goals, T21 allows users to generate scenarios indicating the future consequences of the proposed strategies. Users can then trace changes in outcomes back to the assumptions and polices that produced those changes. Two examples of insights gained from the application of T21 are described in Table 3.

The generic simulation models described in Saeed (1994 and 1998), on the other hand, explore specific development issues in detail. They analyze the structural causes of observed and experienced phenomena such as the organizational arrangements that cause hunger and poverty to persist or the preconditions for technological development initiatives to successfully facilitate growth and influence income distribution.

Table 3: Exemplary insights gained from T21 applications

Country	Focus of the application	Main insights	Reference
Ghana	Millennium Development Goal (MDG) analysis	• Synergies and dissynergies between MDG interventions • Importance of considering implementation delays for some interventions • Importance of planning for long-term sustainability of interventions	Pedercini and Barney 2004
Mali	Poverty and growth analysis	• Not very encouraging base run for the country → growth targets are not likely to be achieved under normal conditions • Importance of making transparent assumptions • Importance of investing in resources with long implementation times (e.g. education)	Pedercini et al. 2007

In general, the different simulation models generate three broad types of outcomes and insights (Table 4). Such outcomes and insights constitute at the same time possible learning goals that can be pursued with the use of different kinds of simulation models. The learning goals determine the level of detail and dynamic complexity of the corresponding simulation models (model characteristics). By detail complexity we mean the sort of complexity in which there are many variables. Dynamic complexity, instead, refers to situations where cause and effect are subtle, and where the effects over time of interventions are not obvious (Senge 1990). Finally, the learning goals and model characteristics help to overcome a certain category of impediments to learning, the bounds on human cognition (see Sterman 1994). These bounds refer to the poor quality of our mental maps (misperception of feedback structure) and our inability to make correct inferences about the dynamics of complex nonlinear systems (misperception of feedback dynamics).

Table 4: Model characteristics and learning goals in the context of national planning in developing countries

Model outcomes and insights/ learning goals	Model characteristics	Model examples	Bounds on human cognition addressed by the model
Formulation of detailed development strategies to comply with an overall development vision and to derive implications for mid term budgeting	High detail complexity	T21 PDE Transition model Dangerfield (2005)	Misperception of feedback structure

Understanding of the fundamental characteristics of effective policies	Medium detail complexity High dynamic complexity	Generic models Saeed (1994, 1998)	Misperception of feedback structure
Linking of structure to behavior, i.e. inferring of behavior from structure	Low detail complexity High dynamic complexity	Simple, generic substructures of key development issues	Misperception of feedback dynamics

The learning goals that are at the core of BLEND, the Bergen Learning Environment for National Development, fall into the second category in Table 4. Users should understand and experience the characteristics of effective development policies.

In addition, BLEND aims at providing them with a comprehensive and integrated view of the long-term development of a developing country. The simulation model underlying the learning environment is therefore based on T21. As T21 is a large-size model containing more than one thousand equations, a first step towards building the interactive learning environment consists of simplifying T21 so that it provides an adequate basis for the learning environment. The second step will be to provide hands-on experience and a platform to learn about the consequences of ineffective planning and the characteristics of effective planning. This second step consists in the actual development of the interactive learning environment (i.e. the design and implementation of the user interface that allows users to access and modify the assumptions in the simulation model) and is not the focus of this paper.

3 Detailed development planning model: T21

T21 is a relatively large-size model, comprising more than one thousand equations, about 60 stock variables, and several thousands feedback loops.[1] Given the size and the level of complexity of the model, its structure has been reorganized into smaller logical units, called modules. T21 has 37 modules (Figure 1). A module is a piece of the T21 model whose internal mechanisms can be understood in isolation from the rest of the model. The size of a module is determined based on consideration of the amount of information a user can take in at once, and the standard size of computer monitors. All modules fit in a 1024x768 screen.

T21's modules are grouped into 18 sectors: 6 social sectors, 6 economic sectors, and 6 environmental sectors. A sector is a group of one or more modules related by their functional scope. For example, the water sector groups the water demand and water supply modules; and the education sector groups the primary education and secondary education modules.

[1] For more information on the model see Pedercini and Kopainsky 2007 and http://www.millennium-institute.org/integrated_planning/tools/T21/.

Figure 1: T21 sectors and modules

Society	**Economy**	**Environment**
Population sector	**Production sector**	**Land sector**
1. Population	14. Agriculture	29. Land
2. Fertility	15. Animal husbandry-fishery-forest	**Water sector**
3. Mortality	16. Industry	30. Water demand
Education sector	17. Services	31. Water supply
4. Primary education	**Technology sector**	**Energy sector**
5. Secondary education	18. Technology	32. Energy demand
Health sector	**Households sector**	33. Energy supply
6. Access to basic health care	19. Households accounts	**Minerals sector**
7. HIV/ AIDS	**Government sector**	34. Fossil fuel production
8. HIV children and orphans	20. Government revenue	35. Non fuel mineral production
9. Nutrition	21. Government expenditure	**Emissions sector**
Infrastructure sector	22. Gov. functional expenditure	36. Fossil fuel and GHG emission
10. Roads	23. Gov. balance and financing	**Sustainability sector**
Labor sector	24. Government debt	37. Ecological footprint
11. Employment	**Rest of the world sector**	
12. Labor availability/ cost	25. International trade	
Poverty sector	26. Balance of payments	
13. Income distribution	**Investment sector**	
	27. Relative prices	
	28. Investment	

The development of each national T21 model starts with the implementation of a Starting Framework, which is subsequently customized to capture the peculiar issues of the country being analyzed. The T21 Starting Framework is a generic structure that represents development mechanisms that can be found in most developing and industrialized countries. It covers a broad range of issues that countries over the world face on the path to sustainable development, for example, poverty, environmental degradation, education, healthcare, economic growth, and demographic shifts. T21 therefore covers the most common long-term issues countries encounter in the development process.

T21 has so far been applied to more than 20 countries. On a general level, the application of T21 can pursue the following purposes:

- Design of win-win strategies between economic development and environmental protection.
- Prepare poverty reduction strategies and analyze the impact of Millennium Development Goals related interventions in developing countries.

4 Simplification of T21

In the educational use of computer simulation literature model simplification is concerned with the issue of whether simulations should be very realistic (and complex) versus being simplified (and illustrative). There is ample evidence that learning environments are more effective when the underlying models are simplified (Alessi 1988 and 2000, Allen et al. 1986, Boreham 1985, Brooks and Tobias 1999, Cannon 1995, Chwif et al. 2000, Dittrich 1977, Doerner 1980, Feinstein and Cannon 2001 and 2002, Gentner et al. 1993, Maran and Glavin 2003, Nobel 2002, Quinn and Alessi 1994, van Merriënboer et al. 1997).

Model simplification distills essential model structures that cause problematic behavior. Model simplification has to be driven by a specific motivation or purpose (section 4.1). Based on this purpose simplification decisions (section 4.2) are made. The resulting simplified simulation model must be tested continuously and validated both in terms of model structure and model behavior (section 4.3).

4.1 Simplification purpose

The purpose of the simplification process for BLEND is to highlight the characteristics of effective development policies in the context of the medium to long term development of developing nations. The focus therefore shifts from detailed decision support for specific nations towards educational purposes.

The simplified version of T21 highlights how social, economic and environmental issues at the national level are interrelated. It provides a framework to understand and represent a country's development challenges and offers insights on the impact of possible development policies. While a country-specific application of the simplified T21 will still be possible, the focus shifts towards the representation of typical development issues that are common to most developing countries and to the identification of the characteristics of effective policies as opposed to the analysis of the detailed impacts of specific policies. The characteristics of effective policies that must be conveyed by the simplified T21 and that can subsequently be experienced and experimented with in BLEND can be described as follows:

- Integrated across sectors, i.e. development policies explicitly consider feedback loops.
- Long term perspective, i.e. development policies explicitly consider the existence of time delays.
- Address structural causes of observed behavior, i.e. development policies explicitly consider the existence of non-linearities and their effects on shifts in loop direction and loop dominance.

Countries tend to have from around 10 up to around 30 government ministries. With the simplified T21 not all of them can be represented with a level of detail sufficient for an insightful and illustrative interactive learning environment. The current version of the simplified T21 provides enough information for a ministry of finance, education, health, transport and communications, agriculture and environment, as well as a prime minister. It would, however, be difficult to represent a ministry of tourism.

4.2 Simplification process

Simplification decisions can be reached in several ways. Eberlein (1989) developed a formal theory of model simplification which identifies important feedback loops in linearized models with respect to a selected dynamic behavior. In a similar line of research structural dominance analysis links model structure to observed or experienced behavior (for an overview see Kampmann and Oliva 2007).

Saysel and Barlas (2006) present a general procedure for model simplification and validation. This procedure understands model simplification as a move from case-specific to generally applicable model structures and takes into account questions regarding model boundary, level of aggregation, validity, relevance of the simplified structure to the general theory and empirical studies. The procedure constitutes a semi-formal approach to distill the essential structures of a large-scale model. The first step of the procedure is the identification of the reference behavior, the selection of policy experiments and the design of indirect structure validation tests.

The simplification of T21 included the elimination of detail complexity as well as in the elimination of non-fundamental structural components. The elimination decisions were based on the simplification purpose and driven by experiences with the application of T21 in various countries and the wide range of policy analyses in the context of these applications. The elimination did, however, not include formal methods for structural dominance analysis.

- Elimination of detail complexity. Elimination of detail complexity consists of the *aggregation* of model components. For example, agriculture, animal husbandry-fishery-forests, industry, and services are aggregated into a single production activity that does not make a distinction between the economic sectors anymore.
- Elimination of dynamic complexity. The elimination of dynamic complexity results in the *elimination* of feedback loops and links between variables.

Table 5 lists the individual simplification decisions for the population, economy and environment module of T21 in detail. The table shows that the simplification decisions consisted mainly of eliminating details and not in the reduction of dynamic complexity.

Table 5: Simplification decisions

Model sectors	**Considered**	**Notes/Assumptions**
	SOCIETY	
Population Sector:		One sketch for the whole sector, including a simplified version of the three sectors below. Fertility is based on education and income only. Mortality is based on income and access to basic health care only.
1. Population	YES	
2. Fertility	YES	
3. Mortality	YES	
Education Sector:		One sketch representing primary education only. This implies the assumption that primary education well represents education level in the country… OK for developing countries.
4. Primary Education	YES	
5. Secondary Education	NO	
Health Sector:		One sketch representing access to basic health care only. This implies that treatment of HIV/AIDS and other epidemics is included in the access to basic health care. Also, level of nutrition is assumed to be tightly related to level of income.
6. Access to basic health care	YES	
7. HIV/AIDS	NO	
8. HIV children and orphans	NO	
9. Nutrition	NO	
Infrastructure Sector:		Fully represented as in T21.
10. Roads	YES	
Labor Sector:		This sector is entirely not represented: full employment is assumed.
11. Employment	NO	
12. Labor Avail./Cost	NO	

Model sectors	Considered	Notes/Assumptions
Poverty Sector:		This sector is not represented: we just look at average income and not at income distribution.
13. Income distribution	NO	
ECONOMY		
Production Sector:		Just one aggregate production function is used to represent production of all different sectors. This means that the model will not be able to look at the structural transformation of the economy, but just at its overall development.
14. Aggregate production	YES	
15. Agriculture	NO	
16. Animal husbandry-fishery-forest	NO	
17. Industry	NO	
18. Services	NO	
Technology Sector:		This sector is not explicitly represented: we assumed that technological development follows human capital development.
19. Technology	NO	
Households Sector:		This sector is fully represented
20. Households accounts	YES	
Government Sector:		One sketch for the whole sector, except for government debt, which is represented in the "Banks" sector. Formulations for revenue and expenditure are simplified, and the government budget is divided only among major items.
21. Government revenue	YES	
22. Government expenditure	YES	
23. Gov. functional expenditure	YES	
24. Gov. balance and financing	YES	
25. Government debt	YES	
ROW Sector:		This sector is not explicitly represented, and transactions with the rest of the world are accounted for in the households, government, and Banks sectors. An explicit balance of payments is not calculated.
26. International trade	YES	
27. Balance of payments	NO	
Investment Sector:		The investment part is calculated in the new "banks" sector, together with public debt. Relative prices are not represented, as we are representing production as a whole.
28. Relative prices	NO	
29. Investment	YES	
ENVIRONMENT		
Land Sector:		Fully represented in the model, with some simplifications (i.e. less types of land use).
29. Land	YES	
Water Sector:		Water demand and supply are represented in the same sketch, with simplified formulations. Demand depends on population, income, production and literacy rate. Supply is exogenous.
30. Water demand	YES	
31. Water supply	YES	
Energy Sector:		Energy demand and supply are represented in the same sketch, with simplified formulations. Demand is a function of GDP and energy efficiency. Supply is based on the oil resources. Fossil fuel production is also represented in this sketch.
32. Energy demand	YES	
33. Energy supply	YES	
Minerals Sector:		Fossil fuel production is represented in the energy sector.
34. Fossil Fuel production	YES	
Emissions Sector:		This sector is represented by the new "Air" sector.
36. Fossil Fuel and GHG emission	YES	
Sustainability Sector:		This is not represented.
37. Ecological footprint	NO	

The resulting model sectors are summarized in Figure 2. Sectors with a grey background color are sectors that exist both in T21 and its simplified version but that have a more aggregate structure in the simplified version. The figure also lists a number of sectors with no background color (e.g. minerals). These sectors exist in T21 but have been eliminated for the purpose of the simplified version. Figure 2 has to be interpreted in comparison to Figure 1 where full T21 with all its sectors and their modules are listed.

Figure 2: Simplified T21 sectors

Society	Economy	Environment
Population sector	Production sector	Land sector
		Water sector
Education sector		
	Technology sector	Energy sector
Health sector	Households sector	
		Minerals sector
	Government sector	
		Emissions sector --> Air
Infrastructure sector		
		Sustainability sector
Labor sector		
	Rest of the world sector	
Poverty sector		
	Investment sector --> Banks	

4.3 Assessing simplification

The simplification process was accompanied by the most common validation tests with a focus on indirect structure validation. Indirect structure tests or structure-oriented behavior tests provide indirect information about possible flaws in the model structures (Barlas 1996). The simplification decisions described in the previous section were followed and evaluated on the basis of extensive extreme condition and behavior sensitivity testing. This section focuses first on a numerical comparison of the two models and subsequently on the comparison of the behavior of the two models.

Numerical comparison of the models

Table 6 provides a numerical comparison of T21 and its simplified version. The information about the simplified version is based on the version of the simulation model that will be underlying the interactive learning environment. The consequence of this is that it includes a number of variables that are not in T21 but that provide necessary information for the performance and the available decisions of the simulated government ministries (e.g. performance ministry of education, desired share of education budget for teachers). This version of the simplified T21 also introduces some stocks that are necessary for the simulated ministries to make a number of decisions (e.g. health centers, doctors, nurses).

Table 6: Numerical comparison of full and simplified T21

	T21	**Simplified T21**
Number of sectors	18	10
Number of modules	37	17
Number of stocks (without subscripts)	56	46
Number of equations	1040	645
Working days to calibrate model for a specific country	100	30

Table 6 indicates that the simplification process cut the number of sectors, modules, stocks and equations roughly in half. The resulting reduction in the necessary calibration effort, however, exceeds this ratio and assumes a value of approximately thirty percent (30 instead of 100 working days for calibrating the model to a specific country).

Behavior comparison

Figure 3 to Figure 5 present the behavior over time of social, economic and environmental indicators. For the purpose of comparing the behavior generated by the full and simplified T21 the model was calibrated to Mali. The results presented in the figures represent the base run for this country. The simulation horizon is from 1990 to 2025. It therefore allows a comparison between model behavior and data in the past and it simulates behavior for a time period that is relevant for the medium to long-term nature of the national development planning process.

Overall, the figures demonstrate a close fit between the behavior generated by the full and the simplified model. The developments in the social, economic and environmental realms highlight some issues typical to the transformation processes in developing countries. Economic growth (Figure 4) is accompanied by further population growth (Figure 3, left hand side). Economic growth alone is not sufficient for an increase in adult literacy rate that exceeds 50 percent (Figure 3, right hand side). The combination of economic and population growth leads to a considerable increase in energy demand (Figure 5, left hand side). It also affects the environment negatively which is illustrated by the reduction in forest land (Figure 5, right hand side).

Figure 3: Behavior comparison of social indicators

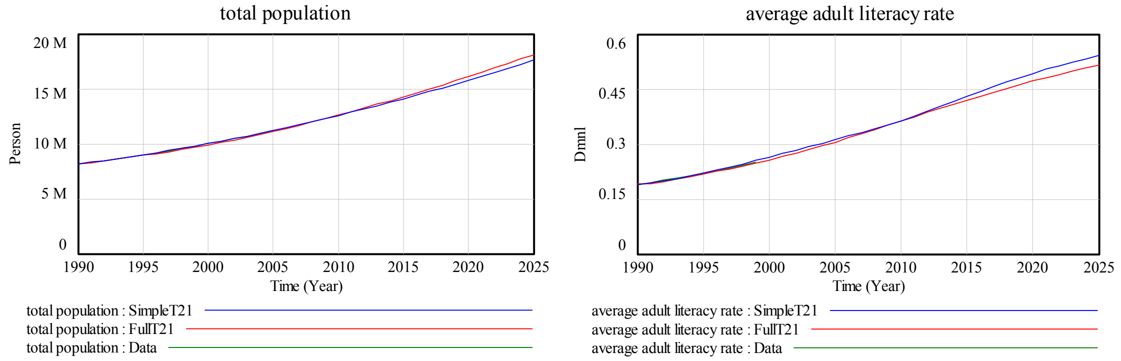


Figure 4: Behavior comparison of economic indicators

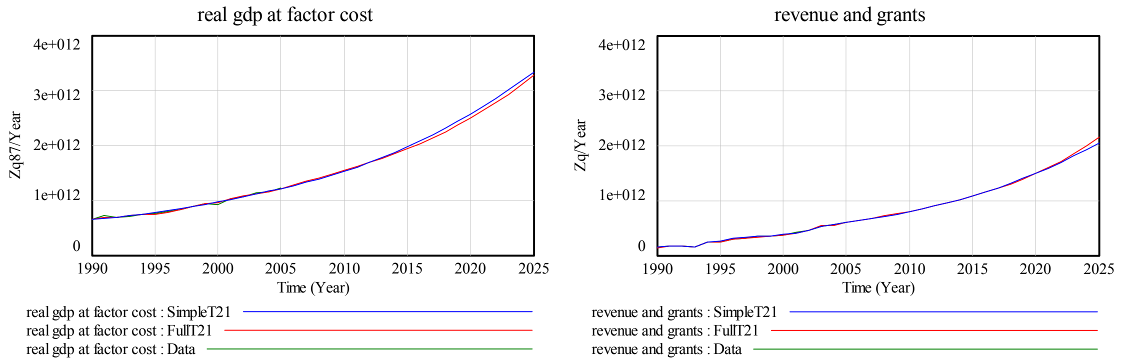
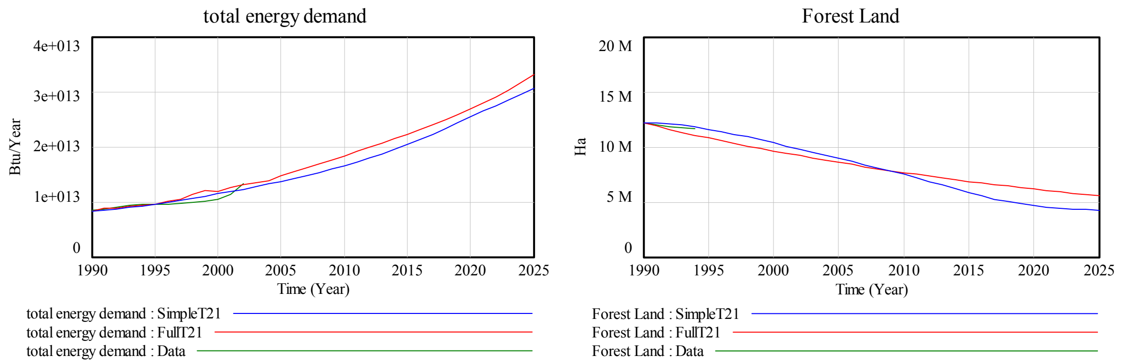


Figure 5: Behavior comparison of environmental indicators



5 Conclusions

Computer-based simulation models provide a means for better understanding the impact of alternative policies and their implementation in the form of decisions. They offer foresight through scenario analyses (predicting how systems might behave in the future under assumed conditions) and thus facilitate comprehensive and consistent policy design (designing organizational structures that allow for new decision-making) (Sterman 1988). There are several learning goals that can be pursued when developing and applying simulation models. These learning goals, in turn, determine the level of detail and aggregation that is suitable in the simulation model.

The purpose of this paper was to describe the simulation model underlying an interactive learning environment about national development planning. This learning environment is called BLEND, the Bergen Learning Environment about National Development. BLEND aims at informing decision makers in the planning process about the characteristics of effective policies for national development planning.

The simulation model underlying BLEND is a simplified version of Millennium Institute's Threshold 21 (T21) model. The motivation of the simplification process was to shift the focus from a detailed analysis of development policies and from detailed decision support towards the distillation of the characteristics of effective policies and the use of the simulation in a more education-oriented context. Effective policies are integrated and long-term and they address the structural causes of observed development problems. The subsequent simplification of T21 included both aggregation of detail complexity and elimination of non-fundamental model structures. The simplified model primarily serves educational purposes and is used for policy analysis on a rather high level of aggregation.

As such the simplified version provides an adequate basis for BLEND in that it maintains the capability to address the most important development issues in developing countries as well as the capability to convey the characteristics of effective policies. It illustrates how delays, feedbacks and non-linearities affect the development process of a nation in the short and the long run. If it comes to make users reason about the structural reasons for observed behavior the simplified model is still to complex. The literature shows that people have difficulties in predicting the behavior of a simulation model even for very simple model structures (e.g. Jensen and Brehmer 2003, Moxnes 2004, Sterman and Booth Sweeny 2007). We therefore consider the simplification of T21 for educational purposes a first step in the direction of a research agenda that has planning for and learning about national development at its heart.

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