Project N°: 036992

ACRONYM : **S**cience **P**olicy **I**ntegration for **Co**astal **S**ystems **A**ssessment

REPORT

COASTAL SAF GLOSSARY

Alison Gilbert, Cedric Bacher, Johanna D'Hernoncourt, Teresa Fernandes, Zoi Konstantinou, Christopher Lowe, Loraine McFadden, Anne Mette, Sally Priest, Pascal Raux, Wim Salomons, Paul Tett, Sylvia Tunstall, and Tim Stojanovic

March, 2011

Institute for Environmental Studies at the VU University Amsterdam

How to cite: Gilbert, A. et al (2011), Coastal SAF Glossary, Spicosa project report, available at: www.coastal-saf.eu.

Integrated Project funded by The European Community
Under the Sixth Framework Programme
Priority 1.1.6.3
Global Change and Ecosystems

Introduction to the SAF glossary

Alison Gilbert

The SAF glossary has been developed to assist users of the SAF products, in particular the Systems Approach Framework Handbook (SAF) and the various case studies. The SAF makes use of wide variety of terms. The aim of the glossary is to provide clear and unambiguous definitions of terms that might be unfamiliar to users.

The SAF provides a way to understand and model problems in ecological, social and economic systems. It draws heavily on General System Theory, largely the work of Ludwig von Bertalanffy, on the Soft Systems Methodology of Peter Checkland, as well as on social-ecological concepts and approaches from such sources as Eugene and Howard Odum, C.S. (Buzz) Holling, Niklas Luhmann, Jürgen Habermas, Robert Costanza, Elinor Ostrom, Herman Daly, and Karl Popper. The mix of disciplines, and particularly of 'hard' and 'soft' perspectives on systems, poses challenges for language and communication. As has been discovered in countless other cross-disciplinary efforts, different disciplines can have different perspectives on, and definitions of, the same words. Existing definitions did not always adequately encompass the way some terms were used in the SAF, and so these terms have come to have their own, unique, SAF nuance.

The SAF glossary serves as a reference point for standardising language when applying the SAF. It comprises more than 230 terms and definitions, of which about 150 are derived from or based on existing definitions. Sources are provided and range from scientific literature, to glossaries constructed by such organisations as UNDP, OECD and EEA, to internet sources (Wikipedia, on-line dictionaries, etc.). Its focus on the coastal zone means that the glossary augments the coastal wikipedia (http://www.coastalwiki.org/coastalwiki/Main_Page).
Construction of the glossary confronted the editorial team with the multitude of terms and the diversity of meanings, and so facilitated rationalisation, consistency and clarity of language in the generation of the SAF, the handbook, and related products. By streamlining language and by encouraging discussions directed towards streamlining language, the glossary also makes an important contribution to multi-/inter-/transdisciplinary science.

Term	Definition	Cross reference	Non-SPICOSA Source(s)
accuracy	Closeness of computations, estimates or measurements to the exact or true values.		International Glossary of Hydrology (http://grdc.bafg.de/servlet/is/Entry.1600.Display/)
actor	Person who carries out one or more of the activities in the system.		Checkland (1981)
algorithm	A precise rule (or set of rules) for solving a problem.		Pasqual et al. (2003)
altruistic value	A non-use value element of total economic value. The value that individuals derive from knowing that a resource will be available for others (of the current generation).	total economic value, Non-use value	Pearce et al. (2006)
appraisal step	The step in the SAF that implements system appraisal	SAF; system appraisal	
assumption	A statement that is used as the premise of a particular argument but may not be otherwise accepted		http://dictionary.reverso.net/english-definition/
averting behaviour	Behaviour in which individuals and households insulate themselves from a non-market bad (for instance to avoid or mitigate the impacts of pollution) by selecting more costly types of behaviour. These behaviours might be more costly in terms of the time requirements they imply, of the restrictions they impose on what the individual would otherwise wish to do, or because of the purchase of a market good.	defensive expenditure	Pearce et al. (2006)
BAU	Short for 'Business as Usual'. The future states of society and the environment for which no new policies are projected. Hence the future condition of a system if its management, use, regulation, trend etc remain the same as present.	scenarios	
benefits	In its broadest sense benefits are defined as increases in human well-being (utility). The benefit of a project, programme or policy is the positive, expected aspect of an outcome, including the improvement in environmental protection or environmental quality, which will flow from it, but also including other improvements – for example, in cost savings, social benefits, such as health, convenience, or general welfare.	costs	Pearce et al. (2006)
benefits transfer	A method for transferring the value of a non-market good estimated in an original or primary study to a different study site, as a proxy for values of the (same) good in another site.	a	Pearce et al. (2006)
bequest value	A non-use value element of total economic value. The value that individuals derive from knowing that a resource will be passed on to future generations (similar to altruistic value but differing in that concern is for future generations, not the current generation).	total economic value, non-use value, existence value	Pearce et al. (2006)
block	EXTEND object used to preform routine model functions, mathematical, statistical, data inputs, conversions, import, export or store data, etc. These come with the software or can be created by the operator.	state variable, functional component, hierarchical blocks	ExtendSim User Guide (Anon. 2007)
boundary	In the formal system model, the area within which the decision-taking process of the system has power to make things happen, or prevent them from happening	boundary conditions	Checkland (1981)
boundary conditions	Refers to the information needed from systems external/adjacent to the one being considered. Usually concerning mass, energy, or information conditions that affect the function of the considered system.	boundary	
capital	Within classical and neoclassical traditions of economics capital is one of the three factors of production that are used to produce other goods and services (the other factors of production are labour and land – which includes natural resources). There are three major categories of capital: natural capital, such as land or natural resources; human capital, which includes knowledge and entrepreneurship, and; physical capital, which includes all physical, man-made goods used to produce other goods and services – machinery, tools, buildings etc. The latter is quite often more simply called "capital" while the others are always preceded natural or human.		
CATWOE	A mnemonic describing problem situations and the human activity associated with them. It can be used when identifying the problem, to prompt thinking about what might be achieved, as well as when seeking to implement the solution, to help consider the impact on the people involved.		Checkland (1981)
choice modelling	Stated preference methods used to determine willingness to pay (or, willingness to accept compensation) for a specified ecosystem good or service or a change in that good or service. A family of survey based methodologies that ecompasses choice experiments, contingent ranking, contingent rating and paired comparisons. Differs from contingent valuation methods in that they elicit values by presenting respondents with a series of alternatives (each of which has a value associated with it) and	stated preference	Pearce et al. (2006)
coastal zone	The interface between land and sea, delineated as the part of the land affected by its proximity to the sea, and the part of the sea affected by its proximity to the land.		Adapted from Mangor (2004); http://www.coastalwiki.org/spicosa/Coastal_zone
commodity chain analysis	The overall group of economic agents (or the relevant activities of those agents) that contribute directly to the determination of a final product. Thus the chain encompasses the complete sequence of operations which, starting from the raw material, or an intermediate product, finishes downstream, after several stages of transformation or increases in value, at one or several final products at the level of the consumer.		FAO (2005)
computable general equilibrium	Framework for evaluating the economic implications of policy intervention on resource allocation and incomes of agents. The model consists of equations describing the variables and a database consistent with the model equations.		Böhringer (2004)
conceptual model	1) A description of reality in terms of words, equations, governing relationships or natural laws that encompasses the user's perception of the key processes in the study area, and that corresponds to acceptable simplifications and numerical accuracy limits for the purpose of the modelling. 2) A systematic account of a human activity system, built on the basis of that system's root definition, usually in the form of a structured set of verbs in the imperative mode.	human activity system, root definition	Refsgaard and Henriksen 2004
constant	A number, often dimensionless, that remains unchanged during a simulation, although it may be changed for different runs of a simulation, i.e. as a part of a scenario or sensitivity run.		
constraint	Legislation, regulation, or rules that may help to define acceptable scenarios.		
consultation	A one-way flow of information feedback from stakeholders		
consumer surplus	Difference between what a consumer is willing to pay for a good or service and the amount actually paid.	producer surplus	Pindyck and Rubinfeld (2005)
consumption	Goods and services purchased by consumers.		Mankiw (2000)
contingent valuation	A stated preference method used to determine willingness to pay (or, willingness to accept compensation) for a change in a specified ecosystem good or service. Structured questionnaires are used in which respondents are given detailed information on the issue to be valued and are then asked to answer yes/no to suggested values (dichotomous choice or payment ladder) or provide a willingness to pay (or, accept compensation) value themselves (open ended).	stated preference, valuation approach	Pearce et al. (2006)
convenor	Individual or representative of the organisation or group that has initiated and led the SAF process ?	SAF	
cost benefit analysis	A framework for analysis that quantifies, in money terms, as many of the costs and benefits of a policy or project as possible, including those for which the market does not provide a measure of economic value. It differs from commercial investment appraisal techniques since its primary aim is to assess social worth and to this end uses criteria based upon welfare economics. Cost benefit analysis is based on the principle that benefits are defined as increases in human well-being (utility) and costs are defined as reductions in human well-being. For a project or policy to qualify on cost-benefit grounds, its social benefits must exceed its social costs.	multi-criteria analysis, cost-effectiveness analysis	Pearce et al. (2006)
cost effectiveness analysis	Form of analysis which enables the identification of the least expensive way of achieving a given environmental quality target, or the way of achieving the greatest improvement in some environmental target for a given expenditure of resources.	cost-benefit analysis; multi-criteria analysis	http://glossary.eea.europa.eu
costs	In microeconomics, costs refer to the value in alternative uses of the factors of production used by a firm (labour costs, materials costs, capital costs). Costs may be fixed or variable. In its broadest sense costs are defined as decreases in human well-being (utility).	benefits	http://stats.oecd.org/glossary/; Pearce et al. (2006)
coupling	The process of linking two or more variable or models together through functions to create a systems model from smaller components	Linkages, linking variables	
critical natural capital	Ecosystem goods and/or services which provide important environmental functions and for which there are essentially no substitutes.	natural capital	Pearce et al. (2006)
cultural services	A category of ecosystem services.	ecosystem services	

DPSIR	The chain of links between the driving forces within society (D), the pressure on the environment (P), the state of the environment itself (S), the impact on people and nature (I) and the desirable response (R)	driving forces, pressures, states, impacts, responses	Luiten (1999)
decision-maker	Individual, group or organisation that has the power/authority to decide on a course of action for a specific site or set of circumstances from amongst a range of policy options available	policy-maker, stakeholder, environment manager	
defensive expenditures	Expenditures undertaken to avoid exposure to non-market bads via the purchase of a market good (for instance to avoid or mitigate the impacts of pollution). The value of each of these purchases represents an implicit price for the non-market good or bad in question.		Pearce et al. (2006)
deliberation	An open process of discussion and exchange of knowledge and ideas between individuals, groups and organisations to identify, appraise and, perhaps even, choose amongst various options or courses of action.		
deliberative democracy	A system of political decision-making that relies on popular consultation to make policy. In contrast to the traditional theory of democracy, where voting is central, deliberative democracy theorists argue that legitimate lawmaking can arise only through public deliberation. May also be called discursive democracy.		http://en.wikipedia.org/wiki/; Bessette (1980; 1994)
demand	The desire, ability and willingness of an individual to purchase a good or service. The consumer must have the funds or the ability to obtain funds in order to convert the desire into demand. The demand of a buyer for a certain good is a schedule of the quantities of that good which the individual would buy at possible alternative prices at a given moment in time.	supply	http://glossary.eea.europa.eu
depreciation	The reduction in the capital stock that occurs over time because of ageeing and use. Alternatively the value of the amount that must be spent on new capital goods to maintain the existing capital stock.		Mankiw (2000)
dialogue	Conversation between two or more parties involving an exchange of information , ideas and views.		
direct effect	Changes in economic activity during the first round of spending. For tourism for instance this involves the impacts on the tourism industries (businesses selling directly to tourists) themselves.	economic impact assessment	Stynes (1997)
direct use value	A component of total economic value that relates to physical interaction with the ecosystem and could include, for example, the value of the benefits derived from fishing.	total economic value, use value	Pearce et al. (2006)
discount factor	The multiplication factor that converts a projected cost or benefit in a future year into its present value. Discount factors are computed based on the selected discount rate. Mathematically, a discount factor is equal to $1/(1 + r)^n$, where r is the discount rate and n is the number of years since the base year.	discounting	
discount rate	The annual percentage rate at which the present value of a unit of account (e.g. €, £ or $) is assumed to decline through time. This rate can be constant through time or can decline as the time periods considered extend further into the future.	discounting	
discounting	A method by which costs or benefits that occur in the future are converted to present values using a discount rate (assigning a lower weight to a unit of benefit or cost in the future than to that unit now).		
discrete choice model	Econometric model in which the dependent variable is an indicator of a discrete choice, such as a "yes or no" decision.		Greene (1997)
domain of applicability	Prescribed conditions in space, time and types of applications, for which the model has been tested.		
driver/driving force	Social, demographic and economic developments in societies and the corresponding changes in lifestyles, overall levels of consumption and production patterns.	HA	EEA (1999)
DST	Short for 'Deliberation Support Tool'. Communication tool(s) for facilitating a science-policy interface.		
dynamic equilibrium	(1) A system in dynamic equilibrium is a particular example of a system in a steady state. (2) A state of balance with respect to environmental factors and populations of organisms. (3) A system that fluctuates, but overall is in balance. (4) A system in flux, but with influxes equal to outfluxes.		(1) en.wikipedia.org/wiki/Dynamic_equilibrium (2) www.cabq.gov/aes/glossary.html (3) www.cliffsnotes.com/Section/Earth-Science-Glossary.id-305499,articleId-57021.html (4) www.soest.hawaii.edu/SEAGRANT/bmpm/glossary.html
ecological quality	The quality of the composition, structure, and function of an ecosystem.		Based on the definition for 'ecological status' within the Water Framework Directive (http://ec.europa.eu/environment/water/water-framework/index_en.html); Tett et al 2007
ecological quality element	A discrete part of ecological quality, such as phytoplankton abundance or the faunistic composition of the benthos, as exemplified in Annex V of the Water Framework Directive.		Water Framework Directive (http://ec.europa.eu/environment/water/water-framework/index_en.html)
EcoQO	Short for 'ecological quality objective'. The desired level of an ecological quality element.		e.g. Mee (2005); Rogers and Greenaway (2005); Tett et al. (2007)
economic efficiency	See Pareto efficiency.	Pareto efficiency	
economic impact assessment	An economic impact assessment traces the flows of spending associated with an activity in a region to identify changes in sales, tax revenues, income, and jobs due to the activity.		Stynes (1997)
economic instruments	Financial rewards, incentives and punishments that operate automatically via market forces, to encourage beneficial behaviour. Examples include: taxes on environmentally damaging consumption or production activities; tradable pollution permits; subsides to encourage environmentally benign (or less environmentally damaging) activities.		
ecosystem	Any area of nature that includes living organisms and nonliving substances interacting to produce an exchange of materials between the living and nonliving parts.		Odum (1959); term coined in 1930 by Roy Clapham to mean the combined physical and biological components of
ecosystem services	Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.		Millenium Ecosystem Assessment (2005)
effectiveness	Effectiveness means the extent to which the activity's stated objectives have been met.	efficiency	http://stats.oecd.org/glossary/
efficiency	Efficiency means achieving maximum output from a given level of resources used to carry out an activity.	effectiveness	http://stats.oecd.org/glossary/
elasticity	Percentage change in one variable resulting from a 1 percent increase in another.		Pindyck and Rubinfeld (2005)
emergent properties	Properties of a system which derive from its component activities and their structure, but cannot be reduced to them	human activity system	Checkland (1981)
empowerment	A process whereby individuals, groups, organisations and communities develop a sense of control over their lives in order to act efficiently in the public sphere, to have access to resources and promote change in their common circumstances.		Ortiz-Torres (1999); Ortiz-Torres et al. (2000)
environment	The non-living part of a system is its environment; the living part is its (biological) community.		Odum (1959); term coined in 1930 by Roy Clapham to mean the combined physical and biological components of an environment. British ecologist Arthur Tansley later refined the term, describing it as "The whole system,… including not only the organism-comple
environmental accounting	Adjusted System of National Accounts with physical and monetary accounts of environmental assets and/or the costs of their depletion and degradation.		http://stats.oecd.org/glossary/
environmental management	Management of human activities that affect the environment in such a way so as to ensure their sustainability in the long-term		
environmental manager	An individual, such as a public official, who carries out environmental management. At the operational level of governance, managers plan or give consent to individual human activities (HAs) taking account their likely environmental impact; at the collective or constitutional levels of governance, they make environmental plans, oversee the implementation of environmental policy, decide policy, or support legislators who make environmental law.	decision-maker, policy-maker, stakeholder	

environmental quality	Conditions in environmental media, measured directly or expressed in terms of indicators or indices related to environmental quality standards.	ecological quality	Based on http://stats.oecd.org/glossary/
ESE analysis	Short for 'ecological, social and economic analysis'; the process in which the integration of different components of sustainability takes place.	ESEsystem	
ESEsystem	Short for 'ecological, social and economic system': a Virtual System or model including these components	ESE analysis; socio-ecological system; SAF	
existence value	A non-use value element of total economic value. Existence value is the value that individuals derive from simply knowing that an ecosystem (or species, or some other environmental attribute) continues to exist -with no actual or planned use for his/herself or for anyone else.	total economic value, non-use value, bequest value	Pearce et al. (2006)
exogenous variable	Exogenous variables influence other variables in the model but are not calculated by the model.		Sterman (1991)
expert group	A group of multidisciplinary experts of varying experience (including not only ecologists and modelers, but also sociologists, economists etc.) participating in quantitative and qualitative assessments.	scientist, stakeholder	
external variables		forcing function	
externality	Externalities refer to situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided.		http://stats.oecd.org/glossary/
facilitator	Independent individual, usually professionally trained in this context, who enables groups and organizations to work more effectively; to collaborate and achieve synergy.		
factor of production	An input used to produce goods and services; for example, capital and labour.		Mankiw (2000)
feedback loop	Closed loop structure that brings results from past action of a system back to control future action thanks to positive or negative feedback actions which tend to increase or decrease system rate		Forrester (1971)
financial analysis	Determines whether a business will generate sufficient revenues to cover its costs and make a reasonable profit. It generally includes a short-term analysis of the availability and costs of start-up capital as well as a longer-range analysis of debt service, operating costs and revenues.		Stynes (1997)
finite difference method	In mathematics, finite-difference methods are numerical methods for approximating the solutions to differential equations using finite difference equations to approximate derivatives. Finite-difference methods approximate the solutions to differential equations by replacing derivative expressions with approximately equivalent difference quotients.		http://en.wikipedia.org/wiki/Finite_difference_method
forcing	What a human activity or natural variability does to a system. 'Pressure' in DPSIR terms.	SAF	
forcing functions	Functions or variables of an external nature that influence the state of the ecosystem. In a management context the problem to be solved can often be reformulated as follows: if certain forcing functions are varied, how will this influence the state of the ecosystem? Also termed external variables.	scenario, exogenous variable	Jorgensen (1994)
forecast	Attempt to produce a most likely description or estimate of the actual evolution of a variable or system in the future.	hindcast	Carpenter et al. (2005).
formulation step	The step in the SAF in which models are constructed and data gathered.	SAF; system formulation	
functional components	A set of linked processes and state variables that perform an important function in the system.	ecological, social and economic analysis	
GDP	Short for 'Gross Domestic Product'. The maket value of an economy's domestically produced goods and services over a specified period of time. It is gross since no allowance is made for the replacement of	GNP, NNP	Barro (1993)
GNP	Short for 'Gross National Product'. The total market value of the goods and services produced by the residents of a country over a specified period of time; GNP equals GDP plus the net factor income from abroad (income earned by domestic residents from foreign investments -income earned by foreign investors in that region's domestic market).	GDP	Barro (1993)
governance	The exercise of political, economic and administrative authority in the management of a country's affairs at all levels. Governance comprises the complex mechanisms, processes, and institutions through which citizens and groups articulate their interests, mediate their differences, and exercise their legal rights and obligations		UNDP (1997)
governance scale	The most common way to define the relations between social actors and biophysical resources is by t use of rights and rules (e.g. property rights) that connects actors to these resources. Such rules make up the 'Governance Structure' that operates at three scales or levels: operational, collective, and constitutional.	actor	Sandberg (2007); Sørensen and Torfing (2007)
governance scale: operational level	The level at which rules for the direct interaction between the human activity and natural (biophysical resources are enacted - or modified, e.g. in the form of harvesting.	governance scale	
governance scale: collective level	The level at which rules for activities on the operational level are made, e.g. for the access to, for exploitation of and for maintenance of the natural resources .	governance scale	
governance scale: constitutional level	The deeper level at which the rules for how to make decisions at the collective choice level are made, e.g. who is in position to make decisions, who can block decisions, how decisions are made (unanimo or simple majority), the amount of information required to make decisions etc.	governance scale	
green accounting	See Environmental accounting.	environmental accounting	
GST	short for 'General Systems Theory', which sees the physical and social world as containing systems with a set of formal properties; cf. SSM, ('Soft Systems Methodology') in which systems are conceptual devices	SSM, SAF	Bertalanffy (1968, 1975)
hedonic pricing method	A revealed preference approach to environmental valuation. Estimates the value of a non-market good by observing behaviour in the market for a related good. The method uses a market good via which the non-market good is implicitly traded (for instance property markets or labour markets).	valuation approach, revealed preference	Pearce et al. (2006)
hindcast	Using a model to simulate past conditions.	forecast	
HA	Short for 'human activity'. A deliberate or unintentional human intervention in the function and structu of natural systems.	SAF	
human activity system	A notional system which expresses some purposeful human activity which could, in principle, be found in the real world	HA	Checkland (1981)
impact	A deterioration of the goods or services from an ecosystem. An impact is usually expressed in the form a change in a variable or in a characteristic of the system.	SAF	
indicator	A quantitative output of the Simulation Model which has some standard properties with respect to the system: to simplify, to quantify and to communicate.		
indirect effect	Changes in sales, income or employment within the region in backward-linked industries supplying goods and services to businesses impacted by a change in spending. For example, in the tourism industry, the increased sales in linen supply firms resulting from more motel sales is an indirect effect visitor spending.	economic impact assessment	Stynes (1997)
indirect use value	The value of benefits derived from services provided by ecosystems which do not involve actual physical interaction; e.g. carbon sequestration by some coastal wetland ecosystems provide.	total economic value, use values, direct use values	Pearce et al. (2006)
induced effect	Increased sales within the region from household spending of the income earned in in industries impacted by a change in spending (and supporting industries). For instance, employees in tourism and supporting industries spend the income they earn from tourism on housing, utilities, groceries, and other consumer goods and services. This generates sales, income and employment throughout the region's economy.	economic impact assessment	Stynes (1997)
input	Component of production; that goes into the production of output	output	http://wordnet.princeton.edu/
input-output multipliers	Capture the size of the secondary effects in a given region, generally as a ratio of the total change in economic activity in the region relative to the direct change. Multipliers may be expressed as ratios of sales, income or employment, or as ratios of total income or employment changes relative to direct sales. Multipliers express the degree of interdependency between sectors in a region's economy and therefore vary considerably across regions and sectors.	input-output table, economic impact assessment	Stynes (1997)
input-output table	A means of presenting a detailed analysis of the process of production and the use of goods and servic (products) and the income generated in that production. Information can be presented either in the form of supply and use tables or symmetric input-output tables.		http://stats.oecd.org/glossary/

institution	Systems of rules and procedures, both formal and informal, that structure social interaction by constraining and enabling actors' behaviour. Institutionalized ways of doing certain practices give rise to organisations, such as schools and churches, that seek to maintain the rules that are favourable for them.	organisation, actor	North (1990), Knight (1992), Carey (2000)
institutional arrangements	Define the authorities and offices responsible for decisions related to public resources and the implementation of instruments.	institution, governance scale	Ostrom (1990)
institutional mapping	A procedure for indentifying socio-economic relationships amongst institutions, organizations and groups		
integrated model	A model that includes several domains. Domains may be: 1) coupled, so that feedback between domai is accounted for within each time step, typically in an iterative scheme; or 2) uncoupled or forward coupled, so that output from one domain is used as input to another domain without feedback.		
interest	A moral claim or legal share; something in which such a right, claim, or share is held; a person or grou of persons holding such a right, claim, or share		Based on http://www.thefreedictionary.com/
interest group	A group that exists because its members have a shared interest in an activity, objective and/or a location	stakeholder	
interest rate	An interest rate is the cost or price of borrowing, or the gain from lending, normally expressed as an annual percentage amount.		http://stats.oecd.org/glossary/
intrinsic value	Values which are usually defined as residing in the asset and unrelated to human preferences or even human observation.		Pearce et al. (2006)
inverse modelling	A versatile statistical technique, based on estimation theory, that can be used to estimate quantities that are directly or indirectly related to the measured quantity. For instance, absorption features in Earth's electromagnetic spectrum can be used to estimate concentrations of atmospheric trace gases that can subsequently be used to estimate surface flux estimates.		http://www.geos.ed.ac.uk/research/eochem/inv.html
investment	Goods purchased by individuals and firms to add to their stock of capital.		Mankiw (2000)
leverage point	Those influences within a system where small changes can effect a substantial change in the system itself.		Bellinger (2004)
linking variables	An intermediary variable placed between two or more sub models which is relevant to each and therefore allows connection between those sub models.	coupling	
macroeconomics	Branch of economics that deals with aggregate economic variables, such as the level and growth rate o national output, interest rates, (un)employement and inflation.	microeconomics	Pindyck and Rubinfeld (2005)
management choice	A tactical choice (presented by environment managers to stakeholders) amongst specific actions	policy option	
market	Collection of buyers and sellers that, through their actual or potential interactions, determine the price of a product or set of products.		Pindyck and Rubinfeld (2005)
market failure	Situation in which an unregulated competitive market is inefficient because prices fail to provide propa signals to consumers and producers. Market failures provide a rationale for government intervention.	market	Pindyck and Rubinfeld (2005) and http://stats.oecd.org/glossary/
microbial loop	A trophic pathway in aquatic environments where dissolved organic carbon (DOC) is reintroduced to the food web through the incorporation into bacteria. Bacteria are consumed mostly by protists such as flagellates and ciliates		en.wikipedia.org/wiki/Microbial_loop
microeconomics	The study of individual markets and decision makers.	macroeconomics	Mankiw (2000)
model	A simplified representation of the essential or dominant features of relationships amongst components of real systems, used to (i) increase and promote understanding of the real system, and (ii) simulate the behaviour of the real system under particular scenarios.		Based on Smith (1795)
model calibration	The procedure of adjustment of model parameter values to reproduce the response of reality within the range of accuracy specified in the performance criteria.		Refsgaard and Henriksen (2004)
model code	A mathematical formulation in the form of a computer program that is so generic that it, without program changes, can be used to establish a model with the same basic type of equations (but allowing different input variables and parameter values) for different study areas. Many authors and many guidelines use the term model both in the meaning of a model code and as a site-specific model.		Refsgaard and Henriksen (2004)
model confirmation	Determination of adequacy of the conceptual model to provide an acceptable level of agreement for the domain of intended application. This is in other words the scientific confirmation of th theories/hypotheses included in the conceptual model.		Refsgaard and Henriksen (2004)
model error	1) Difference between observed and simulated variables; can be cumulative, absolute, quadratic, etc. 2) A recognizable deficiency in any phase or activity of modeling and simulation that is not due to lack of knowledge.		Refsgaard and Henriksen (2004); Schaller (2004)
model stability			
model validation	Substantiation that a model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model.		Refsgaard and Henriksen (2004)
model verification	The process of determining that a model implementation accurately represents the developer's conceptual description of the model and the solution to the model.		Anon. (1998)
multi-criteria analysis	Framework that allows decision makers to evaluate and rank different management options according a set of well defined evaluation criteria.	cost-benefit analysis; cost-effectiveness analysis	
multiplier effect	The second round effects on the level of economic activity (output, income or employment) associated with a policy intervention (e.g. where the employees of a new project spend their earnings and so increase consumer demand).	economic impact assessment, indirect and induced effects	
natural capital	The stock of natural resources and environmental assets (e.g. a forest) which produces the flow of ecosystem goods (e.g. new trees) and services (e.g. carbon sequestration, erosion control, habitat).	critical natural capital	http://glossary.eea.europa.eu
NNP	Short for 'Net National Product'. Gross national product less depreciation.	GNP	Barro (1993)
NPV	Short for 'Net Present Value '. The result of subtracting the total present value of costs from the total present value of benefits (in a cost benefit analysis framework).	cost benefit analysis	Pearce et al. (2006)
non-use value	Non-use values for ecosystem goods and services are those values that individuals derive without any physical interaction with them. They are further classified into: existence, bequest and altruistic values	total economic value, bequest value, existence value	Pearce et al. (2006)
opportunity cost	Costs associated with opportunities that are forgone when a firm's/project's/policy measure's ressources are not put to their best alternative use.		Pindyck and Rubinfeld (2005)
option value	An individual's willingness to pay to guarantee that an ecosystem good or service is available for their future use. An element of total economic value that arises due to uncertainty about future conditions. gained by delaying any decision.	total economic value, quasi-option value	Pearce et al. (2006)
organisation	'Teams' of actors or players, that is, groups of individuals which are bound by a common purpose to achieve objectives. These players can be political bodies, economic bodies, social bodies or educational bodies.	institution	
output	Output consists of those goods or services that are produced within an firm that become available for use outside that firm, plus any goods and services produced for own final use.	input	http://stats.oecd.org/glossary/
output step	The final step in the SAF that returns the results of the analysis to the stakeholders deliberates on these	SAF	
paradigm	A philosophical or theoretical framework for interpreting situations or conditions		http://www.merriam-webster.com/dictionary/
parameter	Coefficients in the mathematical representation of processes.		Jorgensen (1994)
parameter	A quantity that is assumed constant in time. A parameter is most often a representation of a physical, chemical or ecological characteristic of reality.		
parameter uncertainty	Uncertainty that is caused by measurement errors, analytical imprecision and limited sample sizes during collection and treatment of data.		Pasqual et al. (2003)
parameterisation	Activities to transform system characteristics into model parameters.		

Pareto efficiency	Situation where resources are so allocated that it is not possible to make anyone better off without making someone else worse off.		http://stats.oecd.org/glossary/
parsimony principle	Implies that a conceptual model has been simplified as much as possible, yet it retains enough complexity so that it adequately represents the physical system and its behaviour.		
performance criteria	Level of acceptable agreement between model and reality. The performance criteria apply both for model calibration and model validation. The performance criteria are usually formulated so that a number of objective functions have to be better than specified numerical values.		Refsgaard and Henriksen (2004)
phase	The fraction of the whole period that has elapsed, measured from a fixed time instant. Periodic waves having the same frequency and waveform, are said to be in phase if they reach corresponding amplitudes simultaneously.	phase shift	Ballour (2005)
phase shift	Any change that occurs in the phase of one quantity	phase	Ballour (2005)
policy	A deliberate plan of action to guide decisions and achieve rational outcome(s).		Wikipedia
policy evaluation	Assessment of relationship between a policy and its outcomes. Has a policy has achieved its objectives? What were the effects? Are further policy changes needed?		Anderson (1994)
policy issue	A coastal zone problem or dysfuntion that that needs policy attention. In the SAF the problem (impact) is first indentified and the Policy Issue then becomes the options, conflicts, and controversy surrounding a policy action to miigate or resolve the conseqeunces of the Impact.	SAF	
policy options	The set of alternatives considered by interested parties in order to make a strategic choice		
policy-maker	Individual, group or organisation that has the power/authority to decide on the range of policy options that may be implemented in certain circumstances or conditions	environment manager, decision-maker, stakeholder	
post-normal science	A methodology of inquiry (operating under different standards than conventional scientific methodology) that is appropriate for cases where facts are uncertain, values in dispute, stakes high and decisions urgent		Funtowicz and Ravetz (1991)
preference	Concept that assumes for individuals a real or imagined "choice" between alternatives and the possibility of rank ordering of these alternatives, based on the utility they provide.		Wikipedia
present value	The value of a stream of future costs or benefits expressed in present terms, i.e. the discounted value of future costs or benefits.	discounting, NPV	Pearce et al. (2006)
price	The amount of money paid per unit for a good or service.		http://glossary.eea.europa.eu
pricing approach	Technique to estimate the price of ecosystem goods and services.		
process	Natural sciences: a method or event that results in a transformation in a physical or biological object, a substance or an organism. Processes are always properties of dynamic systems; they are characterized by such system attributes as variables and parameters. Economics: processes affect the production, development and management of material wealth. Social sciences: the means by which culture and social organisations change or are preserved.	process block	Natural science: http://en.wikipedia.org/wiki/Process Economics: http://dictionary.reference.com/browse/economic+process Social science: http://dictionary.reference.com/browse/social+process
process block	A block representing a process, incorporating the variables and parameters that determine the process and the functional relationships between them.	block, process	
process function	A mathematical equation representing a process development in time.	process, process block	
producer surplus	Difference between what a producer receives for the goods it produces and the cost of producing them	consumer surplus	Schotter (2009)
production function	The mathematical relationship showing how the quatities of the factors of production determine the quantity of goods and services produced; for example Y = F(K,L) with Y as output; K and L as inputs capital and labour.		Mankiw (2000)
profit	Difference between total revenue and total cost for a firm.		Pindyck and Rubinfeld (2005)
provisioning services	A category of ecosystem services.	ecosystem services	
public participation	A framework of policies, principles and techniques which ensure that citizens and communities, individuals and organisations have the opportunity to be involved in a meaningful way in decisions that will affect them, or in which they have a stake.		Water Framework Directive (http://ec.europa.eu/environment/water/water-framework/index_en.html)
quasi-option value	An individual's willingness to pay to avoid taking irreversible decisions in the present given an expectation that our knowledge of the implications of those decisions will increase in future. An element of total economic value that arises due to uncertainty about future conditions.	total economic value, option value	Pearce et al. (2006)
regulating services	A category of ecosystem services.	ecosystem services	
rent	Return on a factor of production above the amount necessary to entice that factor into the production process.		Schotter (2009)
replacement costs	A method by which the value of ecosystem goods or services are estimated by calculating the cost of replacing or recreating them.		
resilience	The capacity of a system to absorb and utilize, or even benefit from, perturbations and changes, and so to persist without a qualitative change in the system's structure.	stability, dynamic equilibrium	Holling (1973)
response	A forced change in the ecosystem (e.g. eutrophication). Note that this is different from use of this term in the DPSIR framework.	SAF, HA, forcing	
return	Total monetary flow of an asset as a fraction of its price.		Pindyck and Rubinfeld (2005)
revealed preference	Revealed preference techniques of valuation use market information and behaviour to infer the economic value of an associated non-market impact.	valuation approach, preference, stated preference	Pearce et al. (2006)
risk	Possibility that human actions or natural events lead to consequences that affect aspects of what humal value.	risk assessment	
risk assessment	Scientific process of identifying unwanted consequences (and their causes) and calculating their probabilities and magnitude.	risk	Renn (2000)
role	In a SAF application, roles include stakeholding, policy-making, decision-making, being an actor, working as a scientist. A role is the behaviour expected of an individual who occupies a given social position or status.	stakeholder, policy-maker, decision-maker, actor, scientist, environment manager	Encyclopedia Britannica
SAF	Short for 'Systems Approach Framework', and comprising: 1) the use of General Systems Theory (GST) and Soft Systems Methodology (SSM) to understand and model problems in social-ecological systems; 2) the simulation of scenarios including problem management options; and 3) the engagement of stakeholders at the science-policy interface.	GST, SSM, scenario, stakeholder, stakeholder engagement	
satellite account	Satellite accounts provide a framework linked to the central accounts and which enables attention to be focussed on a certain field or aspect of economic and social life in the context of (the system of) national accounts; common examples are satellite accounts for the environment, or tourism, or unpaid household work.	System of National Accounts, environmental accounting	http://stats.oecd.org/glossary/
scale	The spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon		Gibson et al. (2000)
scenario	A coherent, internally consistent and plausible description of a possible future state of the world. A scenario is not a forecast; rather, each scenario is one alternative image of how the future can unfold. A projection may serve as the raw material for a scenario, but scenarios often require additional information (e.g., about baseline conditions). A set of scenarios is often adopted to reflect, as well as possible, the range of uncertainty in projections.	driving force, storyline, policy options	IPCC-TGICA (2007)
scientist	Technical expert, such as an ecologist, economist, mathematical modeller, political scientist, social scientist, and systems analyst, who will apply the SAF to provide stakeholders with the information th need for better deliberation of management or policy options.	expert group, stakeholder, actor, decision-maker, policy-maker	
sensitivity analysis	Analysis of the sensitivity of the model results to changes in parameter values or other assumptions (e input data). In a sensitivity analysis the various sources of uncertainty are analysed individually.		
simulation (in the sense of 'to simulate')	Use of a validated model to gain insight into reality and obtain predictions. These include insights into how reality can be expected to respond to human interventions.		Refsgaard and Henriksen (2004)

simulation model	A model based on mathematical equations and quantitative information, which allows a virtual system to be simulated. Within the SAF, the model formed by linking the ecological, social and economic components to generate the outputs from scenarios.		
simulation model result	A particular solution of a model for a given set of parameter values and initial and boundary conditions		
social choice	A possible way to arrive at judgements about society, given the diversity of preferences, concerns and predicaments of the different individuals within society		Sen (1998)
social-ecological system	An area in the physical world in which human society interacts with 'nature' or 'the environment'.	ESEsystem	Based on Berkes & Folke (1998) and Odum (1959); see also http://www.stockholmresilience.org/research/whatisresilience/resiliencedictionary.4.aeea46911a3127427980004355.html
socio-economic modelling domain	Comprises all modelling activities related to human interventions and evaluations.		
SSM	Short for 'soft system methodology'. Approach to systems' design that focuses on explicating different perspectives; SSM builds on the interpretative or hermeneutic paradigm and "is a methodology which recognizes the role of the individual's 'world images' and the influence of historical background on the interpretation of reality.	GST	Checkland (1981); Checkland and Holwell (1997); Checkland and Scholes (1999); Wilson (1992, 2001); Bergvall-Kåreborn (2004)
stakeholder	An individual, a group of individuals, a non-governmental or government entity that has a direct or indirect interest or claim; stakeholders will, or may, be affected by a particular decision or policy. Stakeholding can be seen as a role.	interest group, policy maker, decision maker, environment manager, expert group, scientist, actor, role	
stakeholder engagement	Any process of gaining information from, imparting information to, consulting with, or working with, stakeholders or the representatives of stakeholder groups		
stakeholder forum	A (time-limited by the SAF process) vehicle, such as an open meeting, workshop or online space, enabling an exchange of information, ideas and views amongst the various stakeholders	stakeholder	
stakeholder mapping	A social mapping method for identifying the stakeholders relevant to a particular issue and for assessing their interests in the issue.		
state	The condition of a system.	state variable, system	
state variable	A variable that describes one aspect of the state of the system.	state, system	Jorgensen (1994)
stated preference	Stated preference techniques of valuation utilise questionnaires which either directly ask respondents for their willingness to pay (accept), or offer them choices between "bundles" of attributes and from which choices the analysts can infer willingness to pay (accept).	revealed preference, valuation approach	Pearce et al. (2006)
storyline	A narrative description of a scenario (or a family of scenarios), highlighting the main scenario characteristics and dynamics, and the relationships between key driving forces.	scenario, driving force, policy options	IPCC-TGICA (2007)
supply	The willingness and ability to sell a range of quantities of a good at a range of prices, during a given time period. Supply is one half of the market exchange process; the other is demand.	demand	http://glossary.eea.europa.eu
supply chain analysis	Analysis of the system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer.	supply	http://en.wikipedia.org/wiki/
supporting services	A category of ecosystem services	ecosystem services	
system	A set of interconnected components within defined boundaries; often including hierachically-arranged sub-system and feedback loops, and possessed of emergent properties as a result of the latter		Smith (1795)
system appraisal	Fourth step in the SAF: simulation and interpretation of the coastal zone system's response to the selected policy issue(s). The goals of this step are: to devise the simulation model for delivery of the specified outputs; to conduct the accompanying interpretive analyses and so provide the scientific and descriptive supplements to these outputs; and, to evaluate the results	SAF; appraisal step	
system design	First step in SAF, in which 1) stakeholders and environment managers are consulted to identify the issue, or coastal zone problem, that involves a cause-&-effect chain from a human activity to its impact on ecosystem goods and services; 2) a virtual system is identified, embodying suffciently real-world behaviour to allow the problem to be explored through modelling; 3) remedial management options are agreed with stakeholders	SAF	
system dynamics	System dynamics is a method for studying the world around us. It deals with understanding how complex systems change over time. Internal feedback loops within the structure of the system influence the entire system behavior.		http://sysdyn.clexchange.org/
system formulation	Third step in SAF, in which 1) conceptual, mathematical and numerical models are built for use in simulating system behaviour or its ecological, economic and social components; 2) data needed by the models is sought	SAF; formulation step	
System of National Accounts	The System of National Accounts consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules.		http://stats.oecd.org/glossary/
system output	Fifth and final step in SAF, in which results are taken back to the stakeholders; the analysis is explained and the stakeholders are assisted in deliberating on their choice amongst options.	SAF; output step	
system stability	Equilibrium stability: a discrete measure that considers a system stable if it returns to its equilibrium after a small perturbation away from the equilibrium. A stable system, therefore, has no variability in the absence of perturbations. General stability: a measure which assumes that stability increases as the lower limit of population density moves further away from zero. Under non-equilibrium dynamics, such limits to population dynamics generally imply a decrease in population variance.		McCann (2000) based on Pimm (1984)
system-based model	A model constructed of various sub-systems to represent the whole system. In the SAF, this includes economic, social and environmental components.		
systems approach	The systems approach devises strategies to extract information on the functioning of complex systems that could not have been garnered from a sequence of subsystem-scale studies. This contrasts to analytical approaches that reduce the considered system to simple constitutive elements for separate study. The systems approach is more global, focusing on interconnections between sub-systems and on system structure.		
systems thinking	A way of understanding the human and natural worlds as systems made up of interacting components.		http://en.wikipedia.org/wiki/Systems_analysis
technological progress	Improved knowledge about methods of production that shifts the production function upwards.		Barro (1993)
time step	Unit interval of time used by discrete model for time series simulations.		
total economic value	The economic value of any environmental asset. It decomposes into use and non-use values, and further sub-classifications can be provided if needed.		Pearce et al. (2006)
trade-off	Situation that involves losing one quality or aspect of something in return for gaining another quality or aspect. It implies a decision to be made with full comprehension of both the upside and downside of a particular choice. In economics, the opportunity costs of selecting one alternative rather than another.		Wikipedia
travel cost method	A revealed preference method of valuing non-market environmental assets. Use values associated with a site (usually recreational in nature) are estimated by collecting information on the costs that have been incurred by users travelling to that site (in terms of time, fuel, etc.).	valuation approach, revealed preference	Pearce et al. (2006)
uncertainty analysis	Quantification of uncertainty in model results due to incomplete knowledge of model parameters, input data, boundary conditions and conceptual model. In an uncertainty analysis the combined effects of these uncertainties are taken into account.		
use value	Value derived from actual use (e.g. a visit to a national park), planned use (a visit planned in the future), or possible use (say in the future) of a good ; further divided into direct use or indirect use.	total economic value, direct use value, indirect use value	Pearce et al. (2006)

utility	Economic jargon for satisfaction, welfare or well-being. An assumption that underlies most conventional economic theory is that people aim to maximise their utility, i.e. they want as much utility as they can get. The hypothesis of utility maximisation is countered by some empirical evidence that the economic decisions made by individuals are partly guided by attitudes, habits and traditions, in addition to being limited by their cognitive capacity, their unconscious reflexes, their values and concepts, making them unable to make optimal decisions in the sense that economic theory posits.	welfare	
valuation approach	Technique to estimate the value of ecosystem goods and services; to determine the importance of environmental consequences of economic activities that are not taken into account in market transactions.		http://glossary.eea.europa.eu
value	Value at the level of a single, homogeneous good or service is equal to the price per unit of quantity multiplied by the number of quantity units of that good or service; in contrast to price, value is independent of the choice of quantity unit.		http://stats.oecd.org/glossary/
value added	The value of a firm's output minus the vale of the intermediate goods the firm purchased.		Mankiw (2000)
virtual system	the system represented by the Simulation Model. It is a simplified version of the real system, with physical boundaries prescribed during the Design Step.		
welfare	Refers to the economic well-being of an individual, group or economy. For individuals, the concept of utility is often used.	utility	
willingness to accept compensation	The amount of money an individual would be willing to accept as compensation for forgoing a benefit or tolerating a cost.	willingness to pay	Pearce et al. (2006)
willingness to pay	The amount of money an individual would be willing to pay to secure a benefit or avoid a cost. Willingness to pay (accept) for ecosystem goods and services can be estimated using various economic valuation techniques such as revealed and stated preference methods or pricing approaches.		Pearce et al. (2006)

Literature Cited

Anderson J. E. 2005. Public Policymaking: an introduction. 2nd Edition., Houghton Mifflin, Boston.

Anon. Guide for the Verification and Validation of Computational Fluid Dynamics Simulations. 1998. Reston, VA, USA, American Institute of Aeronautics and Astronautics.

Anon. ExtendSIM User Guide. 2007. San Jose, CA, Imagine That Inc.

Ballou G. 2005. Handbook of sound engineers (3rd ed), Focal Press, Gulf Professional Publishing, Boston, pp 1499.

Barro R. J. 1993. Macroeconomics, 4th Edition, John Wiley & Sons, 599pp.

Bellinger, G. Systems Thinking : A journey in the realm of systems. http://www.systems-thinking.org/index.htm . 2004.

Bergvall-Kåreborn B., A. Mirijamdotter, and A. Basden. 2004. Basic Principles of SSM Modeling: An Examination of CATWOE from a Soft Perspective. Systemic Practice and Action Research, **17:**55-73.

Berkes F. and C. Folke, editors 1998. Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience, Cambridge University Press, Cambridge, UK.

Bertalanffy L. v. 1968. General System Theory: Foundations, Development, Applications, George Braziller, New York.

Bertalanffy L. v. 1975. Perspectives on General Systems Theory, George Braziller, New York.

Böhringer C. 2004. Sustainability impact assessment: the use of computable general equilibrium models. Economie internationale, **99:**9-26.

Carey J. M. 2000. Parchment, equilibria, and institutions. Comparative Political Studies, **33:**735-761.

Carpenter, S. R., Pingali, P. L., Bennett, E. M, and Zureck, M. B. Ecosystems and Human Well-being: Scenarios: findings of the Scenarios Working Group, Millennium Ecosystem Assessment. v. 2. 2005. Washington, DC., World Resources Institute, Island Press. Millennium Ecosystem Assessment Series.

Checkland P. B. 1981. Systems Thinking, Systems Practice.

Checkland P. B. and J. Scholes 1990. Soft Systems Methodology in Action.

Checkland P. B. and S. Holwell 1997. Information, Systems and Information Systems.

EEA. Environmental indicators: Typology and overview. http://org.eea.eu.int/documents/brochure2002/approach.html Technical report No 25. 1999. Copenhagen, EEA.

Food and Agriculture Organization of the United Nations (FAO) 2005. Commodity Chain Analysis. Constructing the Commodity Chain Functional Analysis and Flow Charts, EASYPol, On-line resource materials for policy marking, Module 043. Available for download : http://www.fao.org/docs/up/easypol/330/cca_043EN.pdf.

Forrester J. W. 1971. Principles of Systems, Pegasus Communications.

Funtowitz S. O.and J. R. Ravetz. 1991. A new scientific methodology for global environmental issues. *in* R Costanza, editor. Ecological Economics: The Science and Management of Sustainability. Columbia University Press, New York.

Gibson.C.C.G., E. Ostrom, and T. K. Ahn. 2000. The concept of scale and the human dimensions of global change: a survey. Ecological Economics, **32:**217-239.

Greene W. 1997. Econometric Analysis, Sixth Edition, Pearson Education, 1178pp.

Habermas, J. (1981). *Theorie des kommunikativen Handelns 1, Handlungsrationalität und gesellschaftliche Rationalisierung,* Frankfurt am Main: Suhrkamp. Published in English in 1984, as *The Theory of Communicative Action. Volume 1: Reason and the Rationalization of Society,* Boston, MA: Beacon Press

Holling C. S. 1973. Resilience and stability of ecological systems. Annual Review of Ecology and Systematics, **4:**1-23.

IPCC-TGICA 2007. General Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment, Prepared by T.R. Carter on behalf of the Intergovernmental Panel on Climate Change, Task Group on Data and Scenario Support for Impact and Climate Assessment.

Jørgensen S. E. 1994. Fundamentals of Ecological Modelling, Elsevier, Amsterdam, 628pp.

Knight J. 1992. Institutions and social conflict, Cambridge University Press, New York.

Luhmann, N. (1989) *Ecological Communication* (translated by Bednarz, John), Chicago: University of Chicago Press.

Luiten H. 1999. A legislative view on science and predictive models. Environmental Pollution, **100:**5-11.

Mangor, K. Shoreline Management Guidelines. 2004. DHI Water and Environment, 294pp.

Mankiw N. G. 2000. Macroeconomics, 4th Edition, Worth Publishers, 553pp.

McCann K. S. 2000. The diversity–stability debate. Nature, **405:**228-233.

Mee L. D. 2005. Assessment and monitoring requirements for the adaptive management of Europe's regional seas. *in* JE Vermaat, L Bouwers, RK Turner, and W Salomons, editors. Managing European coasts: past, present and future. Springer, Berlin, pp 227-238.

Millennium Ecosystem Assessment 2005. Ecosystem and human well-being: synthesis, Island Press, Washington, DC, 137pp.

North D. C. 1990. Institutions, institutional change and economic performance, Cambridge University Press, Cambridge.

Odum E. P. 1959. Foundations of Ecology, Saunders, Philadelphia.

Ortiz-Torres B. 1999. Empowerment as a theoretical alternative for Latin America. Revista Interamericana de Psicologia, **33:**49-65.

Ortiz-Torres B., I. Serrano-Garcia, and N. Torres-Burgos. 2000. Subverting culture: Promoting HIV/AIDS prevention among Puerto Rican and Dominican women. American Journal of Community Psychology, **28:**859-881.

Ostrom E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action, Cambridge University Press, New York.

Pasqual P., N. Stiber, and E. Sunderland 2003. Draft guidance on the development, evaluation and application of regulatory environmental models, The Council for Regulatory Environmental Modelling, US EPA.

Pearce D. W., G. Atkinson, and S. Mourato 2006. Cost-benefit analysis and the environment: recent developments, Organisation for Economic Co-operation and Development, Paris. A browsable edition of this is available on the OECD's website at http://213.253.134.43/oecd/pdfs/browseit/9706011E.PDF.

Pimm S. L. 1984. The complexity and stability of ecosystems. Nature, **307:**321-326.

Pindyck R. S. and D. L. Rubinfeld 2005. Microeconomics, Sixth Edition, Pearson Education, 720pp.

Popper, K. (1978) *Three worlds. The Tanner Lecture on Human Values, delivered at the University of Michigan, April 7, 1978*. Salt Lake City: University of Utah. Obtainable at URL: www.tannerlectures.utah.edu/lectures/documents/popper80.pdf (visited 23 January 2011)

Refsgaard J. C. and H. J. Henriksen. 2004. Modelling guidelines--terminology and guiding principles. Advances in Water Resources, **27:**71-82.

Renn O. 2000. International Conference on Risk Analysis and its Role in the European Union, 18 and 19 July 2000, Brussels.

Rogers S. I. and B. Greenaway. 2005. A UK perspective on the development of marine ecosystem indicators. Marine Pollution Bulletin, **50:**9-19.

Sandberg A. 2007. Property Rights and ecosystem properties. Land Use Policy, **24:**613-623.

Schaller C. 2004. Concepts of Model Verification and Validation, Los Alamos National Laboratory LA-14167-MS, Los Alamos.

Schotter A. 2009. Microeconomics: A modern approach, First Edition, South Western, 742pp.

Sen A. 1998. The Possibility of Social Choice. Nobel Lecture. 178pp.

Smith A. 1795. Astronomy, Essays on Philosophical Subjects, as given in the Introduction by A. Skinner to Smith's 'The Wealth of Nations', Penguin Books, London, 1986 reprint; the word 'maker', here, replaces 'artist' in the original.

Sørensen E. and J. Torfing 2007. Theories of Democratic Network Governance, Palgrave Macmillan, Basingstoke.

Sterman J. D. 1991. A Skeptic's Guide to Computer Models. Pages 209-229 *in* GO Barney, WB Kreutzer, and MJ Garrett, editors. Managing a Nation: The Microcomputer Software Catalog. Boulder. Westview Press, Boulder Co.

Stynes D. J. 1997. Economic impacts of tourism: A handbook for tourism professionals, University of Illinois, Tourism Research Laboratory, Urbana, IL. Available for download https://www.msu.edu/course/prr/840/econimpact/pdf/ecimpvol1.pdf.

Tett P., R. Gowen, D. Mills, T. Fernandes, L. Gilpin, M. Huxham, K. Kennington, P. Read, M. Service, M. Wilkinson, and S. Malcolm. 2007. Defining and detecting Undesirable Disturbance in the context of Eutrophication. Marine Pollution Bulletin, **53:**282-297.

United Nations Development Programme. Governance for sustainable human development: A UNDP policy document. 1997. United Nations Development Programme. 20-5-0010.

Wilson B. 1992. Systems: Concepts, Methodologies and Applications, 2nd edition. Wiley, Chichester, UK.

Wilson B. 2001. Soft Systems Methodology: Conceptual Model Building and its Contribution, Wiley, Chichester, UK.