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Fear for Sustainability? A Simulation Study

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ABSTRACT

The question addressed in this contribution is whether fear / anxiety is an emotion that inhibits or fosters the sustainability of our planet. To be meaningful, this question has to be modified straightaway: Can fear be a factor for the enhancement of sustainability? If so, how? Fear, if it is pathological, can paralyze. But in its healthy forms it can stimulate coping behavior. The threats to the sustainability of our planet are manifest in the crisis of the last years. This is a systemic crisis, and that is what makes it intractable. The system that is now in crisis is constituted in a way that crises must occur, again and again. A closer look shows that the economic, social and ecological spheres are not at all distinct, but intertwined, which makes most policies obsolete, and even worse, leads to ever increasing damage to the natural environment. Fear / anxiety per se is not the best advisor, but the adaptive function of fear can trigger new collective behaviours toward sustainability, as will be demonstrated with the help of a System Dynamics model.

Keywords: Sustainability, Natural Environment, Fear, Anxiety, Adaptiveness

1. INTRODUCTION

The title of this contribution is ambiguous. On the one hand it expresses an anxious concern, a fear that the natural environment is endangered. The other meaning imputes that fear can be a force for sustainability. Can fear / anxiety be a driver towards a sustainable world? The purpose of this paper is to try to answer this question so that light can be shed on the role of fear or anxiety in the quest of humanity for ecological sustainability.

In the first place, a definition is necessary. The terms "fear" and "anxiety" will be used interchangeably, even though subtle semantic differences exist. For example, fear refers to a specific threat, while the sources of anxiety are indefinite (Russell Davis 1985; May 1977) and relate to a longer-term problem. While fear refers to the experience of apprehension (Rachman 1985) - an unpleasant and often strong emotion stemming from an expectation or awareness of danger - anxiety

has the connotation of inquietude, a painful or fearful uneasiness of mind (Webster 44, 366). For the purpose of this presentation, one can by and large abstract from these differences. We will use both terms, suggesting that threats to sustainability can evoke both - fear in the short term and anxiety in the long term.

The unit of analysis is a collective, not an individual. Fear / anxiety, then, will be referred to a society as a whole. In other words, the context considered is the social domain.

This is a theoretical paper. Empirical work is drawn only from secondary sources. Following the tradition of critical rationalism, the propositions are formulated in a way that permits their falsification (Popper 2002). A simulation model which embodies the proposed theory will be used as an approach to "modeling as theory-building" (Schwaninger and Groesser 2008): ensuing challenges of the model and improvement of its functions can potentially improve the theory.

After these preliminaries, the chapter will proceed with a perspective on the dynamics of fear. Thereupon, a dynamic simulation model will be constructed and validated. The results of ensuing simulations will then be discussed. Finally, implications and conclusions will be derived.

2. THE DYNAMICS OF FEAR - EXAMPLES

The concept of fear tends to be used in a static manner. However, in the real world fear has eminently dynamic features: it can grow and decrease, the process of increase being self-reinforcing in nature. Two examples will be given, the first of which shows the impact of media activity on the fear in a population (Figure 1).

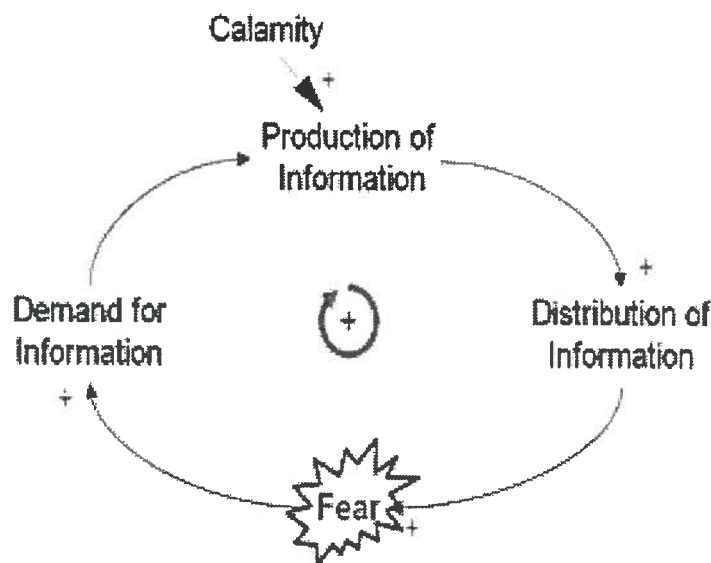


Figure 1. Dynamics of fear and the media

A fatality, such as a crime or accident, happens. Serious incidents are reported because they are dramatic, tragic and frightening (Gardner 2009). Immediately, the media produce information, distributing it to the public. If the information thrives on the fatalities and dangers of the case in point, fear is produced. The more people fear, the more information they want. The response of the media is to deliver more information, in more detailed and more fear-inspiring ways. As this circular process continues, a process of proliferation is put in operation: here, of course, we have a mammoth feedback loop.

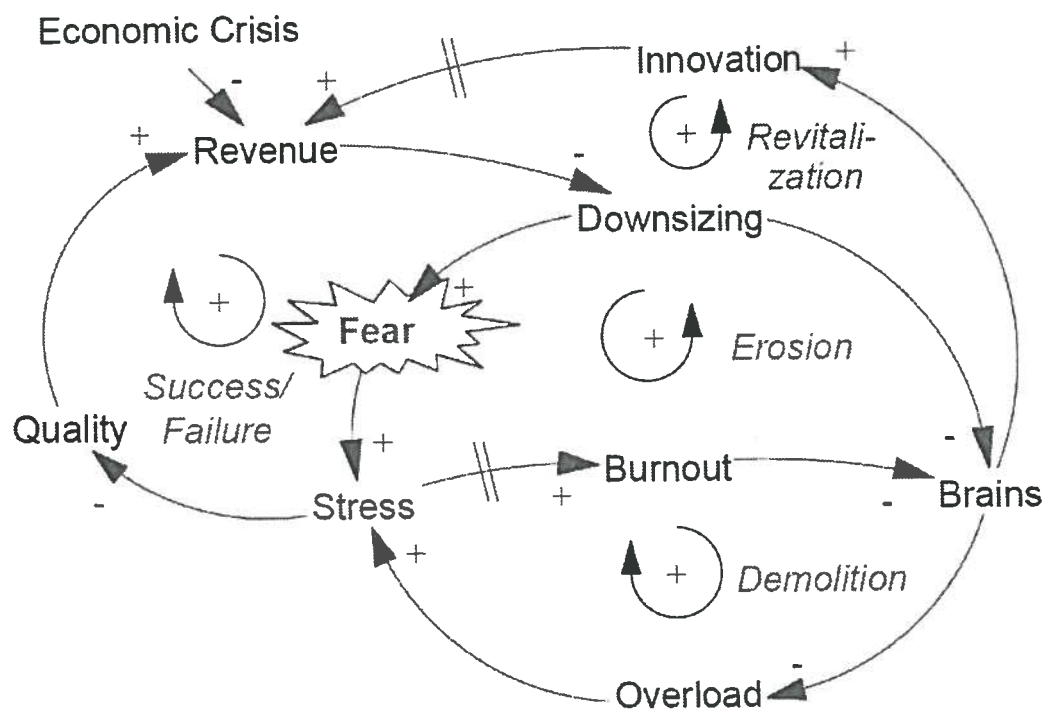


Figure 2. Dynamics of a culture of fear

The second example is typical for organizations in our day (Figure 2). A crisis hits the economy, leading to a dip in the revenue of a company. The company reacts with a layoff, "downsizing" the workforce. People leave, and with them go their brains. Those remaining get overloaded. Stress is the consequence. With some delay (denoted by the cross beam [//] on the arrow), burnouts will happen, and more brains will leave the company. We call this circle the *demolition* loop: sooner or later the company is demolished (always with the footnote *ceteris paribus*, - all other things being equal). The second loop, which is linked to the first one, starts with the fear evoked by downsizing, which again produces stress. Workers under stress tend to impair the quality of their products. Less quality entails less revenue. This is the *success/failure* loop. Like the demolition loop, it is self-reinforcing (in both cases, the product of the signs on the arrows that make up the loop is "+"). The third loop is the combination of the first two. We call it the *erosion* cycle. The last

cycle is the *fatality* cycle: fewer brains lead to less innovation, and less innovation, after some time, implies less revenue. The whole network expresses the calamitous interrelationships in a culture of fear which can lead to the demise of a firm. But the diagram also puts into evidence the fact that there are ways of counteracting this pathological trajectory. One could not downsize at all. Or one could foster innovation in new ways, eliminating the fatal link between the number of brains and the intensity of innovation.

Up to this point, we have studied two examples of the dynamics of fear in a qualitative manner. The method used was the causal loop diagram, which is part of the system dynamics methodology.¹ In the following, a more encompassing model will be developed. It will first be conceptualized in qualitative terms and then implemented quantitatively.

3. SYSTEM DYNAMICS MODEL

The purpose of the system dynamics model is to examine the interrelationships between fear / anxiety and the state of the environment. It should enable one to explore the interaction of fear and sustainability. Any model should be designed with a view toward its potential users. In the case of the model to be presented here, the perspective is a holistic one - that of a politician or researcher looking at the connections among the big aggregates which characterize the system under study, and the synergetic dynamics which they generate. The model is theory-driven, and the modelling approach primarily a deductive one.

3.1. Qualitative Model

First, we draw the qualitative model. The diagram shown in Figure 3 shows the model's basic logic.

¹ System Dynamics (SD) is a methodology for the modelling and simulation of complex systems, developed by Prof. Jay Forrester at MIT (Massachusetts Institute of Technology), and grounded in Control Theory as well as in the modern Theory of Nonlinear Dynamics (see: Forrester 1961; Sterman 2000). The focus of SD is on issues which are modelled as systems made up essentially of stock and flow variables forming closed feedback loops and simulated as continuous processes. The mathematics of the models is based on differential equations.

It is of the causal-loop-diagram type, used in System Dynamics (Lane 2008).²

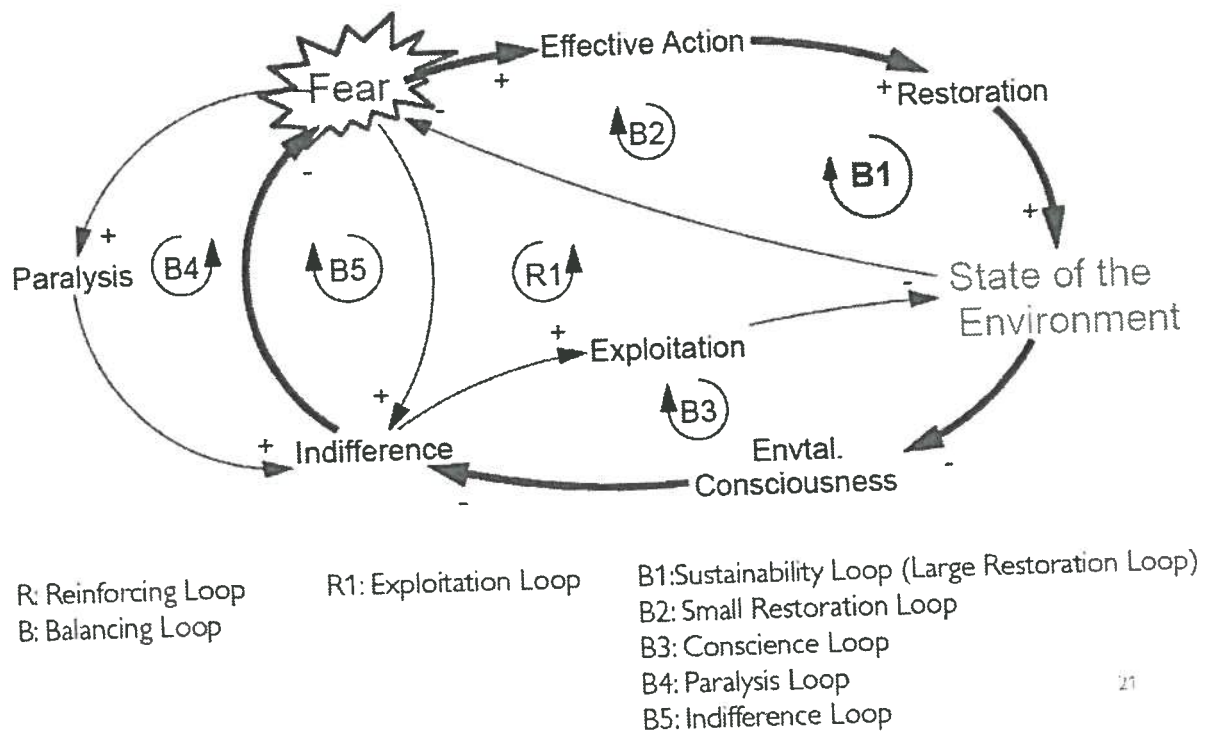


Figure 3. Fear and sustainability - qualitative feedback system

Fear can trigger either the liberation of energies for overcoming the causes of the fear, or it can lead to indifference if not paralysis. In the first case, it is a constructive force by which the source of concern can be neutralized. The countervailing tendency - in the latter two cases - are those of neglect and ultimately of obstruction.

The adaptive value of fear, as emphasized by Richard Lazarus and others, is that an arousal of fear stimulates the search for a means of coping with difficulties or dangers (Bachmann 1978). We know that existential fear has been a major factor in the generation of human culture (Hankiss 2001). On the other hand, it is also known that excessive fear can jeopardize psychological functioning, leading to depression, errors of perception, paralysis and destruction (Bachmann 1978, Krohne 2010). The only way to learning, development and maturity is in confronting anxieties, while trying to evade them leads to obstruction, stagnation and immaturity (Tillich 1952; May 1977).

The main loop in the diagram is what we call a *Sustainability Loop* - a balancing loop³ denoted as B1. It shows the adaptive function of fear, which triggers effective

² In the modelling process, more detailed causal-loop diagrams were elaborated, from which the essential variables were extracted successively. We refrain from printing all of these diagrams, limiting ourselves to the one which is the most insightful from a didactic point of view.

action, in turn entailing the restoration of the natural environment. The state of the environment impinges on environmental consciousness in a dampening way: the better the state of the environment, the lower the environmental consciousness, and vice versa. Environmental consciousness dampens indifference vis à vis the environment. Indifference then dampens fear (Indifference Loop B5), while high fear can also increase indifference, directly or via paralysis (Paralysis Loop B4). The higher the indifference, the higher is the exploitation of the environment, because an indifferent population cares next to nothing about protecting or restoring the environment. Exploitation deteriorates the state of the environment. Via environmental consciousness, the loop is closed (Conscience Loop B3). Assuming that, besides the indirect influence of the state of the environment on fear via environmental consciousness (B1), there is also a direct influence in the same direction, we get a Small Restoration Loop (B2). There is one self-reinforcing loop, connecting indifference, exploitation, state of the environment and fear (R1). In this case, fear leads to more fear, and the state of the environment develops in one and the same direction - either it increases or decreases exponentially (*ceteris paribus*, i.e., all other aspects being equal). We have drawn more detailed qualitative diagrams, which we shall not present here so as to avoid unnecessary detail. The additional aspects that were included will be captured in the quantitative model.

In sum, we have five balancing loops and one self-reinforcing loop. It is difficult, however, to say what the compound dynamic behavior of the system under study is. We can certainly assume that it will be non-linear. But to gain additional insights about the system under study, we need to revert to a quantitative model.

3.2. Dynamic Hypothesis and Reference Mode

We started off with some deliberations about the likely behavior of the system under study. The dynamic hypothesis is embodied in the closed-loop diagram just explained. We assume a reference mode, i.e., a system behavior that is likely to occur if nothing is changed actively in the system (Figure 4).

³ A balancing loop is the case in which the product of the signs of all the arrows which constitute it is negative. In the case of the Sustainability Loop, we have three "+" and three "-", their product being "-". Therefore it is a balancing loop (labeled with B). In the case of the Exploitation Loop, we have two "+" and two "-", the product being a "+". Therefore it is a self-reinforcing loop (labeled with R). Rule: Loops with an uneven number of negative signs are balancing loops, while all other loops are of the self-reinforcing type. The methodology of System Dynamics is available in Forrester (1961) and Sterman (2000), among others.

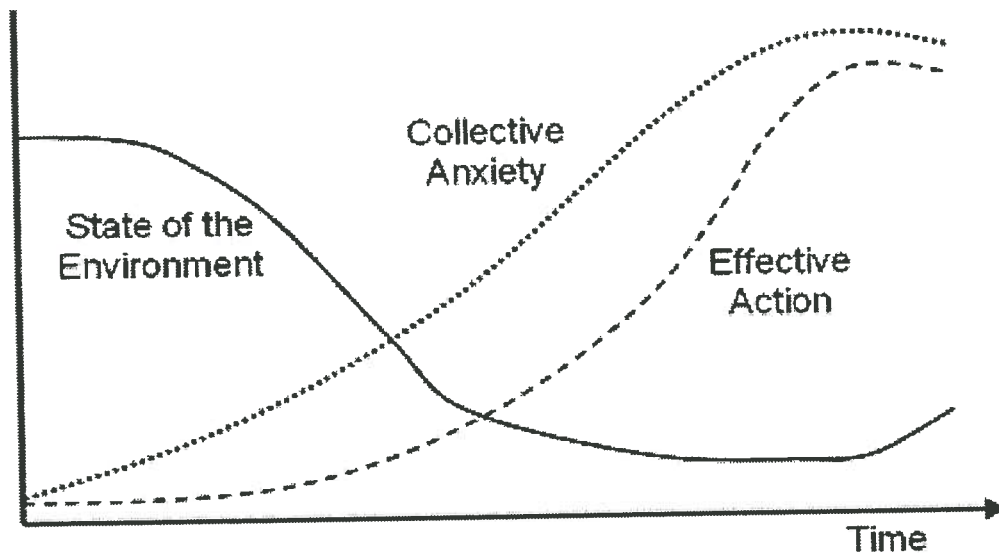


Figure 4. Reference mode - system behavior assumed ex ante

The basic pattern assumed is an oscillation of all three variables, *state of the environment*, *collective anxiety*, and *effective action*. The oscillations of the latter two have the inverse shape of the oscillation of the former. One can also discern time lags between the three variables, given that the reaction of *anxiety* to both changes in *state of the environment* and the triggering of *effective action* is being delayed.

3.3. Quantitative Model

In the following, the quantitative system dynamics model will be described, which is construed on the basis of the qualitative structure presented in the last section. The stock-and-flow-diagram of the model is shown in the Appendix.⁴

The model is formulated in the form of differential equations underlying the variables and connections represented in this stock-and-flow diagram. The time horizon chosen is 100 years (400 quarters).

It is evident that the quantitative model exhibits additional details in comparison with the qualitative model shown in Figure 3. The main additional features are:

- Differentiation between stocks and flows: The model has five stocks, (1) *anxious people*, (2) *indifferent people*, (3) *education level*, (4) *knowledge*, and (5) *state of the environment*.
- The constructs *fear* and *indifference* from the CLD are now operationalized in stocks (1) and (2). The aspect of paralysis is implemented in the link

⁴ The model is made up of stocks (symbolized by the boxes), flows (valves), auxiliary variables (endogenous variables) and parameters (exogenous constants or variables triggering scenarios). The links represented by arrows denote causal connections. See also Lane (2008).

between *intensity of fear* and *commitment*, where high levels of fear lead to a collapse of the influence on *commitment*.

- New are stocks (3) and (4); the levels of *education* and *knowledge* impinge on both *ecological consciousness* and the effectiveness of action for environmental restoration.
- The *state of the environment* is on the one hand improved by restorative action, and on the other hand undermined by deteriorating impacts stemming from *indifference* which triggers detrimental behavior, such as patterns of reckless consumption.
- The *state of the environment* is considered in two ways, the actual state (stock (5)) and the desired state of the environment. The difference between the two, measured as a *discrepancy*, triggers flows between stocks (1) and (2), in conjunction with the state of *environmental consciousness*. In addition, the *discrepancy* between actual and desired states of the environment causes changes in the *intensity of fear*; with an S-shaped relationship of the impact of *discrepancy* on *fear*.
- Fear impinges on the *commitment* of people to improve the environment, with an S-curve until a maximum, and then - as briefly mentioned above - a collapse in the region of paralysis (due to high fear).

For the purpose of testing, policy and scenario levers have been included: currently, the model contains a number of policy levers, which can be set at different values, to test policies, e.g., for *investment in restoration*, *investment in education*, *incentives for environment-friendly behavior*, and *money for defensive measures* to mitigate environmental deterioration. An example for a scenario input is the parameter *commitment scenario*, by which different levels of commitment can be tested for their impact. More of these levers can be inserted, if needed.

At this point we will proceed with an analysis of the system behavior shown in the simulations, and try to derive insights from them.

4. SIMULATIONS

First we will give an overview of the behavior of the simulation results (Figures 5 to 7).

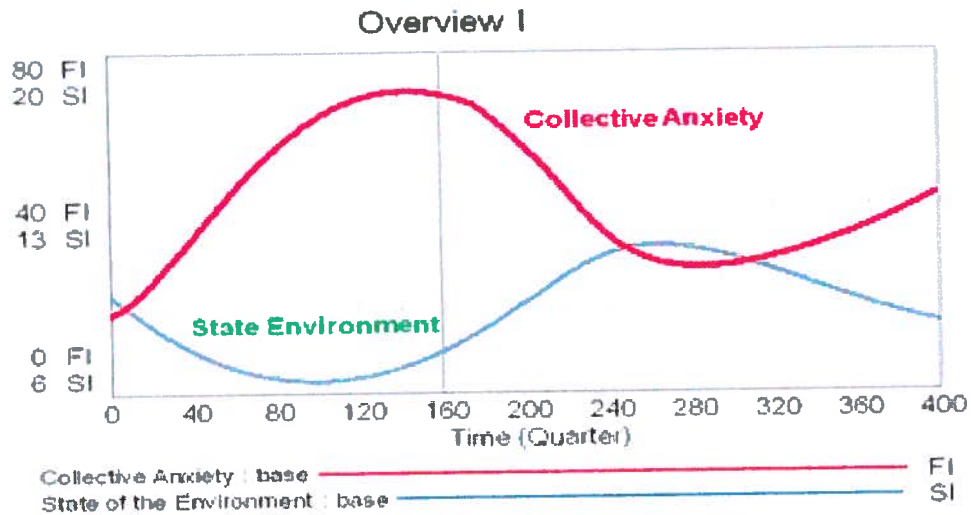


Figure 5. State of the environment and collective anxiety

As the state of the environment deteriorates, *collective anxiety* grows with some delay, and it only cools down once a substantial improvement of the *state of the environment* has been achieved (Figure 5). Between the minimal value of state of the environment and the maximum of collective anxiety, there is a delay of roughly 40 years, a magnitude that exceeds our estimate in the reference mode by far.

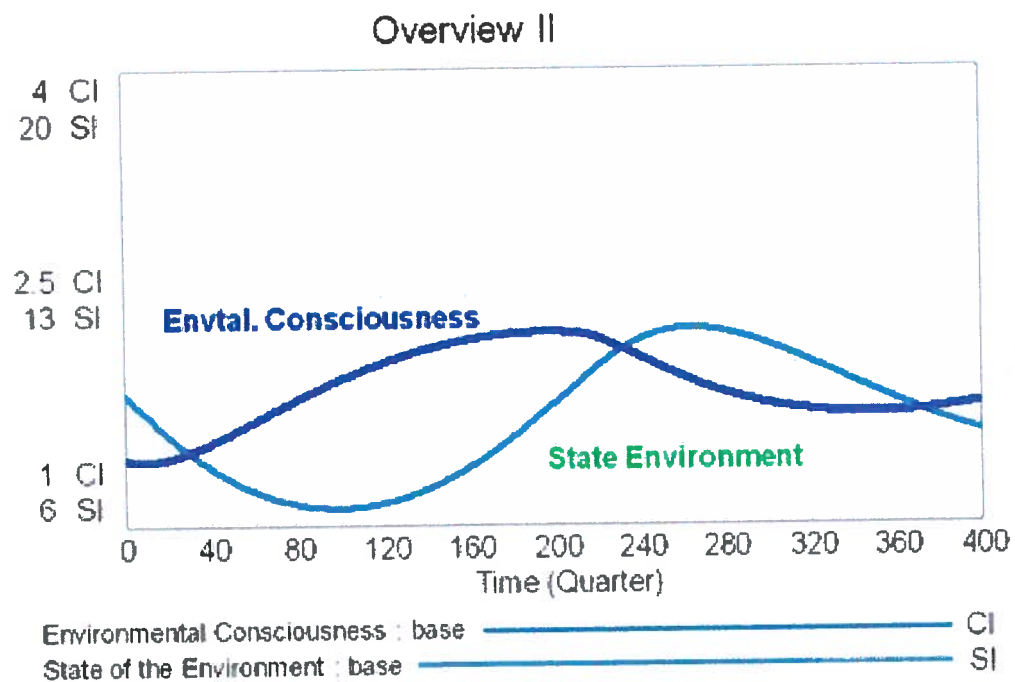


Figure 6. Ecological consciousness and state of the Environment

The interplay of environmental consciousness and the state of the environment is visible in Figure 6. Environmental consciousness awakens only as the environment deteriorates. It keeps growing during further degradation and beyond, until the state of the environment is back at a high level. The fact that it falls into decay about 12 years before state of the environment has reached its maximum, can be explained by the effect of complacency among the affluent.

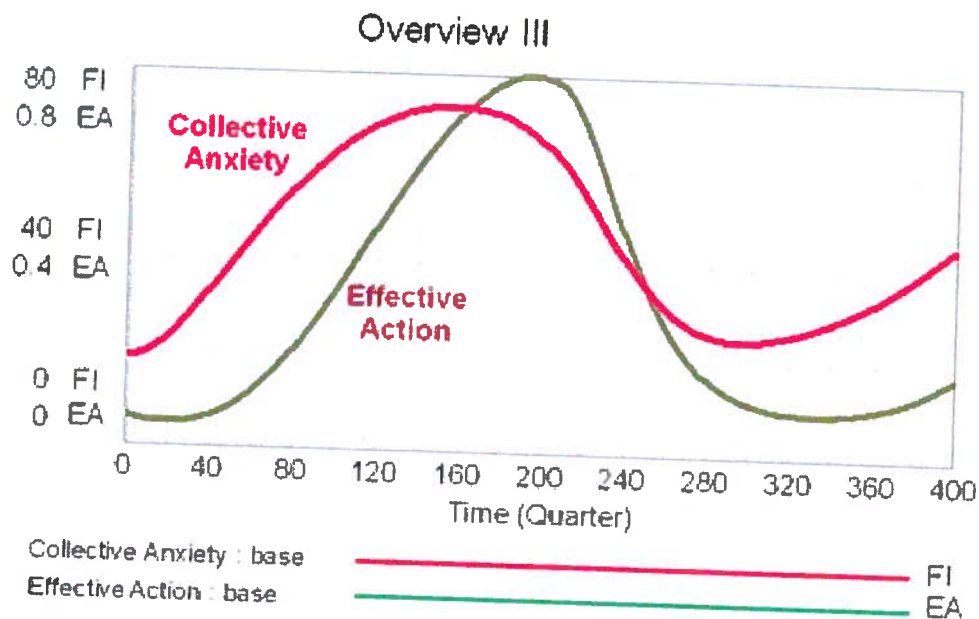


Figure 7. Collective anxiety and effective action

Collective anxiety, which is influenced by the *state of the environment*, is a trigger for *effective action*, which again is facilitated by knowledge. The time lag between the anxiety and the action amounts to 10 years (Figure 7).

Altogether, the patterns produced by these simulations show some similarity with those estimated as reference modes (Section 3.2). We will refrain from comparing the two sets of time series - those in the reference mode and those in the simulation outputs - to avoid pseudo-exactitude and even spurious precision. The next Figures - 8 to 10 - show the evolution of the state of the environment as a function of different levels of fear. For these simulations, *intensity of fear* was exogenized, i.e., set as a parameter. In the case of Figure 8, simulation runs for three levels of *intensity of fear* were compared - low, high, and intermediate.

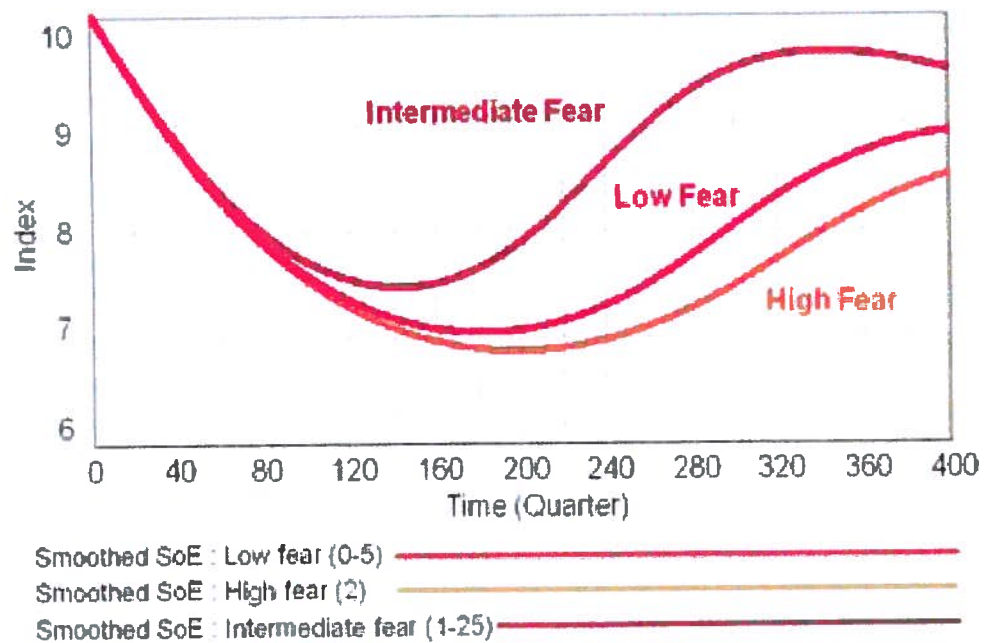


Figure 8. State of the environment (SoE) as a function of fear I^5

The lowest "performance", in terms of environmental state, results from high fear, while intermediate fear breeds the best results. Apparently, that represents a "healthy" level of fear, which mobilizes more energy for restoring the environment. These results are not totally unexpected, but the size of the gain is surprising.

Figures 9 and 10 show additional scenarios; these are run across a time frame of forty years (160 quarters), so that a concentration on the first development cycle can be maintained. Figure 9 compares the high and intermediate ("healthy") fear scenarios with an additional one - the scenario that applies to societies in which fear is a taboo. In other words, fear is forbidden, and confidence is the obligation. The great psychiatrist Horst-Eberhard Richter calls this state the "okay morale", and diagnoses a collective neurosis (Richter 2005:44) which suppresses alarm signals that call for protection or restoration of the environment. This is reflected in the behavior shown in the *okay society* scenario: if *fear* is set at zero or even negative values, the state of the environment continues deteriorating, because the commitment to change anything, while not quite at zero, stays at a very low level.

⁵ The vertical axis shows the value of State of the Environment, smoothed over the duration of the simulation. The fear parameter (exogenized intensity of fear) is set at three different levels.

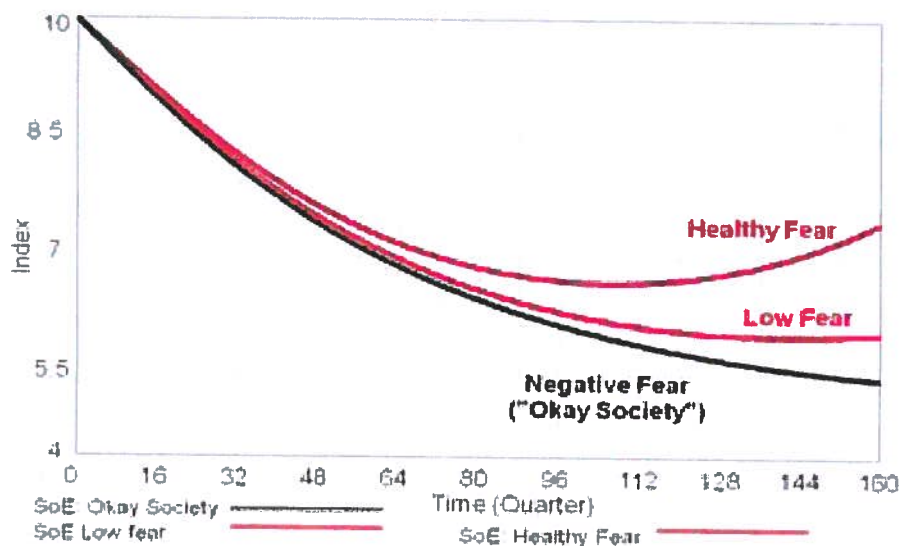


Figure 9. State of the environment (SoE) as a function of fear II

Figure 10 is a resumé of the scenarios just analysed, with an important addendum: The reframing parameter is activated. This is a lever by which the effectiveness of actions can be increased due to a new, mostly unorthodox approach. Such an approach needs creativity (implemented in the reframing lever) but also new knowledge (coming from the stock variable *knowledge*, which is in a multiplicative relation with *reframing*).

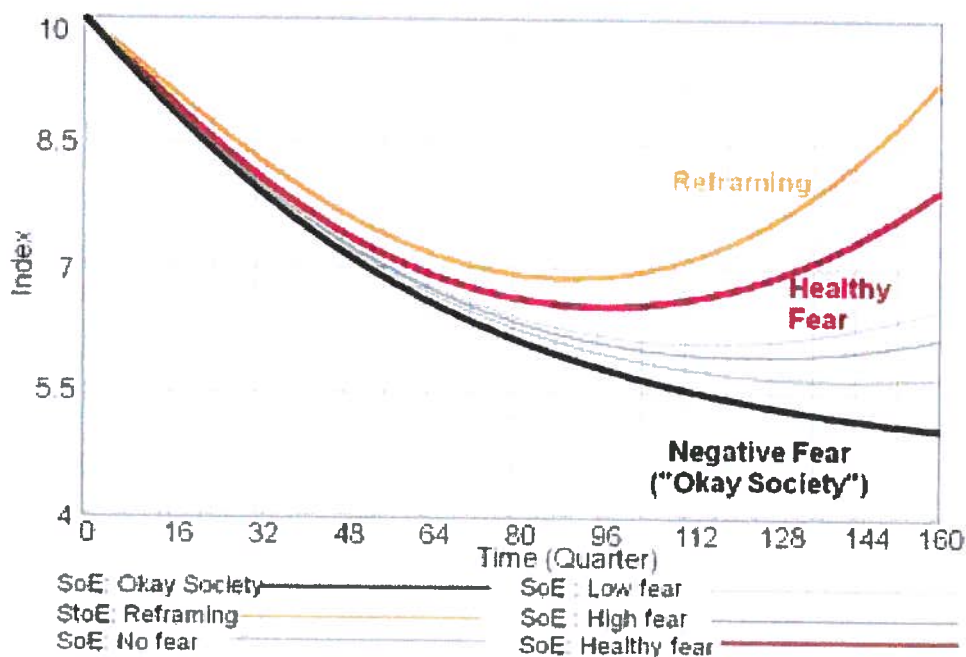


Figure 10. State of the Environment (SoE) - Scenarios

Finally, we explore two policy scenarios and compare them with the base scenario (Figure 11).

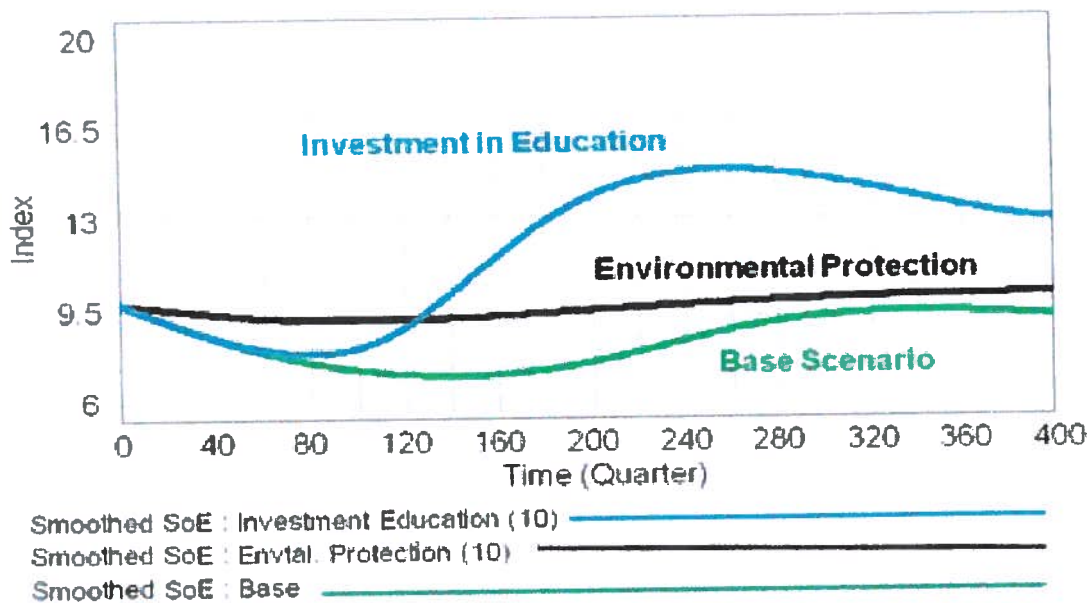


Figure 11. Policies for improving the state of the environment (SoE)

The first is a policy of environmental protection, implemented through the lever *money defensive measures*. This policy improves the situation beyond the base scenario. The second policy consists in a substantial *investment in education*. The diagram shows that the latter policy is by far superior to the former one. The reason must be sought in the defensive nature of the environmental protection policy. We could very well go on, now, running additional scenarios, but we must abide by the space restrictions of this contribution.

5. MODEL QUALITY

It is important to gauge the quality of any model one builds, because only good models will enhance progress⁶. For this purpose we revert to a list based on Howe (2007) and Schwaninger and Groesser (2008):

1. *Refutability*: the ability of a theory to be falsified (refuted) or supported. In principle, all model outputs can be falsified on the basis of empirical data or logical arguments.
2. *Importance*: the quality or aspect of having great worth or significance. According to a study conducted in Switzerland, fear of ecological threats has been number one among the most important menaces perceived by the population since the

⁶ The precise formulation of that principle is the Conant-Ashby theorem (Conant and Ashby 1981).

1990s (Raymann 2005). Therefore, from an empirical standpoint, examination of the connection between fear and the environment is necessary.

3. *Precision and clarity*: a state of being clear, allowing hypotheses more easily to be developed from the theory. Overall, the quantitative model is undergirded by formulas that express the relationships between the variables in a precise and clear way.

4. *Parsimony and simplicity*: uncomplicated; limitation of complexity and assumptions to essentials. The model is limited to the essential variables representing the system under study. Variables and parameters amount to no more than 46.

5. *Comprehensiveness*: covering completely or broadly the substantive areas of interest. The adopted view is a broad one, including the ecological, economic and socio-cultural dimensions.

6. *Operationality*: specific enough to be testable and measurable. The high level of aggregation and abstractness makes it somewhat difficult to test the model empirically. Variables such as state of the environment, fear, knowledge, etc. are difficult to measure, but not beyond estimation.

7. *Validity*: valid, accurate representation of the real system under study. As the model is conceptual-theoretical in nature, the most important validation tests are those of structural validity. The following tests were carried out⁷:

- Direct structure tests: The main theoretical foundations for the parameters and relationships, as well as certain empirical underpinnings, were given in the description of the model (sections 3.1. and 3.3.). On that basis, structure and parameter examination tests, extensive walkthroughs and semantic analyses were carried out. Further tests included boundary adequacy tests and dimensional consistency tests.
- Indirect structure tests: A number of routine tests, e.g., extreme condition tests, behavior sensitivity tests and phase relationship tests were completed..
- Behavior tests: The standard battery of modified behavior tests, behavior anticipation tests and behavior anomaly tests was applied. What could not be implemented was the behavior reproduction test, i.e., the comparison of simulation results with real-world data, because the model is a theoretical one.

Some of the tests helped improve the model considerably. For example, an extreme behavior test brought to the fore a flaw in one equation that led to negative values for the state of the environment, an error that could be easily mended.

⁷ The tests enumerated here are described in detail in Forrester & Senge (1980), Barlas (1996), Schwaninger & Groesser (2009).

8. *Fruitfulness*: statements are made that are insightful, leading to the development of new knowledge. The connection between fear and sustainability is herewith examined for the first time. The development of the model as such is a gain. New relationships have been discovered. The insights derived from the model, while they are not groundbreaking, do substantiate assumptions that to date were exclusively intuition-based.

10. *Practicality*: provides a conceptual framework for practice. The model provides a new framework that enables a purposeful exploration of the connection between fear and ecological sustainability.

6. CONCLUSION

In line with the purpose of this contribution, we have tried to shed light on the role of anxiety in humanity's quest for ecological sustainability. The research question was whether or not fear / anxiety can be a driver for a sustainable world. The answer coming from our exploration is that fear, in principle, has a strong potential for influencing the drift of ecology through human agency, or, in better terms, through social agency. This answer can be qualified on analytical grounds.

Our analysis of the simulations has led to a number of insights:

1. *Oscillation*: The system under study oscillates, showing patterns of overshoot and collapse. This makes sense; the story of the rise and fall of systems is well reflected in the model. What could be further discussed is the current cycle length of 80 to 90 years. This may well be too short, and should be reviewed at a later stage, in the light of empirical accounts that might become available.
2. *Nonlinearity*: The nonlinearity of the system generates responses that were not expected, at least to a certain extent. Higher levels of anxiety do not necessarily lead to a better state of the environment. There is an intermediate ("healthy") level of fear that entails the best results in terms of ecological restoration.
3. *Delays*: In the system at hand, the delays are longer than we would suppose. The magnitude of the delays goes far beyond our estimates made in the reference modes.
4. *Levers of change*: The level of ecological restoration can be influenced. The investment of more money, however, is not always an effective policy. In contrast, an extraordinarily powerful lever of change comes with investments in education and the corresponding creativity that leads to a reframing of the approaches to restoration.

The model confirms the supposition that fear, if it becomes pathological, can paralyze. However, in its healthy forms, it can stimulate coping behavior and adaptiveness. An absence of fear can foster dangerously careless behavior (Bachmann 1978). Or, to put it in the categories pronounced by Horst-Eberhard Richter (2005): a society in which confidence is mandatory and anxiety a taboo deprives itself of a vital alarm signal, which could warn everybody about imminent and irreversible damages to the conditions of life. This is probably the most important lesson emanating from our exploration.

A number of significant aspects could not be covered in this short contribution, and so should be examined in a follow-up. One should determine if some of the qualitative variables in the model are amenable to measurement, and if so, how. Also, the length of the delays needs to be reviewed. Finally, control strategies for the system under study should be elaborated: Can overshoot and collapse be avoided? And also, how can the system be brought into balance?

These are some of the tasks ahead, and they should be fulfilled within the ambit of improving the real system under study. We are here to change the world, not all at once, but step by step.

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APPENDIX

Stock-and-flow diagram of the quantitative model

