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GLOSSARY OF SYSTEMS ECOLOGY TERMS

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ABSTRACT

Many systems ecology-oriented terms used by scientists are ill-defined, inconsistently used, or even incorrectly applied. This glossary was written to serve as a common reference which might lead to consistent usage of some of the terms and phrases used in the US/IBP Grassland Biome.

INTRODUCTION

This glossary was compiled to aid various writing efforts in the Grassland Biome, US/IBP. Many systems ecology-oriented terms used by scientists within the program are ill-defined, inconsistently used, or even incorrectly applied. Thus, this glossary was written not to stand as an authoritative source but rather as a common reference which might lead to consistent usage of terms and phrases within the program.

Where possible, Webster's Dictionary[18] was used as the source of definitions. When this source proved inadequate, I selected what I felt were common and generally accepted (minimally offensive) definitions from other sources.

Many terms obviously are not included, and the reader is referred to sources of a more specific subject matter area for definitions. For terms used in ecology, Odum's[10] and Smith's[11] textbooks are recommended.

NOTE: When in doubt about the appropriate usage of a term, try to follow a definition given in Webster's Dictionary[18] or use another equivalent term which is defined.

ABSTRACT MODEL

1. "An abstract model is one in which symbols, rather than physical devices, constitute the model. The symbolism used can be a written language or a thought process."[5]

See PHYSICAL MODEL.

ACCURACY

1. "Degree of conformity of a measure to a standard or true value."[18]

ARITHMETIC MEAN

1. "A value that is computed by dividing the sum of a set of terms by the number of terms."[18]

AVERAGE

1. "Something that represents the middle point between extremes."[18]

Synonym of MEAN, MEDIAN, NORM(al).

Note: If desired meaning is "a value that is computed by dividing the sum of a set of terms by the number of terms," USE ARITHMETIC MEAN.

BLACK BOX

1. "Any unit whose function may be evaluated without specifying the internal content."[10]
2. "A usually electronic device (biological or physical phenomenon) whose internal mechanism is hidden from or mysterious to the user."[18]

BOX

See COMPARTMENT.

BOX-AND-ARROW DIAGRAM

See FLOW DIAGRAM.

CANONICAL

1. "Reduced to the simplest or clearest schema possible, for example, a matrix."[18]

Note: Used in the Grassland Biome to describe the attributes of similar state variables, i.e., soil layers or mammals or forage plants, etc., in a standard format so that different entities are represented by simply changing parameters in a vector.

CLIMATE

1. "The average course or condition of the weather at a place over a period of years, as exhibited by temperature, wind velocity and precipitate."[18]

See WEATHER.

CLOSED DYNAMIC MODEL

1. "A closed model is one that internally generates the values of variables through time by interaction of the variables on one another."[5]

See OPEN DYNAMIC MODEL.

CLOSED SYSTEM

1. ". . . is a system that functions without connection to externally supplied (exogenous (driving)) variables that are generated outside the system."[5]

See OPEN SYSTEM.

CODE

1. "A system of symbols for representing data or instructions in a computer."[2]

   • Coding

   a. The act of representing data or instructions for a computer with the appropriate symbols.

COEFFICIENT

1. "Any of the factors of a product considered in relation to a specific factor, especially a constant factor of a term as distinguished from a variable."[18]

2. "A number that serves as a measure of some property or characteristic (as of a device or process)."[18]

COMPARTMENT

1. ". . . easily recognized component of the (system) ecosystem which contains, at any time, a certain amount of matter and (or) energy which we measure in concentration units. Usually these are dependent, or intrinsic, variables in the system . . . ."[14]

I prefer using COMPARTMENTS in reference to ecosystems or the systems being represented and STATE VARIABLES in reference to mathematical models.

See STATE VARIABLE.

COMPARTMENT MODEL

1. A model of a system in which the components of the system are described as discrete entities.

COMPILER

1. "A routine used to produce a specific program for a particular problem by determining the intended meaning of an element of information expressed in pseudocode, selecting or generating the required subroutine, transforming the subroutine into specific coding for the specific problem, assigning specific storage registers, etc., and entering it as an element of the problem program, maintaining a record of the subroutines used and their position in the problem program and continuing to the next element of information in pseudocode."[2]

COMPONENT

1. "A constituent part."[18]

COMPUTER

1. "A device capable of accepting information, applying prescribed processes to information, and supplying the results of these processes. It usually consists of input and output devices, arithmetic, storage, communication units and a control unit."[2]

   • Digital Computer

   a. "Fundamentally, a computer operating by the use of numbers to express all quantities and variables of a problem. In most digital computer systems, the numbers, in turn, are expressed by electrical impulses."[2]

   b. "A computer which processes information represented by combinations of discrete or discontinuous data as compared with an analog computer for continuous data. More specifically, it is a device for operating, not only on data but also in its own program."[2]

   • Analog Computer

   a. "A computer representing variables by physical analogies. Thus, any computer that solves problems by translating physical conditions . . . into related mechanical or electrical quantities, and uses mechanical or electrical equivalent circuits as an analogy for the physical phenomenon being investigated. . . . an analog computer measures continuously whereas a digital computer counts discretely."[2]

CONSTANT

1. "Something invariable or unchanging: *a*. a number that has a fixed value in a given situation or universally or that is characteristic of some substance or instrument. *b*. a number that is assumed not to change value in a given mathematical discussion."[18]

CONTINUOUS

1. "Marked by uninterrupted extension in space, time, or sequence."[18]
2. "Of a function: having a numerical difference between the value at any point in a sufficiently small neighborhood of the point arbitrarily small."[18]

CONTROL

1. Biotic or abiotic factors which influence the rate and nature of a process.
2. Regulator of the flow of matter or energy from one compartment or state variable to another.

See FLOW DIAGRAM.

CORRELATE (noun)

1. Either of two things so related that one directly implies the other.
2. A phenomenon that accompanies another phenomenon and is related in some way to it.

CORRELATE (verb)

1. a. "To establish a mutual or reciprocal relation of,"[18]
   b. "to show a causal relationship between."[18]
2. "To present or set forth so as to show relationship."[18]

CORRELATION

1. a. "The act of correlating."[18]

   b. "The state of being correlated."[18]

2. "An interdependence between mathematical variables especially in statistics."[18]

CORRELATION COEFFICIENT

1. "A number or function that indicates the degree of correlation between two sets of data . . . and that is equal to their covariance divided by the product of their standard deviations."[18]

DECISION EQUATION

See FLOW EQUATION.

DELTA TIME

See TIME STEP.

DETERMINISTIC MODEL

1. From Determinism--"A doctrine that . . . occurrences in nature . . . are determined by antecedent causes."[18]
2. A deterministic model is one in which the state of the system results from determining causes, and those causes can be identified and adequately described without considering probabilistic elements.

See STOCHASTIC MODEL.

DIFFERENCE EQUATION

1. An equation that represents the arithmetic difference between the value of a quantity at one time and the value of that quantity at a discrete, arbitrary, previous time. The equation form can be shown as follows:

$$X_{T+DT} = X_T + DT \cdot f(Y)$$

where X_{T+DT} is the value of a quantity at time T plus a discrete, arbitrary time interval DT; X_T is the value of the quantity at time T; and f(Y) is all described controlling functions that determine the amount of change in the quantity X_T in the time interval DT.

DIFFERENTIAL EQUATION

1. "An equation containing differentials or derivatives of functions."[18]

   • Differential

   a. "The product of the derivative of a function of one variable by the increment of the independent variable."[18]

   b. "The sum of the products of each partial derivative of a function of several variables by the arbitrary increments of the corresponding variables."[18]

DISCRETE

1. "Constituting a separate entity: individually distinct."[18]
2. a. "Consisting of distinct or unconnected elements: NONCONTINUOUS."

   b. "Taking on or having a finite or countably infinite number of values: not mathematically continuous (as with a random variable)."[18]

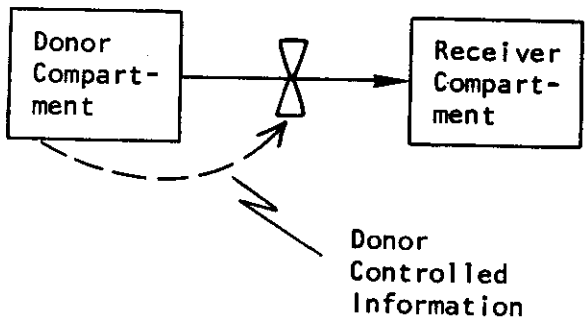
DONOR COMPARTMENT

1. The state variable or compartment from which energy or matter is subtracted or removed.

See FLOW DIAGRAM and RECEIVER COMPARTMENT.

DONOR CONTROLLED

1. A feedback control which originates from the compartment or state variable from which energy or matter emanates.



See FLOW DIAGRAM and FEEDBACK

DRIVING VARIABLE, DRIVING FUNCTION, DRIVING FORCE, FORCING FUNCTION, INPUT VARIABLE, INPUT FUNCTION

1. Independent or extrinsic variables which cause the system to respond, but themselves are not affected by the system.

DT

See TIME STEP.

DYNAMIC MODEL

1. A model describing a system which changes in time.
2. "Deals with time-varying interactions."[5]

DYNAMIC PROGRAMMING

1. "Techniques (from operations research) that may be looked at as optimizing (maximizing or minimizing) 'the total cost' over a *path* or *policy* which moves between *states* subject to decisions which result in minimal (or maximal) cost over the time period of the problem. The decision stages are generally at discrete time intervals. Thus, dynamic programming problems are dynamic in that they offer solutions to objective functions over a period of time."[13]

DYNAMIC SYSTEM

1. A system which operates with time-varying interactions.
2. "The descriptions of rates of movement of energy or matter from one state variable (or compartment) to another."[8]

ECOSYSTEM

1. "A level of organization that considers not only the total array of plant and animal species in an environment, but also the matter which cycles through the system and the energy which is used to power the system."[16]

ELM

1. A generalized simulation model of a grassland ecosystem developed by the US/IBP Grassland Biome.

EMERGENT PROPERTIES

1. Properties of a system which appear to be unique to the system as a whole rather than as being explained by examination of individual components of the system.

See HOLISTIC MODEL.

EMPIRICAL

1. "Originating in or based on observation or experience."[18]
2. "Capable of being verified or disproved by observation or experiment."[18]

FEEDBACK

1. Information about or generated by a compartment or state variable which can influence or control the future behavior of itself or other compartments or state variables in the system.

   • Positive Feedback

     Information that "generates growth processes wherein action builds a result that generates still further action."[6]

   • Negative Feedback

     Information that compares the status of a compartment or state variable with "a goal and responds as a consequence of failing to achieve the goal."[6]

See INFORMATION SYSTEM.

FLOW

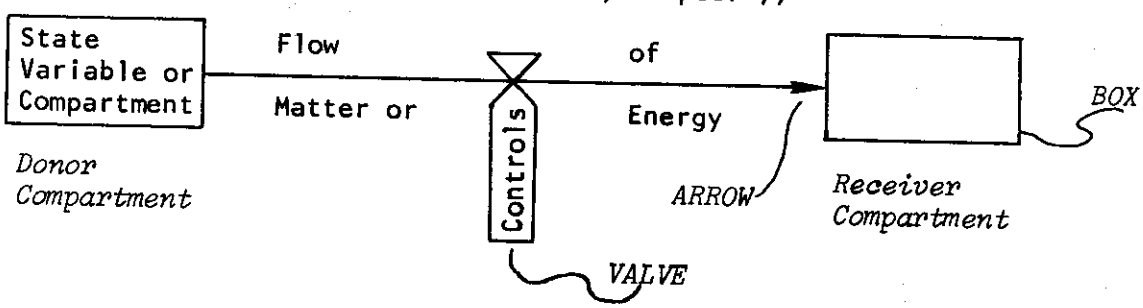
1. Movement of matter or energy from one compartment (or state variable) to another.

FLOW DIAGRAM, BOX-AND-ARROW DIAGRAM

1. A pictorial representation, generally abstract, of a system indicating flow of matter or energy (processes), state variables, controls, etc.

INFORMATION CONTROL

(After Forrester 1968, Chapter 7)



These diagrams are used as information organizers.

2. "A technical, 'working,' diagram to show the structure of a system in terms of physical and information flows between compartments as a basis for a simulation model. (In a 'multiple-flow' diagram the simultaneous, often interdependent, flows of a number of different materials are shown.)"[9]

FLOW EQUATION, TRANSFER FUNCTION, DECISION EQUATION or RATE EQUATION

1. "A mathematical relationship describing the response of a component (or state variable) of the system to its immediate environment."[5]
2. Mathematical relationship(s) describing the movements of energy or matter from one state variable to another.

3. Specific for TRANSFER FUNCTION.

"The transfer function specifies how conditions at the input will be transferred to the output."[5]

FLOW RATE

1. The rate at which energy or matter moves between one state variable and another.

In a simulation model all flow rates described in a submodel must be in consistent units.

FORCING FUNCTION

See DRIVING VARIABLE.

FORRESTER DIAGRAM

See FLOW DIAGRAM.

FUNCTION

1. "The action for which a thing is specially fitted or used or for which a thing exists."[18]

FUNCTION, MATHEMATICAL

1. "A mathematical entity that assigns to each element of one set at least one element of the same or other set."[18]

FUNCTIONAL MODEL OR EQUATION

1. A model or equation in which the cause-and effect interrelationships between dependent and independent variables are known and understood.

GENERALITY (General model)

1. "Refers to the breadth of applicablility of the model (the number of different situations in which it can be applied)" or is expected to yield realistic results.[15]

HIERARCHICAL

From Hierarchy--"A graded or ranked series."[18]

1. Of or pertaining to a graded or ranked series.

HIERARCHICAL ORGANIZATION, PRINCIPLES OF

1. "States it is not necessary to understand precisely how a component of a system is structured from simpler subcomponents in order to predict how it will behave."[15]

HOLISTIC MODEL

From Holism:

"A theory or doctrine according to which a whole cannot be analyzed, without residue, into a sum of its parts or reduced to discrete elements."[7]

"A theory that the universe and especially living nature is correctly seen in terms of interacting wholes (as of living organisms) that are more than the mere sum of elementary particles."[18]

1. A model which exhibits "emergent properties" or properties which are not explained by the individual components of the system.

See BLACK BOX.

INFORMATION (-FEEDBACK) SYSTEM

1. "An information-feedback system exists whenever the environment leads to a decision that results in action which affects the environment and thereby influences future decisions."[5]

See FEEDBACK.

INITIAL CONDITIONS

1. The values of the state variables of a simulation model at the beginning point of a simulation run (time 0).
2. The starting values of the state variables used in a simulation model exercise.

INPUT FUNCTION, INPUT VARIABLE

See DRIVING VARIABLE.

LEVEL

See STATE VARIABLE.

LINEAR

1. "Involving or expressed by a linear equation: having or being a response or output that is directly proportional to the input."[18]

See LINEAR FUNCTION, LINEAR MODEL.

LINEAR FUNCTION

1. "A mathematical function in which the variables appear only in the first degree, are multiplied by constants, and are combined only by addition and subtraction."[18]

LINEAR MODEL

1. "A particular type of mathematical model in which all the equations present are of the form:

$$a_i \, x_i = 0$$

where x_i, $i = 1 \ldots n$ are the variables present in the model and a_i, $i = 1 \ldots n$ are constants."[9]

2. In simulation modeling sense: "A linear model is one in which the concept of 'superposition' holds. In a linear system the response to every disturbance runs its course independently of preceding or succeeding imputs to the system; the total result is no more nor less than the sum of the separate components of system response. The response to an input is independent of when the input occurs in the case of a linear system with constant coefficients (not for

linear system having time-varying coefficients). Only damped or sustained oscillations can exist in an actual linear system; an oscillation that grows is not bounded and must become explosively larger."[5]

3. In statistical model sense: Refers to linearity in the coefficients in the model

$$Y = b_0 + b_1X + b_2X^2$$

where b_0, b_1, and b_2 are coefficients and Y, X, and X^2 are variables.

LINEAR PROGRAMMING

1. "The techniques (from Operations Research) (that) may be looked at as giving the maximum or minimum value of some *objective function* which is a linear function of a set of variables which may be varied (controlled) by (the) implementer of the linear programming technique. There are also a series of constraints to the problem which limit the size that the variables may take. In linear programming the constraints are also linear functions of the controllable variables."[13]

LP

See LINEAR PROGRAMMING.

MATHEMATICAL MODEL

1. "A conceptual tool which relates the general characterization of a process, object, or concept in terms of mathematics, thus enabling the relatively simple manipulation of variables to be accomplished in order to determine how the process, object, or concept would behave in different situations."[2]

2. "Is a (mathematical) abstraction of the real-world systems, and the variables in the model behave, in some sense, as real-world analogs. The major value of the model is twofold: (i) it provides a framework for the organization and development of a research program and the assessment of different facets of field and laboratory investigations; and (ii) some inferences about the real system can be drawn from observation and manipulation of the model more easily than from observations and manipulations of the real system itself."[14]
3. "Defines a system consisting of an interacting set of decision (flow) equations."[5]

MATRIX

1. "A matrix A is defined as

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

where a_{ij} are scalar quantities. This would be known as an $m \times n$ matrix."[9]

MEAN

See AVERAGE.

MECHANISTIC MODEL

From Mechanism.

1. A mechanistic model is one which attempts to represent a biological system in terms of basic well defined laws or relationships.
2. "A philosophical doctrine that holds that the natural processes and especially life processes are mechanically determined and capable of complete explanation by the laws of physics and chemistry."[7]

MEDIAN

See AVERAGE.

MODEL

1. "A miniature representation of a thing; sometimes a facsimile."[7] Innis states, "'Facsimile' according to Webster is an exact duplicate; but it is not our desire to make facsimiles of our biological systems. Facsimiles would be too expensive, too difficult to build, and the study of the facsimile would have no advantage over the study of the actual system."
2. Defines a system consisting of an interacting set of decision processes.
3. A model which is an abstraction of a system attempts to represent certain attributes of special interest about that system (Charles F. Rodell, personal communication).
4. "A model is a description of the system it represents."[5]
5. "An abstraction from reality, an attempt to present some of the important features of the real thing (system) in a simplified way to aid understanding. (Word, picture and mathematical models use words, 'pictures' (often diagrams), and mathematical equations to present the abstractions from reality.)"[9]

NEGATIVE FEEDBACK

See FEEDBACK.

NOISE

1. "Generally concerns various meaningless bits or words that must be ignored or removed from the data at the time the data is used."[2]

2. Relates to errors (statistical sense) introduced into a system due to random variations of one or more characteristics of any entity such as data, computer system communication channels, etc.
3. "Irrelevant or meaningless bits or words occurring along with desired information (as in computer output)."[18]
4. "Random disturbances."[5]
5. "Uncertainty."[5]
6. Unexplained variability.

NONLINEAR

1. The converse of linear.

See LINEAR.

NONLINEAR FUNCTION

1. A function in which the constraints of a linear function do not hold.

See LINEAR FUNCTION.

NONLINEAR MODEL

1. A model in which the constraints of a linear model do not hold.

See LINEAR MODEL.

NORMAL

See AVERAGE.

OBJECTIVE FUNCTION

From Operations Research.

1. "Refers to the objectives set by planners (managers)."[13]

See OPERATIONS RESEARCH.

OPEN SYSTEM or OPEN DYNAMIC MODEL

1. A system or model which functions with connection to externally supplied (exogenous (driving)) variables that are generated outside

the model. "Such external (exogenous) inputs are valid only under conditions where we are willing to assume that the external inputs are entirely independent of the resulting response within the system."[5]

See CLOSED SYSTEM.

OPERATIONS RESEARCH

1. ". . . techniques which allow the planner (manager) to insert his objectives into a mathematical framework which results in a decision based both on the planner's (manager's) objectives and the physical constraints imposed by the system."[13]

OPTIMIZATION

1. "The process (usually mathematical) of defining the most desirable course of action."[9]

OPTIMIZATION MODELS

1. Models developed using the techniques of Operations Research.

See OPERATIONS RESEARCH.

PARAMETER

1. "A quantity to which the operator may assign arbitrary values as distinguished from a variable which can assume only those values that the form of the function (or biological considerations) makes possible."[17]
2. "A constant whose value characterizes a member of a system (as a family of curves) specifically: a quantity (as a mean or variance) that describes a statistical population."[18]
3. A value, in a mathematical model, that controls functions in the model, but itself does not vary (Ronald H. Sauer, personal communication).

See VARIABLE and COEFFICIENT.

PARAMETERIZE

1. "To express in terms of parameters."[18]
2. In biological modeling "to parameterize" means to replace constants with parameters which can be set in input processes.

PHYSICAL MODEL

1. Physical models "are usually physical replicas, often on a reduced scale, of objects under study."[5]

See ABSTRACT MODEL.

POOL

1. A readily available supply of energy or matter of a system or subsystem.
2. A term used in statistics that represents a collective variance composed of a number of associated variances.

POSITIVE FEEDBACK

See FEEDBACK.

PRECISION (Re: models)

1. "Is the ability of the model to predict numerical change and to mimic the data on which it is based."[15]

PROBABILISTIC MODEL

See STOCHASTIC MODEL.

PROCESS

1. "Those events that govern ways in which energy or matter moves from compartment to compartment in the abiotic and biotic portions of the ecosystem."[4]
2. Biotic or abiotic functions that control the flow (flux or transfer) of matter or energy between compartments.

PROGRAM

See CODE.

PROGRAMMING

See CODE and CODING.

RATE

1. "A variable in a simulation model which describes the physical movement of material between state variables and which (by definition) ceases to exist when the system is at rest."[9]

RATE EQUATION

See FLOW EQUATION.

REALISM

1. "Refers to the degree to which the mathematical statements of the model, when translated into words, correspond to the biological concepts that they are intended to represent."[15]
2. Reliability with which the model gives realistic or reasonable results, at least under normal conditions (Len F. Paur, personal communication).

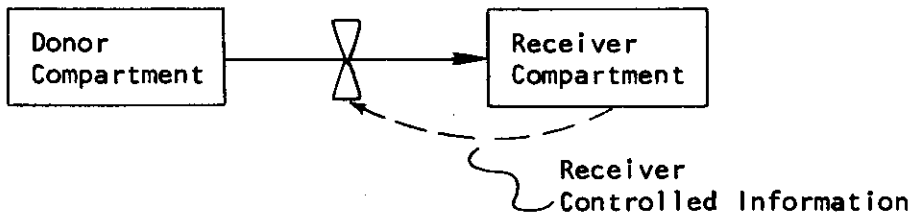
RECEIVER COMPARTMENT

1. The state variable or compartment into which energy or matter is added or placed.

See FLOW DIAGRAM and DONOR COMPARTMENT.

RECEIVER CONTROLLED

1. A feedback control which originates from the compartment or state variable into which energy or matter is flowing.



See FLOW DIAGRAM and FEEDBACK.

REGRESSION

1. "A functional relationship between two or more correlated variables that is often empirically determined from data and is used especially to predict values of one variable when given values of the others; specifically, a function that yields the mean value of a random variable under the condition that one or more independent variables have specified values."[18]

RELATIONAL DIAGRAM

1. "A diagram used to show the interrelationships of (usually) diverse kinds of components and processes in a system. Commonly employed to illustrate a 'whole' picture which is not a suitable subject for modelling in total, but a major function can be to identify complete and coherent subsystems to be modelled."[9]

RESOLUTION

1. ". . . related to the number of attributes of a system which the model attempts to reflect."[1]

See REALISM and GENERALITY.

SENSITIVITY ANALYSIS

1. "A method of determining the relative sensitivity of the model output to the changes in the coefficients, driving variables, and forms of equations of which the model is composed. It is performed

by a systematic (sometimes) variation of the part of the model concerned while the other parts retain their normal (designated) values. If the model output remains essentially the same over the range of variation of the model part being varied, then the model is insensitive to that part. Then less time and energy may be devoted to accurate determination of this part of the model in field and laboratory studies. Alternately, if the part in question is known to have profound effects on the real system output, and if the sensitivity analysis does not reflect this, then the structure of the model is suspect. Combined variation of pairs or higher order combinations of model parts might be necessary (or useful) in sensitivity analysis. This, in effect, reflects the high degree of interaction or coupling of parts of an ecosystem model."[14]

SIMCOMP

1. An acronym standing for SIMulation COMPiler which is the programming language in which the ELM simulation model and other simulation models are written.

See COMPILER, ELM, and SIMULATION.

SIMULATION

1. "The imitative representation of the functioning of one system or process by means of the functioning of another."[18] A mathematical model of an ecosystem.

   "Examination of a problem, often not subject to direct experimentation, by means of a simulating device."[17]

2. "To trace through time."[5]

SIMULATION MODEL

1. A dynamic mathematical model that mimics the functioning of a system or process by the process of step-by-step solution of the equations that describe the system.

SINK

1. "A body (state variable or compartment) that acts as a storage device or disposal mechanism"[18] of energy or matter.

SOURCE

1. A body (state variable or compartment) that acts as a supplier of energy or matter.

STABLE SYSTEM

1. "A stable system is one that tends to return to initial conditions after being disturbed. It may overshoot and oscillate (like a simple pendulum that is set in motion), but the disturbances decline and die out."[5]

See UNSTABLE SYSTEM.

STATE (of a system)

1. The precise set of values (state variables) that represent the condition of a system at a given time.

STATE VARIABLES, SYSTEM VARIABLES, LEVELS

1. "Sets of numbers which are used to represent the state, or condition of a system at any time."[15]

See COMPARTMENT.

STATIC MODEL

1. "A static model describes a system that does not vary with time."[5]

STATISTICAL MODEL

1. A statistical model is an equation in which the dependent variable is estimated by combining one or more independent variables each of which is multiplied by an appropriate coefficient, in various additive combinations.

STEADY STATE SYSTEM

1. "A steady state pattern is one that is repetitive with time and in which the behavior in one time period is of the same nature as any other period."[5]

See TRANSIENT SYSTEM.

STOCHASTIC MODEL

From Stochastic:

- "Involving a random variable."[18]

  Synonym: RANDOM.

- "Involving chance or probability."[18]

  Synonym: PROBABILITY.

1. A mathematical model whose variables (all or some) are drawn at random from some specified distribution.
2. "Models that attempt to include the effects of random variability in driving variables and parameters."[15]
3. A stochastic model is one which does not offer a unique solution but rather a distribution of solutions with the probability of each solution corresponding to some specified probability distribution (Charles F. Rodell, personal communication).

See DETERMINISTIC MODEL.

STRUCTURE

1. "Something arranged in a definite pattern of organization."[18]
2. The arrangement of components (or state variables) in a system (or model).

SUBSYSTEM, SUBMODEL

1. In simulation modeling a subsystem or submodel is a section or component of a total simulation model. The subsystem, while capable of operating as a functional part of the total model is generally capable of being operated independently as a model given the appropriate initial conditions, flows, driving variables, parameters, time increment, and times of beginning and end of the simulation.

SYNTHESIS

1. "Building up of separate elements, especially of conceptions or propositions or facts, into a connected whole, especially a theory or system."[9]

SYSTEM

1. "Implies an interacting, interdependent complex."[14]
2. "An organization that functions in a particular way."[14]
3. "Any structure, device, scheme, or procedure, real or abstract, that interrelates in a given time reference, an input, cause, or stimulus, of matter, energy, or information, and an output, effect, or response of information, energy, or matter."[3]
4. "Regularly interacting, and interdependent group of items forming a unified whole."[18] Implies well defined limits.

SYSTEMS ANALYSIS

1. The study of how the component parts of a system interact and contribute to that system."[9]
2. "The act, process, or profession of studying an activity (as a procedure, a business, or a physiological function) typically by mathematical means in order to define its goals, or purposes and to discover operations and procedures for accomplishing them most efficiently."[18]
3. "Includes the orderly and logical organization of data and information on ecosystems into models."[14]

Note: Systems analysis is a research tool *not* an objective.

See SYSTEMS APPROACH.

SYSTEMS APPROACH

1. "A systematic consideration of problems wherein analysis is stressed as well as intuition."
   a. Implies seeking an optimal course of action, i.e., objectives, costs, effectiveness and risks of alternative strategies. This latter refers to systems analysis.
   b. "Utilizing a systems approach to problems that entails (i) compiling, condensing, and synthesizing a great amount of information concerning the components of the system, (ii) examining in detail the structure of the system, (iii) translating this knowledge of systems components, function, and structure into models of the system, and (iv) using the models to derive new insights about management and utilization of grassland systems."[14]

SYSTEMS ECOLOGY

1. The application of techniques of systems analysis to ecological problems.

TIME STEP (DT, DELTA TIME)

1. "The solution-time interval between evaluations of a set of equations in a simulation model."[5]

Note: The time step of a simulation model need not be the same as the time expressed in the flow rates described in the model.

See FLOW RATE.

TOTAL SYSTEMS MODELS

1. "Conceptual miniaturizations (likenesses, representations) of the ecosystem with which we are concerned. . . . not all inclusive, but rather . . . all encompassing. That is, they include abiotic, producer, consumer, decomposer, and nutrient considerations, but they may not include all of the interesting or important biology which is found in the ecosystem. The specific miniaturization depends upon the objectives for the modeling activity."[9]

Note: The models do not duplicate the real systems.

TRANSIENT SYSTEM

1. "Transient behavior describes those changes where the *character* of the system changes with time. A system that exhibits growth would show transient behavior. Transient responses are 'one-time' phenomena that cannot repeat."[5]

See STEADY STATE SYSTEM.

UNSTABLE SYSTEM

1. "In an unstable system that starts at rest, an initial disturbance is amplified, leading to growth or to oscillations whose amplitude increases."[5]

2. "Many if not all of our real biological, social, economic and political systems are unstable, that is 'tending toward increasing amplitudes of oscillation that are contained by a continuously shifting balance of forces among the system nonlinearities.'"[5]

Note: These systems are considered to be *constrained* unstable systems. Where the system is not so constrained the response to the instabilities is *explosive*.

VALIDATION

1. "Validation means checking output of an appropriately driven model against field or laboratory measurements"[12] and then making a judgment of adequacy of the representation by the model of the field or laboratory system depicted by the measurements.
2. "The validity (or significance) of a model should be judged by its suitability for a particular purpose. A model is sound and dependable if it accomplishes what is expected of it. This means that validity, as an abstract concept divorced from purpose, has no useful meaning. What may be an excellent model for one purpose may be misleading and therefore worse than useless for another purpose."[5]

VARIABLE

1. "A quantity that may assume a succession of values which need not be distinct."[17]
2. "A quantity that may assume any one of a set of values."[18]

See COEFFICIENT and PARAMETER.

VECTOR

1. A vector "is an n × 1 matrix."[9]

WEATHER

1. "State of the air or atmosphere with respect to heat or cold, wetness, calm or storm, clearness or cloudiness."[18]
2. Short-term atmospheric phenomena.

See CLIMATE.

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