

Introduction to IFs

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Purposes

The International Futures (IFs) model helps us explore, understand, and shape global questions about future human well-being. The model empowers users to examine past trends to understand the current trajectory we are on, how human, social, and environmental systems interact over time, and how we think about and address the complex challenges awaiting the global community.

IFs can help you:

- understand the state of major global systems.
- explore long-term trends and consider where they might take us.
- learn about the dynamic interactions between global systems.
- clarify long-term organizational goals and priorities.
- develop alternative scenarios (if-then statements) about the future.
- investigate how different groups (households, firms or governments) can shape the future.
- evaluate the potential impacts of policies.

The IFs platform relies on core, underlying assumptions, including the following.

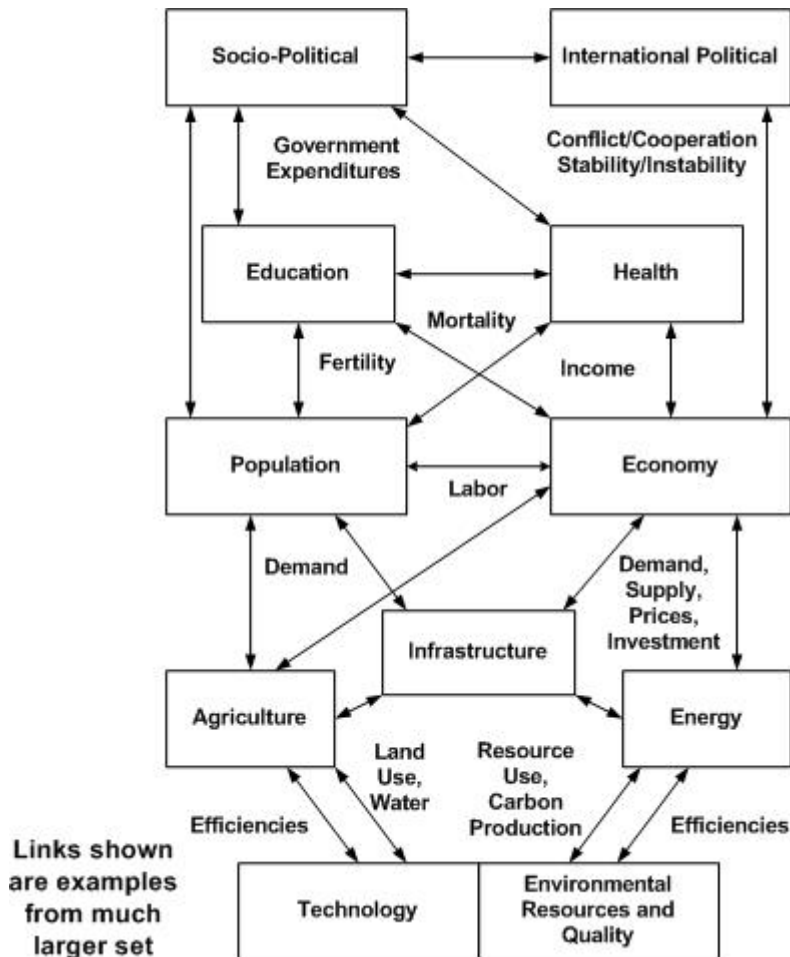
- Global issues are becoming more significant as the scope of human interaction and human impact on the broader environment grow.
- Goals and priorities for human systems are becoming clearer and are more frequently and consistently communicated.
- Understanding of the dynamics of human systems is improving rapidly.

- The domain of human choice and action is broadening.

Which issues can you investigate with IFs? Some examples grouped by issue area include:

- Environment: Atmospheric carbon dioxide levels, world forest area, and temperature change
- Infrastructure: Electricity access, and number of fixed broadband subscriptions
- Health: Life expectancy, HIV prevalence, and death rates by category of cause
- Education: Average years of education, and literacy rate
- Governance: Democracy level, expenditure and spending levels, and debt level
- Human Development: Poverty level, and status of women
- International Relations: Country and regional power levels, and interstate conflict likelihood
- Demographics: Population levels and growth, fertility, mortality, and migration
- Agriculture: Land use and production levels, calorie availability, and malnutrition rates
- Energy: Resource and production levels, demand patterns, fossil fuel usage, and renewable energy share
- Economics: Sectoral production, consumption, trade patterns, and structural change

IFs Issues and Modules: Visual Representation



Visual representation of IFs structure

Among the philosophical premises of the International Futures (IFs) project is that the model cannot be a "black box" to users and be truly useful. Model users must be able to examine the structures of IFs in order (1) to have confidence in them, and (2) learn from them.

The following topics are useful starting points for better understanding the model.

- Dominant Relations of the model structure
- Structure-Based and Agent-Class Driven Modeling
- Equation Notation
- IFs Bibliography of data and data sources

IFs Issues and Models: Quick Survey

International Futures is a collection of interconnected models (sometimes referred to as modules). Below is a quick survey of the major models in IFs. For more information on each one, please click on the model headings.

The demographics model:

- represents 22 age-sex cohorts to age 100+.
- calculates change in fertility and mortality rates in response to income, income

distribution, and analysis multipliers.

- computes average life expectancy at birth and represents migration.

The economic model:

- represents the economy in six sectors: agriculture, raw materials, energy, manufactures, services, and ICT (other sectors could be configured, using raw data from the GTAP project).
- is a general equilibrium-seeking model that does not assume exact equilibrium will exist in any given year; rather it uses inventories as buffer stocks and to provide price signals so that the model chases equilibrium over time.
- contains an endogenous production function that represents contributions to growth in multifactor productivity from R&D, education, worker health, economic policies ("freedom"), and energy prices (the "quality" of capital).
- uses multifactor productivity from the production function along with labor and capital stock as the main drivers of the magnitude of production.
- utilizes a "pooled" rather than the bilateral trade approach for international trade.
- computes and uses a social accounting matrix (SAM) that ties economic production and consumption to intra-actor financial flows both domestically and internationally for households, governments, and industry.
- uses the SAM to calculate changes in income distributions based on its projection of household consumption and on the education model's projections of skill level.

The agricultural model:

- represents production, consumption and trade of crops, meat, and fish.
- maintains land use in crop, grazing, forest, urban, and "other" categories; and water use.
- represents demand for food, for livestock feed, and for industrial use of agricultural products.
- is a partial equilibrium model in which food stocks buffer imbalances between production and consumption and determine price changes.
- overrides the agricultural sector in the economic module unless the user chooses otherwise.

The energy model:

- portrays production of six energy types: oil, natural gas, coal, nuclear, hydroelectric, and other renewable.
- represents consumption and trade of energy in the aggregate.
- represents known reserves and ultimate resources of fossil fuels.
- portrays changing capital costs of each energy type with technological change as well as with drawdowns of resources.
- is a partial equilibrium model in which energy stocks buffer imbalances between production and consumption and determine price changes.
- overrides the energy sector in the economic module unless the user chooses otherwise.

The international relations model:

- represents the prospects for state instability or failure.
- traces changes in power balances across states and regions.
- allows exploration of changes in the level of interstate threat.
- represents possible action-reaction processes and arms races with associated potential for conflict among countries.

The governance model:

- is a two-way interaction between governments and the socio-cultural system.
- has three dimensions of governance: capacity, security, and inclusion that closely interact bi-directionally.
- represents the evolution of democracy.
- represents fiscal policy through taxing and spending decisions.
- shows six categories of government spending: military, health, education, R&D, foreign aid, and a residual category.

The infrastructure model:

- forecasts the demand for infrastructure and the funding available to meet the demand.
- forecasts levels of infrastructure based on this demand and funding constraint.
- measures access to key infrastructures like water, electricity, or broadband.
- maintains and calculates changes in physical stocks like percentage of roads paved, and area equipped with irrigation.

The health model:

- forecasts age, sex, and health indicators related to 15 causes of death modeled in IFs.
- splits the causes of death into three cause groups: communicable, maternal, perinatal, and nutritional conditions; noncommunicable diseases; and injuries.
- is driven by education, technology, and income.

The education model:

- projects educational participation and attainment across primary, secondary, and tertiary levels for each country in IFs.
- determines attainment and participation through the demand for education and the investment in education by governments.
- has educational demand based on income while educational investment is a result of government spending.
- models the rates of dropout, completion, and transition to the next level of schooling.

The environmental model:

- is distributed throughout the overall model.

- allows tracking of remaining resources of fossil fuels, of the area of forested land, of water usage, and of atmospheric carbon dioxide emissions.

The implicit technology model:

- is distributed throughout the overall model.
- allows changes in assumptions about rates of technological advance in agriculture, energy, and the broader economy.
- explicitly represents the extent of electronic networking of individuals in societies.
- is tied to the governmental spending model with respect to R&D spending.
- represents changes in social conditions of individuals (like fertility rates or literacy levels), attitudes of individuals (such as the level of materialism/post-materialism of a society from the World Value Survey), and the social organization of people (such as the status of women).

IFs Background

International Futures (IFs) has evolved since 1980 through eight "generations," with the eighth generation now taking form.

The first generation had deep roots in the world models of the 1970s, including those of the Club of Rome. In particular, IFs drew on the Mesarovic-Pestel or World Integrated Model (Mesarovic and Pestel 1974). The author of IFs had contributed to that project, including the construction of the energy submodule. IFs consciously also drew on the Leontief World Model (Leontief et al. 1977), the Bariloche Foundation's world model (Herrera et al. 1976), and Systems Analysis Research Unit Model (SARU 1977), following comparative analysis of those models by Hughes (1980). That generation was written in FORTRAN and available for use on main-frame computers through CONDUIT, an educational software distribution center at the University of Iowa. Although the primary use of that and subsequent generations was by students, IFs has always had some policy analysis capability that has appealed to specialists. For example, the U.S. Foreign Service Institute used the first generation of IFs in a mid-career training program.

The second generation of International Futures moved to early microcomputers in 1985, using the DOS platform. It was a very simplified version of the original IFs without regional or country differentiation.

The third generation, first available in 1993, became a full-scale microcomputer model. The third generation improved earlier representations of demographic, energy, and food systems, but added new environmental and socio-political content. It built upon the collaboration of the author with the GLOBUS project, and it adopted the economic submodule of GLOBUS (developed by the author). GLOBUS had been created with the inspiration of Karl Deutsch and under the leadership of Stuart Bremer (1987) at the Wissenschaftszentrum in Berlin.

The third generation produced three editions/major releases of IFs, each accompanied by a book also called International Futures (Hughes 1993, 1996, 1999). The second edition moved to a Visual Basic platform that allowed a much-improved menu-driven interface, running under Windows. The third edition incorporated an early global mapping capability

and an initial ability to do cross-sectional and longitudinal data analysis.

The fourth generation took shape in early 2000. It was heavily influenced by the usage of the model by several important organizations for policy-analysis. First, General Motors commissioned a specialized version of IFs named CoVaTrA (Consumer Values Trends Analysis) with a need for updated and extended demographic modeling and representation of value change. An alliance was established with the World Values Survey, directed by Ronald Inglehart, to create that version. Second, the Strategic Assessments Group of the Central Intelligence Agency commissioned a specialized version named IFs for SAG. The work involved in preparing that greatly extended and enhanced the socio-political representations of the model, both domestic and international. Third, the European Commission sponsored a project named TERRA which has led to a specialized version named IFs for TERRA. The IFs for TERRA work led to enhancements across the model, including improved representation of economic sectors, updated IO matrices and a basic Social Accounting Matrix, GINI and Lorenz curves, and preparing for extended environmental impact representation (drawing upon the Advanced Sustainability Analysis framework of the Finland Futures Research Center).

The fourth generation of IFs also had a heavy emphasis on enhancing usability. Ideas from Robert Pestel in the TERRA project led to the creation of a new tree-structure for scenario creation and management. Ideas from Ronald Inglehart led to the development of the Guided Use structure and a somewhat more game-like character within that structure. Inglehart also helped to arrange funding to support the programming of Guided Use through the European Union Center of the University of Michigan.

The fifth generation of IFs (from 2004-2009) focused on improving the model, its usability, and transparency. Model improvements included clearer and more extensive representations of the agent classes and their points of leverage, stemming from the desire to make the modeling system a more valuable scenario-testing and policy analysis tool. The further elaboration of the social accounting matrix, structure, the development of education and health sub-models, and the substantial redesign of an economic production function with endogenous multifactor productivity were all outcomes of this version.

Efforts to enhance the model's usability included the addition of a number of specialized displays, such as those for seeing the social accounting matrices, to display progress towards the Millennium Development Goals, to explore poverty at different income levels, and to represent the educational attainment of population cohorts. Mapping and data analysis tools were also strengthened. The ability to drill down into select countries to explore futures at the state or province-level was also added. Packaged Displays and Flex Packaged Displays were introduced that allowed for the creation of very specific lists of countries/regions, groups or G-lists. Greater transparency came from adding the ability for users to access the flow charts, equations, and code underlying the model.

The fifth version was the first version of this software to be placed online due to the help of the National Intelligence Council (<http://www.ifs.du.edu>). New scenarios were created for UNEP (focusing on environmental change) and Pardee (focusing on poverty). Finally, one of the largest changes made was incorporating 182 countries into the Base-Case scenario used by IFs. Previous versions of IFs used broader regions to forecast global trends. This change also did away with the Student and Professional versions.

The sixth generation of IFs began in 2010 and revolved around the development of the Patterns of Potential Human Progress (PPHP) series. The PPHP volumes, with their focus on major human development systems, spurred the further enhancement of the model's major

subsystems, especially population, economic (especially poverty representation), education, health, infrastructure, and governance. The supporting documentation required for the PPHP series also gave rise to efforts to create the most detailed documentation of the model to date. The sixth generation greatly strengthened the web-based version.

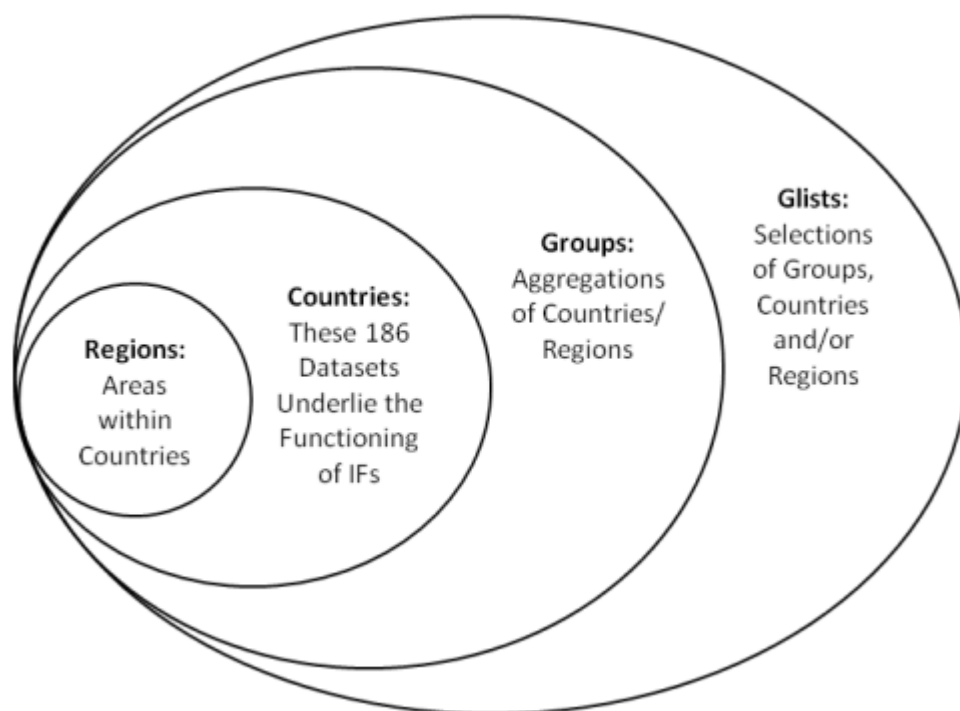
The seventh generation officially began in 2014. This generation emerged after the PPHP volumes and with the advent of a variety of new projects, including wider support for provincial and state breakdowns, new means of forecasting diplomatic and power interactions, and enhanced representations in many of the IFs modules. Central to the institute's efforts this version also had continuous improvements in the existing elements of the model and usability.

The current (eighth) generation is primarily distinguished by a transition in the underlying coding language, shifting from Visual Basic 6 to Visual Basic .NET. This shift has facilitated the integration of both online and standalone user interfaces, streamlining the process of implementing interface modifications. Moreover, the adoption of this new underlying language and user interface has empowered developers to leverage a broader range of third-party applications and dynamic visualization tools, while aligning with Microsoft-supported languages.

Geographic Representation of the World

188 countries underpin the functioning of IFs and these countries can be displayed separately or as parts of larger groups that users can determine.

Below is a visual representation of how different entities are organized into Countries/Regions, Groups or Geography-lists (Sometimes referred to as Gglists):



Visual representation of regions, countries, groups, and geography-lists in IFs

**Note: In older versions of IFs, Regions were used as intermediaries between Countries and*

Groups. In the future, they, or some similarly named unit, will be a sub-unit of Countries. Regions, acting as a sub-unit of Countries, are currently not a feature of IFs. See the image located at the bottom of this Help topic.

When using IFs, there are many occasions where the user must decide whether or not they would like to display their results as a product of single countries, or larger groups. This is typically a toggle switch that moves between Country/Region and Groups; however, it might be a three-way-toggle that includes Country/Region, Group and Geography-List.

Countries/Regions are currently the smallest geographical unit that users can represent. The ability to split countries down into smaller regions, or states, is under development. There are 188 different countries/regions that users can display.

Groups are variably organized geographically, by income, or by memberships in international institutions/regimes.

Geography-lists (*Sometimes referred to as Gglists*) merge both Groups and Countries/Regions. These lists are mostly geographically bound. In the future, the Geography-list distinction will become more important as some users may want to place, for example, both the Indian state of Kerala in a Geography-list with Sri Lanka and Nepal.

Users may also want to explore what countries are members of what groups which can be done through the Identify Groups or Country/Region Members option under Extended Features tab in the Main Menu. Users that want to create their own groups can do so through the Edit Groups or Country/Region Members option also under the Extended Features tab.

IFs Time Horizon

Future Forecasts. IFs begins computation with data from 2020 and can dynamically calculate values for all variables annually through 2100.

Historical Analysis and "Forecasts." IFs also includes an extensive and growing historical database starting in 1960. The database allows analysis of relationships among variables across countries and across time.

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