

# System Dynamics-based Development Planning Course

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## Module 1: Introduction to System Dynamics

Participants will learn how to apply the System Dynamics method to development planning problems and to build and use simple simulation models for policy analysis. The lessons will include:

- Introduction; development planning and System Dynamics; stocks and flows
- Minor feedback loops
- Non-linearity
- Major feedback loops and delays
- Structure-behavior relationship; elements of complexity revisited; modeling process; validation.
- Capacity building for production control: oscillation; analogy between backlog and inventory driven production; distillation into CLD; generic structure; shifting the burden to the intervener; dependence and addiction.
- Limits to growth: growth under a fixed carrying capacity; varying carrying capacity; diffusion; bifurcation; validation.
- Robust policy design: predatory prey interactions; counterintuitive behavior; policy robustness.
- Formation of expectations and synthetic data experiment: information delay and trend; the Livingstone panel; estimation of petroleum consumption; the petroleum model.

## Module 2: Model-based Socioeconomic Planning

### Part I: Integrated socio-economic-environmental modeling and planning

#### Learning Objectives

Participants will learn how to develop and analyze the behavior of integrated dynamic national development planning models. The lessons will include training on:

- Advanced skills of the System Dynamics method and modeling techniques with Vensim software
- Analyzing patterns in historical data and model behavior
- Understanding how common social, economic and environmental issues interact
- Representing economic, social and environmental issues through integrated, multi-sector simulation models
- Running and comparing alternative policy scenarios using multi-sector models

#### Modeling Exercises

Participants will be guided in the development of an integrated national planning model, including a variety of social, economic, and environmental sectors. The exercises will be initially guided closely by the facilitators, and then participants will be gradually performing them more independently, as their modeling skills improve.

#### Reading List

- *Business Dynamics*, John D. Sterman, Irwin McGraw-Hill, 2000, Chapters 13 to 15
- *Vensim Reference Manual*, Ventana Systems, 2003, selected sections
- *iSDG Model Documentation*, Millennium Institute, 2016, <https://www.millennium-institute.org/documentation>
- *Counterintuitive behavior of social systems*, Jay W. Forrester, Technology Review, January 1971
- *System Dynamics, System Thinking, and Soft OR*, Jay W. Forrester, System Dynamics Review, Summer 1994, Vol. 10, No. 2
- Selected papers on development issues

## Part II: Advanced modeling and analysis for development planning

### Learning Objectives

Participants will learn how to develop models of newly emerging development issues, integrate them into a larger model, and analyze the resulting behavior using advanced techniques. The lessons will include training on:

- Operational principles for applying system dynamics method in development policy settings
- Advanced analysis and reporting techniques with Vensim software
- Analyzing alternative policy options, identifying optimal strategies, and testing their sensitivity to specific assumptions
- Managing and reducing complexity for the purpose of policy analysis and reporting
- Creating models of specific development issues and integrating them into multi-sector models
- Conducting optimization and sensitivity analysis

### Modeling Exercises

Participants will perform modeling exercises in group, including conceptualization, model development, scenario design and analysis, and reporting. Interaction among group members with different skill-level in modeling and knowledge of development issues provides the background for engaging discussions and group model building.

### Reading List

- *Business Dynamics*, John D. Sterman, Irwin McGraw-Hill, 2000, chapters 21
- *Vensim Reference Manual*, Ventana Systems, 2003, selected sections
- *T21 Starting Framework Documentation*, Millennium Institute, 2006, [www.millennium-institute.org](http://www.millennium-institute.org), chapter 2 to 4
- *Information sources for modeling the national economy*, Jay W. Forrester, September 1980, Journal of the American Statistical Association, Vol. 75, No. 371
- *Growth theory and after*, Robert M. Solow, June 1988, The American Economic Review, Vol. 78, No. 3
- Selected papers on development issues

### Other materials

Participants will be provided with the Vensim software, the main application that will be used to build and simulate dynamic models. Participants are required to have their own laptops, in order to work independently on modeling exercises.