Environmental Ethics: The Fuzzy Limiting Factors for Sustainable Development

Vides ētika: ilgtspējīgas attīstības ierobežojošie faktori

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It is universally recognized that disharmony of human activities with its environment and the ongoing ecological crisis may lead the Earth to an irreversible chaotic destiny. Politicians and scientists strive for the mitigations of environmental damages but there is no consensus for the causal root and remedy of the problems: global ethical recession. Chasing ephemeral economical progress homo sapiens has gradually evolved from "homo religiosus" to "homo economicus". Family concept has been reduced to its minimal economic unit and social injustices exceed every limit. The gap between the rich and the poor has reached the upper level that human history has never attained. The influences of religions on daily life become marginal and human activities are no longer restricted by ethical consciousness. As a result, the conservation of life support on Earth and the viability of sustainable development become the most alarming challenges for the 21st century.

We proposed methodology for measuring sustainable development called "Sustainability Assessment using Fuzzy logic Evaluation (S.A.F.E.). The results of the SAFE model coupled with the analysis of some case studies on national level reveal that environmental ethics could constitute an important group of "response" indicators which may control overall development sustainability.

The use of fuzzy logic in sustainability assessment appears relevant because environmental ethics indicators are not numerically measurable. As conclusion, decision makers should stop confronting environmental problems with solely technological and political solutions. Religions and environmental ethics revival must be given the highest priority because of their ability to control human activities and, therefore, to secure sustainable behavior. Specifically, Christianity that teaches unconditional love for "neighborhood", human and non-human alike, may actively reinforce the practice of sustainable behavior and avert the unsustainable path of modern society.

Key words: sustainable development, fuzzy logic, environmental ethics, Christianity

1. Introduction

Sustainable development has been the goal of most politicians and decision makers since the publication of the Brundtland report in 1987 [1]. After about 25 years, the list of actions in the Agenda 21 [2] resulting from the Earth Summit held in Rio remains on deliberation.

In 2007, environment ministers met in blistering hot Bali with more journalists than have ever attended a climate conference and the result is a minimal consensus. The progress made in Bali was minimal at best, writes DW's Jens Thurau. But the mandate for a Kyoto successor treaty by 2009 and the isolation of the US delegation were two lights in the dark. Four reports from the Intergovernmental Panel on Climate Change (IPCC), – never before has there been so much talk about reducing greenhouse gases as in 2007, but not a single reduction goal for after 2010 is included in the final text, although such goals have been the topic of discussions for weeks – even months – and warnings from scientists who have been recognized with the very highest prizes can be found in a one-and-a-half-line footnote. It's the same old situation that's to blame: The sacred oath that the wealthy states made at the environment summit in Rio in 1992 (for Rio Declaration *see* Appendix No. 1 at the end of Proceedings) to set a good example in cutting emissions hasn't been kept. The industrialized countries have lost valuable time – or, like the US and Russia, simply approach the climate challenge with demonstrative apathy.

Chasing ephemeral economical progress "***homo sapiens***" has gradually evolved from "***homo religiosus***" to "***homo economicus***". Family concept has been reduced to its minimal economic unit and social injustices exceed every limit. The gap between the rich and the poor has reached the upper level that human history has never attained (*see* Figure 1) [3]. The consequence is the unfair exploitation of the life support on Earth which undermines sustainable development. The disharmony of human society with its environment, which may lead our biosphere to an irreversible chaotic destiny, is universally recognized. Politicians and scientists strive for the mitigations of environmental damages but there is no consensus for the principal cause of the problems which is the global ethical recession.

This paper provides an overview of sustainability assessment by the "SAFE" methodology and an approach to the critical role of environmental ethics in the progress toward sustainable development. The proposed method is applied to a number of selected economies on national level. Results show that any country is following a sustainable path and the stumbling blocks vary from country to country. Critical analysis of the influence of environmental ethics in each sustainability component reveals that ethical recession might be the principal cause of all roadblocks toward sustainable development. Consequently, decision makers should give first priority to ethical reconstitution and then choose different strategies to make efficient sustainable decisions for each country.

The paper is organized as follows. Section 2 introduces the need for sustainability assessment and gives an overview of the SAFE model for purposes of self-containment. Section 3 discusses the proposed approach to sustainable decision-making. Section 4 provides some examples illustrating the application of sensitivity analysis to support sustainable decision-making. Conclusions and perspectives are given in Section 5.

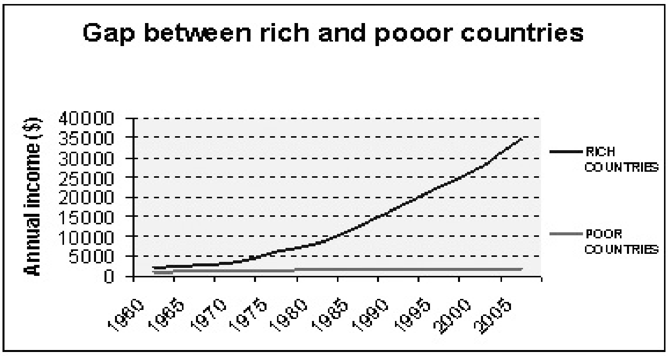

Fig. 1. **"The gap between the rich and the poor has reached the upper level of human history"**

2. Overview of the "S.A.F.E." model

2.1. Need for assessment of sustainable development and the "safe" methodology

The concept of sustainability has gained increasing attention among policy-makers and scientists, which culminated during the world summit in Rio in 1992 (*see* Appendix No. 1). Since then leaders from over 150 states committed themselves to undertaking actions, which will render future development sustainable but without scientific tools to guide policy-making towards a sustainable path [4]. Decisions leading to sustainable development require a pragmatic approach to assess sustainability based on good science and adequate information. The latter is provided in the form of data about environmental, social, and economical factors known as indicators of sustainability. Sustainable projects and optimal strategies for development necessitate answering four fundamental questions: "why unsustainable development occurs", "what is sustainability", "how can it be measured", and "which factors affect it" [5].

There is evidence that development is currently unsustainable. Ozone depletion, global warming, depletion of aquifers, species extinction, collapse of fisheries, soil erosion, and air pollution are among the obvious signs of ecological distress [6]. Human society is also showing similar signs such as poverty, illiteracy, health problems, AIDS, social and political unrest, and violence [7], [8]. ***The latter are principally due to the ethical problems***.

Fuzzy logic has been proposed as a systematic tool for the assessment of sustainability. Fuzzy logic is capable of representing uncertain data, emulating skilled humans, and handling vague situations where traditional mathematics is ineffective. Namely, ethical issues are not numerically quantifiable. Based on this approach, we have developed a model called SAFE (Sustainability Assessment by Fuzzy Evaluation), which uses basic indicators of human characteristics, environmental integrity, economic efficiency, and social welfare as inputs and employs fuzzy logic reasoning to provide sustainability measures on the local, regional, or national levels [9], [10].

2.2. Indicators of sustainable development

Sustainable development, as defined by the Brundtland report, is "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" [1]. Sustainable development is difficult to define but many researchers recognize that it is a function of two major components, ecological and human [11], [12], [13]. Therefore, sustainable decision-making should have two simultaneous goals: (a) Protection and improvement of the environment now and for the generations to come and (b) Achievement of human development to secure high standards of living.

Since the Earth Summit in 1992, an increasing number of researchers and international organizations began to consider "social sustainability", "economic sustainability", "community sustainability" and even "cultural sustainability" as parts of the human dimension of sustainable development [14], [15]. Thus, sustainable development ought to have environmental, economic, political, social, and cultural dimensions simultaneously [16].

The biblical version of the creation of the universe gives an insight of the ecological components of overall sustainability. According to Genesis ***Gen. 1: 1-8***, "WATER SUSTAINABILITY" revealed as the first basic component of overall sustainability and its establishment was finished during the second day of creation. Then, during the third day of creation, according to ***Gen. 1: 9-10*** "LAND SUSTAINABILITY" was completed as the second component of overall sustainability. In the same third day, "PLANTS SUSTAINABILITY" was completed according to ***Gen. 1: 1-13***. Then, according to Gen 1:14-19, "AIR SUSTAINABILITY" was completed during the forth day of creation. In accordance to ***Gen. 1: 20-25***, "ANIMALS SUSTAINABILITY" was the next – fifth component of overall sustainability. Finally, in ***Gen. 1: 26-31***, "HUMAN SUSTAINABILITY' was referred to as the sixth component of the overall sustainability. Figure 2 shows the interdependence between the six components of overall sustainability that was created during the six days of the divine Creation.

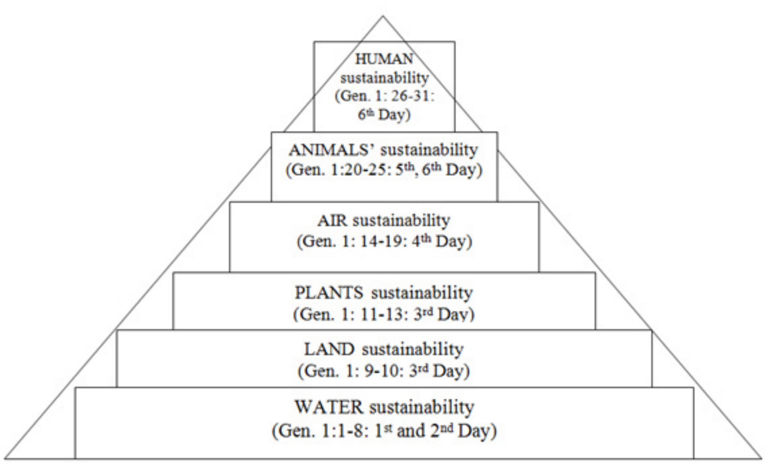

Fig. 2. **"Overall sustainability components** *vs.* **Biblical creation of the Universe (Genesis 1: 1-31)"**

According to the SAFE methodology, the overall sustainability of the system whose development we are asked to appraise has two major dimensions: ecological sustainability (ECOS) and human sustainability (HUMS). These will be referred to as the primary components of the overall sustainability (OSUS). The ecological dimension of sustainability comprises four secondary components: water quality (WATER), land integrity (LAND), air quality (AIR), and biodiversity (BIOD). The variables describing the human dimension of sustainability are political aspects (POLIC), economic welfare (WEALTH), health (HEALTH), and education (KNOW). Thus, sustainable development ought to have environmental, economic, political, social, and cultural dimensions simultaneously (Dunn *et al*., 1995).

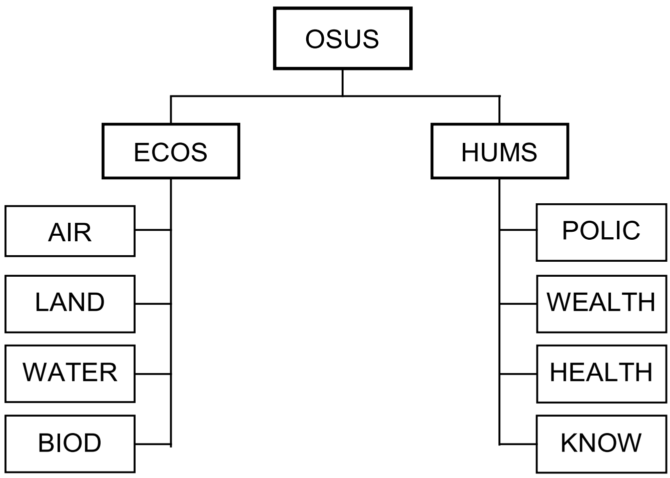

Fig. 3. **Dependencies of sustainability components**

For the explicit dimensions of overall sustainability *see* L. Andriantiatsaholiniaina *et al*. [1].

To evaluate the secondary components we adopt the Pressure-State-Response approach [17], which was originally proposed to assess the environmental component of sustainability (*see* Spangenberg and Bonniot [18] for a review and discussion of variants of this approach). Specifically, the SAFE model uses three quantities to describe each secondary component: PRESSURE, STATUS, and RESPONSE, called *tertiary components*. These tertiary components of sustainability are function of a number of called *basic indicators.* For example, the STATUS of biodiversity is an aggregate measure of the forest area and the numbers of plant, fish, and mammal species per square kilometer. PRESSURE is an aggregate measure of the changing forces human activities exert on the state of the corresponding secondary component. Finally, RESPONSE summarizes the environmental, economic, and social actions taken to bring pressure to a level that might result in a better state.

The indicators used in the SAFE model are given in Table 1. Statistical data for the basic indicators can be obtained from many sources, such as United Nations organizations, World Bank, World Resources Institute, etc. [7], [8], [19].

Table 1

Basic indicators* used in the S.A.F.E. model

Secondary Component	PRESSURE	STATUS	RESPONSE
LAND	(1) Commercial energy use (2) Solid and liquid waste generation (3) Nuclear energy (electricity) production (4) Population density ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	(5) Net energy imports (6) Domesticated land (7) Forest and woodland area	(8) Population growth rate (9) Primary (clean) energy production (10) Nationally protected area (11) Urban households with garbage collection ***(Env. Ethics) Preference for green energy, justice and love for nature***
WATER	(12) Water pollution (13) Urban per capita water use (14) Freshwater withdrawals ***(Spirituality and Ethics) ** Corruption, injustice, immorality, greed***	(15) Annual internal renewable water resources **Quality of water resources: biological oxygen demand, dissolved oxygen, nitrates, phosphorus, pH, etc.	(16) Percent of urban wastewater treated ***(Env. Ethics)** Respect of water sources, justice and wise use of water***
BIOD	(17-19) Threatened plant, fish, mammals species (20) Threatened frontiers forest ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	(21-23) Total number of plant, fish, mammals' species, etc. (24) Current forest	(25) Protected area (26) Annual deforestation – reforestation ***(Env. Ethics)** Respect and love for biodiversity***
AIR	(27) CO_2 emissions (28) Total CH_4 emissions from anthropogenic (29) Total N_2O **Percentage of ozone depletion **Other greenhouse and ozone-depleting gases emissions per capita and per surface land area (ozone, nitrogen oxides, SO_2, CO, etc.) ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	(30-34) Atmospheric concentrations of greenhouse and ozone-depleting gases: – CO_2 (ppm) – N_2O (ppb) – CH_4 (ppb) – SO_2 (mean annual μg/m^3 in urban air) – CFC-12 (chlorofluorocarbons) or CCl_2F_2 (dichlorodifluoro-methane) (ppt), etc.	(35) Fossil fuel use (36) Primary electricity production (37) Public transportation ***(Env. Ethics)** Preference for friendly environmental means of transportation*** ***(Env. Ethics)** Preference for green energy and love for nature***
POLIC	(38) Military spending (39) General government consumption (40) Murders (41) Human rights (42) Environmental laws and enforcement ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	(43) Regime (democratic-nondemocratic) (44) Institutional Investor Credit Rating (45) ICRG (International Country Risk Guide) risk rating (46) Central government finance	(47) Official development assistance (48) Government total expenditure for social services ***(Env. Ethics) ** Righteousness, compassion, sincerity, sympathy and love for nature and humanity***

Table 1 continued

Secondary Component	PRESSURE	STATUS	RESPONSE
WEALTH	(49) GDP implicit deflator (50) Imports (51) Private consumption ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	(52) Total external debt (53) GINI index (54) GNP (55) Resource balance	(56) GDP growth (57) Exports (58) Poor households ***(Env. Ethics)** Soberness, righteousness, sincerity and sympathy for humanity***
HEALTH	(59, 60) Cases of infectious diseases: measles, tuberculosis, AIDS**, etc. (61) Infant mortality rate (62) Maternal mortality rate ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	(63) Life expectancy (64-66) Percent of one-year-old infants immunized against measles, polio, DPT (diphtheria, pertussis and tetanus), etc. (67, 68) Number of people treated per doctor and per nurse	(69) Public health expenditure (70) Daily per capita calorie supply (71) Access to sanitation ***(Env. Ethics)** Soberness, righteousness, sincerity and sympathy for humanity***
KNOW	(72) Number of patent applications filled by non-residents (73) Number of libraries ***(Spirituality and Ethics)** Corruption, injustice, immorality, greed***	74, 75) Expected years of schooling, male, female (76, 77) Gross school enrollment ratio: primary and secondary	(78) Public expenditure on education (79) Number of patent applications filled by residents (80) Personal computer (81) Internet hosts (82) Number of scientists and engineers involved in research and development ***(Env. Ethics)** Sincerity, justice, sympathy and true love for nature and humanity***

* Sources and explanations for indicators in World Bank [20, 21], World Resources Institute [22], and the International Helsinki Federation for Human Rights [23].

** *Not taken into account in the examples because of lack of data for selected economies.*

2.3. Fuzzy assessment of sustainable development

Sustainable decision-making involves complex, often ill-defined parameters with a high degree of uncertainty due to incomplete understanding of the underlying issues. The dynamics of any socio-environmental system cannot be described by traditional mathematics because of its inherent complexity and ambiguity. In addition, the concept of sustainability is polymorphous and fraught with subjectivity. It is therefore more appropriate to use fuzzy logic for its assessment. Fuzzy logic is a scientific tool that permits to model a system without detailed mathematical descriptions, using qualitative as well as quantitative data. Computations are done with words and the knowledge is represented by IF-THEN linguistic rules.

The SAFE model uses a number of relevant knowledge bases to represent the interrelations and principles governing the various indicators and components of sustainability and their contribution to the overall sustainability. The rules and inputs/outputs of each knowledge base are expressed symbolically in the form of words or phrases of a natural language and mathematically as linguistic variables and fuzzy sets. Examples of IF-THEN rules used in the model are:

IF HUMS is *good* ***AND*** ECOS is *bad* ***THEN*** OSUS is *bad*;

IF POLIC is *very low* ***OR*** WEALTH is *very low,* ***OR*** HEALTH is *very bad* ***OR*** KNOW is *very low* ***THEN*** HUMS is *very bad*;

IF PRESSURE(HEALTH) is *weak* ***AND*** STATUS(HEALTH) is *medium* ***AND*** RESPONSE(HEALTH) is *weak* ***THEN*** HEALTH is *intermediate*.

The configuration of the SAFE model is shown in Figure 4. This model may be viewed as a tree-like network of knowledge bases. The inputs of each knowledge base are basic indicators provided by the user or composite indicators collected from other knowledge bases. By using fuzzy logic and IF-THEN rules, these inputs are combined to yield a composite indicator as output, which is then passed on to subsequent knowledge bases. For example, the third order knowledge base that computes the indicator LAND combines PRESSURE, STATUS, and RESPONSE indicators of land integrity, which are outputs of fourth order knowledge bases. Then, LAND is used as input to a second order knowledge base to assess ECOS. The overall sustainability is obtained from the first order knowledge base by combining the composite indicators of the primary components of sustainability, ECOS and HUMS.

The model is flexible in the sense that users can choose the set of indicators and adjust the rules of any knowledge base according to their needs and the characteristics of the socio-environmental system to be assessed (*see* Figure 4).

3. Sustainable decision-making – sensitivity analysis

In this section, we attempt to provide an answer to the question of how to achieve sustainability in a manner that could help decision makers to design a rational path towards it. To be able to design policies for sustainable development, one should have a tool for measuring sustainability and a tool for simulating sustainability scenarios. Without these tools, it is useless to formulate any policy for sustainable development, because not only is there no alternative way to assess the results of the policy, but also it is impossible to tell whether the society is on a sustainable path or not.

The SAFE model provides these prerequisite tools for the formulation of sustainable policies by assessing sustainability for different scenarios of development. A scenario is defined by a suite of sustainability indicators, which largely reflect the results of policies and actions taken in a particular period. When these values are changed and the resulting changes on sustainability observed we could identify the most important indicators promoting or impeding progress toward sustainable development. This procedure is known as sensitivity analysis. The next step is to recommend future policies and actions that would increase or decrease the values of the indicators identified as promoting or impeding, respectively.

In this paper, suggestions regarding the values of indicators are restricted to tendency terms (“increase” or “decrease”). Assigning quantitative values is another bigger issue, not dealt with in this work. This would require the formulation of a constrained optimization problem and is the subject of future research.

Sensitivity analysis plays a fundamental role in decision making because it determines the effects of a change in a decision parameter on system performance. Additionally, since most decisions regarding sustainable development involve groups of experts, politicians and individuals, often with uncertain criteria and conflicting interests, sensitivity analysis could be used to investigate the dependencies of sustainability components on particular policies and decisions [24].

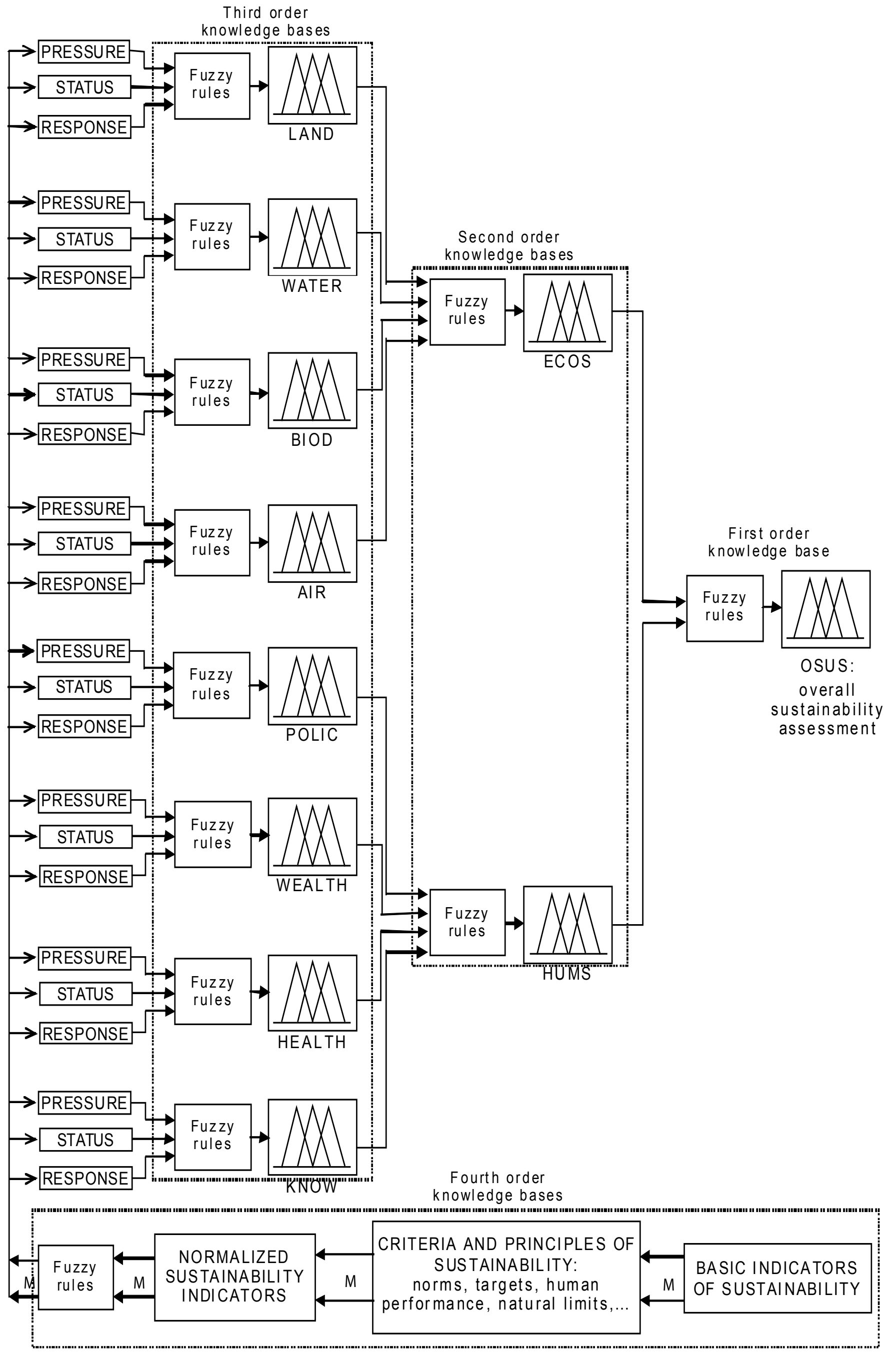

Fig. 4. **Configuration of the *Figure* model**

As discussed in Section 2.3, the SAFE system is a tree-like network of knowledge bases. Mathematically, any primary component of sustainability (ECOS, HUMS) or the overall sustainability can be expressed as a composition of functions each of which is a composition of other functions and so on.

The key variables involved in this representation are the basic indicators used as inputs in the fourth order knowledge bases. Sensitivity analysis entails the computation of the gradients (partial derivatives) of ECOS, HUMS, and OSUS with respect to these basic indicators. Although each knowledge base has its own rule base and uses different inputs, all knowledge bases are equipped with the following components: (a) a normalization module, (b) a fuzzification module (c) an inference engine, and (d) a defuzzification module [10], [25].

4. Application of the safe model to sustainable decision-making

We now provide some examples illustrating the application of sensitivity analysis to support sustainable decision-making. Sensitivity analysis pinpoints those parameters th`at affect sustainability critically. Policy makers then should take proper corrective actions in these critical directions. We examine two countries: Greece and USA. We compute the primary components of sustainability and their sensitivities to various input indicators. We make the following remarks:

1. If the derivative with respect to a basic indicator is negative, then we classify this indicator as *impeding* because an increase of its value will reduce the degree of sustainability.
2. If the derivative is positive, then the indicator is classified as *promoting* because an increase in its value will lead to higher sustainability. Impeding and promoting indicators are crucial in establishing the best practices towards sustainability.
3. When the derivative is zero, the indicator is classified as *neutral* and policy makers could ignore it when recommending short-term policies.

According to the results of sensitivity analysis and the target for each indicator, we may design policies to advance ecological, human, and overall sustainability by

1. proposing mechanisms and projects to improve promoting indicators,
2. taking precautionary measures to correct impeding indicators, and
3. adopting conservative actions for neutral indicators.

In a previous paper [10], we used 57 basic indicators to assess the sustainability of 15 selected countries. The results showed that all economies were unsustainable. As the flexibility of the model permits the use of more indicators, in our following paper [9] we use 82 indicators and perform sensitivity analysis in order to evaluate strategies for sustainable development. We restricted our attention to just two economies, Greece and USA, because of the availability of data and authors' personal knowledge of the prevailing political and social conditions in these two countries. The latter is very important because the SAFE model takes into account subjective evaluations concerning human rights, democracy, law enforcement, etc. Data concerning basic indicators were taken from World Bank [20], [21], World Resources Institute [22], and International Helsinki Federation for Human Rights [23]. Due to correlations and availability of data, we use up to five indicators to evaluate Pressure, Status, or Response (see Table 1). Details about correlation method and selection of indicators used in the model can be found in Phillis and Andriantiatsaholiniaina [10].

To achieve sustainable development, a balanced and continuing improvement of the four components of ECOS (LAND, WATER, BIOD, AIR) and the four components of HUMS (POLIC, WEALTH, HEALTH, KNOW) is needed. Thus, a prerequisite for promoting overall sustainability is the detection of critical indicators that affect the value of ECOS, HUMS, and OSUS, or influence the value of LAND, WATER, BIOD, AIR POLIC, WEALTH, HEALTH and KNOW.

In general, policy makers should be able to identify the factors that promote or impede progress towards sustainability and obtain quantitative information about them. Each sustainability variable is a function of a number of basic indicators. Thus, for a given country or ecosystem, sustainable decisions should be based on assessments concerning the contribution of each indicator to the final value of ECOS, HUMS, and OSUS. Using these assessments policy makers could set priorities for critical (promoting or impeding) indicators on which future policies should focus.

According to the SAFE sensitivity results, sustainable policies in Greece should depend on enhancing the following thirteen ***promoting factors*** and decreasing the following six ***impeding factors*** ranked in order of importance (*see* Table 2):

Table 2

Critical indicators of sustainability for Greece

Promoting factors	*Impeding factors*
1. (46) Central government finance,	1. (51) Private consumption,
2. (42) Environmental laws,	2. (1) Commercial energy use,
3. (74-75) Expected years of schooling (male/female),	3. (13) Urban water use per capita,
4. (37) Public transportation,	4. (14) Freshwater withdrawals,
5. (16) Urban wastewater treated,	5. (79) Number of patent applications filled by non-residents,
6. (77) Secondary ratio schooling,	6. (27) CO_2 emissions.
7. (45) International Country Risk Guide (ICRG) risk rating,	
8. (69) Public health expenditure,	
9. (55) Resource balance,	
10. (26) Protected area,	
11. (15) Internal renewable water resource,	
12. (22) Total number of fish species.	

5. Environmental ethics and Sustainable policies

Broadly speaking, sustainable policies should focus on the ecological and human system. Moreover, there is no unique path towards sustainability and policy makers should choose different strategies in different countries. We notice that overall sustainability for many countries depends essentially on ecological factors. This is in accordance with the common belief that says that environmental damages undermine development sustainability [5], [10] but the crucial target is to determine the principal blockades or limiting factors that hamper sustainable policies to be effective. Only if there is a clear indication of the limiting factors for the viability of sustainable development, we may tackle environmental and human problems.

Returning to our case studies, the critical sustainability factors for Greece are principally environmental, namely land system improvement (LAND), water system sustainability (WATER), biodiversity conservation (BIOD) and air quality improvement (AIR). However, socio-political (POLIC), economic (WEALTH), and educational factors (KNOW) also play an important role in improving sustainability in Greece.

For LAND sustainability in Greece, we notice that the high amount of Commercial energy use which is dependent on the use of imported fossil fuels is one of the most crucial factors. The use of green energy or renewable fuels as a response to the problem of LAND sustainability encounters ***practical ethical problems***. Despite of the "apparent" sensitization of the people, the consumption of fossils fuels is increasing continuously. Following the example of the northern American societies, Greek families tend to have in average 2 to 3 cars and the use of more polluting "SUV" or "4X4" cars is considered as a sign of prosperity. On the global scale, we notice the same phenomenon. From 2004, the world consumption of fossil fuel for transportations is continuously increasing from ~ 2 milliard tons (corresponding to ~5,2 milliard tons of CO^2 emissions) to ~ 2,8 milliard tons in 2030 (forecast of the World energy Outlook, 2006). Moreover car accidents kill around 3 000 persons per day (Health World Organization, 2004). Why couldn't we reduce the world consumption of fossil fuel? The answer, which seems to be a difficult dilemma, is simple but disturbing: ***the global ethical recession*** or the global decline of love for others and for nature. Generally, people don't believe in environmental risks and there is an obvious sign of lack of respect for the nature in the contemporary way of life. Car builders continue to produce higher consumption cars and give the least concern about the promotion of less polluting vehicles. Knowing that airplanes are the most polluting means of transportation, the number of air travelers is increasing six times from 1970 to 2004 (from ~300 million passengers in 1 970 to ~ 1 900 million passengers). The phenomenon is boosted by the so called low-cost e-tickets companies (World Development Indicator, 2007). Why couldn't we reverse this trend toward a cleaner means of transportation? The limiting factor is the ethical blockage resulting from economical greed.

Without knowing it, practically, people may become spiritually blind worshipping "Mammon" instead of God (*see* Luke 6:13). And when people stop worshipping God, they are doomed to destruction and the entire Earth is cursed because of them (Rom. 8:23). The influences of religions on daily life become marginal and human activities are no longer restricted by ethical consciousness. As a result, the conservation of life support on Earth and the viability of sustainable development become the most complicated and alarming challenges for the generations to come.

6. Conclusions and perspectives

Policy makers need a scientific tool to forecast the effects of future actions on sustainability and establish policies for sustainable development. In this paper, we use a previously developed model, called SAFE, in an attempt to provide an explicit and comprehensive description of the concept of sustainability. Using linguistic variables and linguistic rules, the model gives quantitative measures of human and ecological sustainability, which are then combined into overall sustainability. A sensitivity analysis of the SAFE model permits to determine the evolution of sustainability variables subject to perturbations in the values of basic indicators. Then, the problem of sustainable decision-making becomes one of specifying priorities among basic indicators and designing appropriate policies that will guarantee sustainable progress.

Successful policies differ from country to country. More developed countries need to focus mostly on the degradation of their environment whereas less developed countries should strive to improve both the environment and the human system.

Decision makers should stop confronting environmental problems with solely technological and political solutions. Religions and environmental ethics revival must be given the highest priority because of their unique ability to control overall human activities and, therefore, to secure sustainable behavior.

The SAFE approach provides new insights of sustainable development and it may serve as a practical tool for decision-making and policy design at the local or regional levels. Assessment of ethical values and, specifically, environmental ethics is the next necessary step to improve the SAFE model. Conceptual environmental ethics inputs and daily facts from case studies affirm the limiting role of environmental ethics in the progress toward sustainable development. Such approaches are urgently needed nowadays if we want to attack the problem of sustainable development systematically.

7. Acknowledgements

I would like to thank the Foundation for Research and Technology, Hellas (FORTH – IMBB) and the Orthodox Academy of Crete (Institute of Theology and Ecology) for their trust and financial support. Also credits are due to the State Scholarship Foundation of Greece (I.KY.) and the Technical University of Crete for their initial funding of this research.

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Vides ētika: ilgtspējīgas attīstības ierobežojošie faktori

Kopsavilkums

Ir vispāratzīts, ka cilvēka rīcības ietekme uz apkārtējo vidi, kā arī ieilgusī ekoloģiskā krīze var novest planētu līdz neatgriezeniskam haotiskam liktenim. Politiķi un zinātnieki cenšas rast risinājumus, kā novērst videi radītos zaudējumus, taču nepastāv vienprātības par problēmu cēloņsakni un iespējamo dziedniecisko līdzekli: globālo ētisko pagrimumu. Dzenoties pēc ātri gaistoša ekonomiskā progresa *homo sapiens* pakāpeniski ir pārveidojies no *homo religiosus* par *homo economicus*. Ģimenes koncepts ir reducēts līdz tās minimālajam ekonomiskajam kontekstam un sociālais netaisnīgums ir pārsniedzis jebkuru robežu. Plaisa starp bagātajiem un nabagajiem ir sasniegusi augstāko līmeni visā cilvēces vēsturē. Reliģiju ietekme uz ikdienas dzīvi ir kļuvusi margināla un cilvēka rīcību vairs neierobežo ētiskā apziņa. Tā rezultātā dzīvības atbalsta sistēmu konservācija uz zemeslodes un ilgtspējīgas attīstības dzīvotspēja kļūst par vissatraucošākajiem izaicinājumiem 21. gadsimtam.

Rakstā piedāvāts ilgtspējīgas attīstības izvērtēšanas modelis ar nosaukumu "Ilgtspējības novērtējums, lietojot faziloģisko izvērtējumu" (S.A.F.E.). Aplūkotā S.A.F.E. modeļa rezultāti kopā ar atsevišķu piemēru analīzi nacionālā līmenī atklāj, ka vides ētika satur nozīmīgu "atbildes" indikatoru grupu, kas var kontrolēt vispārējo ilgtspējības attīstību.

Faziloģikas lietojums ilgtspējības novērtēšanā ir būtisks, jo vides ētikas indikatori nav mērāmi skaitliskā veidā. Secinot jāsaka, ka lēmumu pieņēmējiem ir jāpārtrauc konfrontēt vides problēmas tikai ar tehnoloģiskiem un politiskiem risinājumiem. Reliģiju un vides ētikas atdzimšanai jāpiešķir augstāko prioritāti, jo tā spēj kontrolēt cilvēka rīcību un tāpēc nodrošināt ilgtspējīgu uzvedību. Konkrēti runājot, kristietība, kura māca beznosacījumu mīlestību pret "tuvāko", kas var būt cilvēks un arī ne cilvēks, var aktīvā veidā stiprināt ilgtspējīgas uzvedības praksi un novērst neilgtspējīgo modernās sabiedrības iestaigāto ceļu.

Atslēgas vārdi: ilgtspējīga attīstība, faziloģika, vides ētika, kristietība

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