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Resilience Thinking:

From Challenges towards Solutions in a Disrupted World

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1. ABSTRACT

This paper describes main findings of a background research study carried out in Nokia Research Center in the spring 2010, which was inspired by recent research highlighting the carbon abatement potential of sustainable ICT applications. In light of the global challenges, the objective of the study was to provide input for strategic decision making to improve the resilience of societies and businesses to disruptions in socio-ecological operating environment. By adopting futures research methods, we identify four main change forces and discuss in detail two of them, climate change and resource depletion. We also consider the change dynamics and propose three main scenarios of societies that are likely to emerge during the period 2010-2020. The conceptual framework serves as basis for a wider discussion on how to apply resilience thinking in business contexts for the creation of sustainability solutions. This study is the starting point of an on-going iterative process to improve and update our work in the future.

Keywords: resilience thinking, peak oil, climate change, future scenarios, sustainable solutions

2. INTRODUCTION

After several decades of uninterrupted growth, global societies have just entered in a period of significant change because of two main interdependent factors, namely climate change and resource depletion. Because of these factors, both developed and developing countries will experience more frequent and severe disruptions. To minimize the negative effects of such disruptions, societies and businesses everywhere need to dramatically improve their resilience. Originally used in physics, resilience refers to the capacity of a material to return to the original state after having been deformed by external forces. The term has been later adopted by psychologists to describe people's capacity to recover from traumas or crises. More recently, resilience has now become an essential keyword of sustainability research: for Reivich K. (2002, p. 1) "*resilience is the ability to persevere and adapt when things go awry…to overcome obstacles…to steer through adversities, to bounce back from major setbacks and reach out to broaden your world*". Walker B. (2006 p. 1) defined resilience as "*the ability of a system to absorb disturbance and still retain its basic function and structure*". The lack of resilience in contemporary complex systems is one of the main causes of unsustainable development. In Darwinian terms, in transition phases, being resilient to change implies enhancing one's chances to survive.

From the viewpoint of sustainability, climate change and resource depletion are two powerful drivers of change that are moving societies around the globe from its current state A to a new state B. In this context, the purpose of developing resilience is not to be able to go back to state A, but rather to quickly and smoothly adapt to the changed environment B. The environmental, financial and economic crises hitting societies around the globe since 2008 demonstrate that irreversible changes are in motion. Are we prepared for such changes? How resilient are businesses, institutions, local communities and single individuals? Which solutions may facilitate our adaptation to a changed world? Although the traditional business thinking believing in the opportunity for secular growth is still dominant, we suggest resilient thinking as a new approach to evaluate and address global challenges. In order to understand the impact of such forces on the economy and society and to develop effective solutions turning threats into opportunities, it is necessary to apply resilience thinking, an approach that "*offers a different way of understanding the world around us and of managing our natural resources. It explains why greater efficiency by itself cannot resolve our resource issues, and it offers a constructive alternative that creates options rather than limits them*" (Walker B. 2006). Related to this view is our definition of sustainability, which focuses on the long term availability of natural resources and minimization of the negative effects of climate change. Therefore, themes that are commonly related to sustainability such as education and economics are out the scope of our contribution. By applying resilience thinking, in the following sections we present first an overview of related research and then illustrate our approach to the problem. Next, we introduce the main findings of a study conducted at the Nokia Research Center in Helsinki to evaluate the resilience of contemporary global societies. Then, we discuss viable approaches to develop sustainable solutions for a disrupted world in the timeframe 2010-2020.

3. RELATED RESEARCH

In order to identify key change drivers we looked for plausible recent reports. In regard to credibility, the vested interests of publishing parties might be difficult to assess with possible indirect biases. For example, with the peak oil the large variance in the peak timing from various sources makes the resulting average useless, which still is usually the implicit suggestion in these reports. The conventional projections from oil industry, oil producers and International Energy Agency (IEA) were replaced with recent and assumably more reliable military and industry reports (Jakobsson et al. 2009 and Reyer 2008). The legacy factor plays a role here in that the Smart 2020 report was the given starting point to our project, from which we decided to extend our work. The WBCD 2050 report served as a reference representing the long term industry vision consensus.

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3.1. Smart 2020

The Smart 2020 report (Gesi 2008) focused on the challenges of climate change driven carbon abatement.. Four main areas in which ICT could contribute to significant CO2 reductions were identified: smart energy/grid, buildings, logistics and motors. By adopting International Energy Agency (IEA) models for energy projections, the report found a 15% carbon abatement opportunity for Green ICT applications. In comparison, our study emphasizes the role of energy leaving the descriptions of actual concrete solutions to further study.

3.2. WBCSD Vision 2050

The World Business Council for Sustainable Development (WBCSD) described in its Vision 2050 report (WBCSD 2010) a pathway that should lead to a sustainable world. The report acknowledged that the key challenges of governance, global frameworks for commerce, roles and responsibilities, and risks need to be answered during 2010-2020. The outlined path cannot be achieved without sufficient coordination and goodwill among all stakeholders to form new alliances, rebuild trust and find good enough answers in that period. The report further noted that there is little historical precedent for realizing such a transformation peaceably, swiftly and successfully, and it explicitly listed various risks that may invalidate its strategic assumption. Contrarily to the WBCSD report, our study describes scenarios where the listed risks and wild cards are included in its scope and aims.

3.3. UK Industry Taskforce on Peak Oil and Energy Security (ITPOES) report

The ITPOES report (ITPOES 2010) discussed the required investments in oil production currently underway, avoiding the weaknesses of similar studies that not acknowledge resource scarcity, especially oil, as a real

problem because of their strong belief in technological progress and market forces. However, the implementation of such infrastructure usually takes 5 before it enhances the existing supply. The report concluded that this problem is likely to cause a significant gap between supply and demand of oil by 2015.

3.4. Joined Operations Environment (JOE) report

The US Joint Forces Command published a report (JOE 2010) assessing various future strategic change impacts. The main message of the JOE report concerns the potential disappearance of the entire surplus of oil production capacity by 2012. This change would make markets vulnerable to anomalies in the daily supply, with the gap between supply and demand reaching 10 million barrels per day or over 10% of overall production. Although the JOE report covers more topics than our study and has a longer time perspective, we evaluate in this study the implications of its key finding.

4. APPROACH

Our objective was not to replace established detailed modeling of dynamics of systemic change advancing (Gladwin T. 2008) in several directions with varying speed. Instead, we attempt to complement these models with a focused set of key change vectors. Selection of the drivers for these vectors is based on their estimated impact scale, timing and relative probability in the 2010-2020 time frame. At this phase, the change dynamics and scenario parts lack a solid theoretical base and empirical data. Instead, they result from our subjective interpretation of the recent reports, and existing work with our aim to create a starting point for an iterative process to improve our study.

In our study we integrated two futures research techniques, namely environmental scanning (Choo, C.W. 1999 and Jogaratnam G. 2005) and scenario analysis (Swart R.J. 2004 and Wiek A. 2006). In the first phase, we selected, aggregated and interpreted authoritative knowledge sources, which allowed describing the main change forces impacting societies. Next, we identified realistic change dynamics that could lead to three alternative scenarios of future society. Finally, we applied resilience thinking (Walker B. 2006) to plan sustainable solutions that would have been useful in any of the planned scenarios.

5. CHANGE FORCES IMPACTING SOCIETIES

5.1. Framework for trends and drivers

Studies addressing the transition towards a sustainable society typically focus on a single main driver of change (Shell 2008). This study instead approaches this problem by taking into account four interdependent key drivers of change. However, we elaborate on mainly on climate change and resource depletion:

- *Climate change*: significant variation in the statistic distribution of weather over long periods of time. Excluding possible non-linear effects, the main impact of climate change is estimated to take place after 2020;
- *Resource depletion*: global scale environmental threat referring to the reduced supplies of materials, energy and water resources;
- *Globalization*: process by which local and national economic, political, social and cultural structures become increasingly interconnected. Globalization heavily relies on reliable and effective means for moving goods and people (i.e. transports), as well as information, communication and media (i.e. ICT). From a political and economic perspective, globalization challenges the traditional dominance of developed countries, which is shifting to fast growing developing economies such as China and India;
- *Societal change*: the way people collectively react to the changes in natural and manmade environments has the potential to attenuate or amplify the speed and severity of such changes. Population growth and demographic trends induce additional effects, which alter nations' competiveness and economical performance, as well as environmental impact.

5.2. Climate change

Climate change and environmental pollution are the key reasons pushing the adaptation capacities of natural and manmade systems to their limits. In the worst case, they may produce irreversible changes and large-scale effects on ecosystems. Thanks to emission scenarios, the potential temperature increases can be estimated with high confidence, but impacts cannot be easily assessed because of the multiple interconnections, feedback mechanisms and natural and add-on adaptation measures. It is commonly agreed that such impacts will vary depending on the extent of adaptation, rate of temperature change and chosen socio-economic pathways. Climate change processes are not necessarily deterministic and predictable. Even though the Stern report (Stern N. 2006) warns of up to 20% GDP losses due to failure to mitigate and/or adapt to the climate change, these impacts on global economy are assumed to be weak or quite delayed in comparison to other drivers by 2020. The non-linearity of the phenomenon makes the timing and scaling of sufficient proactive measures difficult and highlights the importance of precautionary action. However, due to lacking data mitigation actions are driven by the general assumption of linear change. Human activities may have already pushed past the critical states of the Earth ecosystem, known also as tipping points.

In some geographical areas of the globe climate change could bring potential short-term benefits (e.g. increased temperature in high latitudes), which would be rapidly counterbalanced by negative effects (e.g. new disease vectors). Furthermore, climate change increases the volatility in human environments because existing infrastructure are no longer suitable and intensifies geopolitical tension due to the diminishing availability of natural resources (IISS 2007). Climate change thus strengthens existing drivers of conflict and therefore threatens achieved development across many countries. Almost 2 billion people live in zones that are already semi-arid, arid or hyperarid (Bot A.J. 2000). Because of climate change, by 2020 between 75 and 250 million African residents and 7–77 million people in Latin America are likely to have diminished access to water (UNFCCC 2007). In some African countries, yields from rain-fed crops could be halved (UNFCCC 2007). By 2030, armed conflicts in Africa are expected to increase by 50% (Burke et al., 2009).

Additionally, climate change has further indirect impacts on health, including increasing burden from malnutrition, diarrhea, cardio-respiratory and infectious diseases, increased morbidity and mortality from heat waves, floods and droughts, changed distribution of some disease vectors. Finally, climate change would create feedback loops such as melting glaciers and snow decreasing the global albedo, methane released from melting permafrost and clathrates in the sea bed, higher rate of CO2 emissions from bogs and decreased CO2 absorption by forests and warming seas.

Concluding, climate change poses a range of deep challenges, which will not significantly impact societies before 2020, but that nevertheless need to be seriously addressed during this time period.

5.3. Resource depletion

Resource depletion refers to the diminished availability of natural resources. With respect to non-renewable resources, their utilization rate cannot be compensated by human activities like recycling. The situation is even worsened by the gradual scarcity of useful resources, gained relative to expended energy. Resource depletion hits also renewable resources, if the use of resources is higher than the rate of replacement. The most severe forms of resource depletion concern the energy sector, especially fossil fuels, and the agricultural sector (e.g. availability of fresh water, farming and fisheries). Even if agricultural problems are already tremendous in many developing countries, these forthcoming changes will also threaten the long-term growth-based consumer lifestyle (activities, habits and products) in developed economies. However, these threats may be also regarded as new business opportunities for saving technologies and solutions as well as resource efficient processes, which can enhance dematerialization and support the adoption of potential substitutes.

Resource depletion induces six main changes in the chain of energy supply and demand (see Figure 1):

- Lack of spare capacity to meet rising oil demand makes oil markets more sensitive to disturbances and leads to increasing oil price level and volatility. Investors are wary of large capital commitments because of the high price uncertainty. This impacts overall economy since the rate of change in global GDP correlates with the rate of change in oil consumption;
- Oil production is constrained by the lack of sufficient investments to new production capacity and exploration to find replacements to depleting fields. New supply requires more investments of capital

and energy for each barrel of refined petroleum available for consumption because of more difficult access to fields and more complicated extraction processes (Monbiot G. 2008), leading to the phenomenon that can be termed "peak of cheap oil";

- Oil consumption is increasingly constrained by growing prices and disruptions in availability, but price elasticity is limited. Higher prices of oil-intensive products such as fertilizers feed through to agricultural products. Replacing half of the car fleet in US would take 15 years. Increased efficiency alone would be insufficient and not timely enough to solve the problem (Hirsch R.L. 2005);
- Despite policy measures, higher demand for substitutes to oil and oil based products (solar, wind, biomass, biofuels, plug-in hybrid and electric vehicles), does not translate to immediate reduction in oil demand because ramping up their production and the required infrastructure will take 10-20 years and large investments (Hirsch R.L. 2005);
- Demand for non-renewable substitutes of oil (gas, coal and nuclear) increases and accelerates their production peaks (global peak in natural gas within a couple of decades of oil peak, and local peaks before that e.g. in US and possibly Russia). Despite vast reserves of coal and uranium, periods of supply deficiencies may occur;
- Volatility of oil prices increases disruptions in fuel availability, especially in the developing countries.

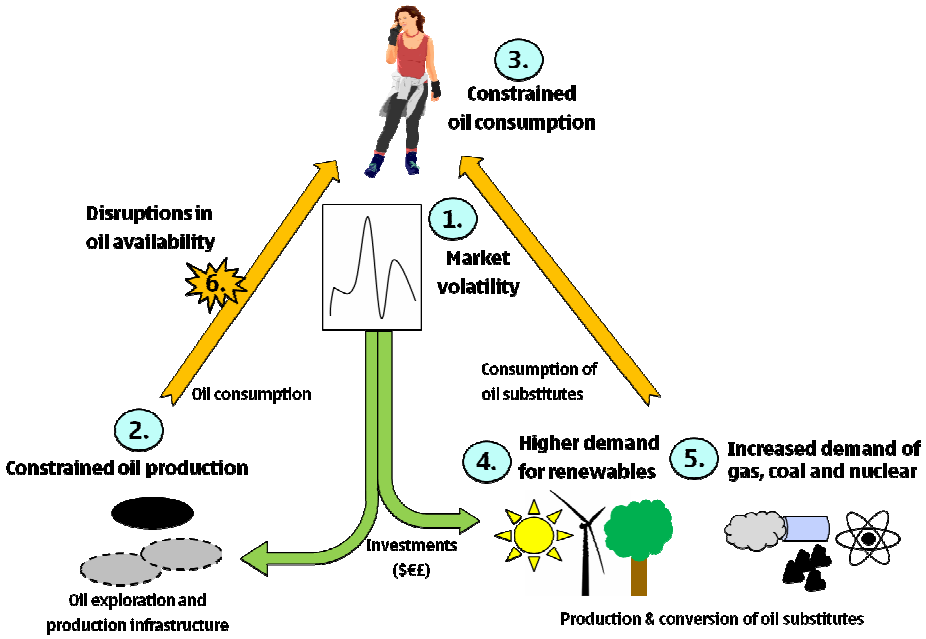

Figure 1. Schematic showing key energy supply and demand factors.

In addition to impact energy supply and demand, resource depletion will deeply affect the availability of basic resources needed for human survival:

- *Peak water*: the increased water use by humans, pollution, exhaustion of non-replaceable groundwater reserves, changes in rainfall patterns and faster flow of rain- and meltwater to the sea cause supply of freshwater to drop. Changes in self-regulating processes of environmental equilibriums are severely threatening aquatic ecosystems and their dependent species. Water depletion is often manageable and reversible, but while some aquifers recharge fairly quickly, the average recycling time for groundwater is 1400 years, as opposed to only 20 days for river water (Sampat P. 1999).

- *Peak agriculture*: the increasing demand driven by higher living standards in growth markets, climate change, peak water and peak phosphorus cause supply of food crops to drop. Arable land area contracts by 0.11 million km2 annually due to erosion exacerbated by the climate change (Bot A.J. 2000). Degradation severly hits the 20% of land under cultivation in the world, even if some regions are still expanding their agricultural land. In China, one-sixth of the total arable land area is polluted by heavy metals, and over 40& is degraded due to erosion and desertification. In 2005, 13% of the area was arable, but in the past decade it has lost 6.6% (Liu Y. 2008).
- *Peak oil*: it reduces the cost efficiency of the most advanced agricultural processes, still based on high fossil energy consumption. Peak oil increases the energy flow to agriculture on average 50 and up to 100 times (Giampietro M. 1995 and Kindell H.W. 1994) comprising of nitrous fertilizers, herbicides, irrigation, and phosphorus mining. Biofuel production also competes with agricultural use of arable land. Improvements can be expected with the gradual development of more persistent plant strains, but the benefits of GMO remain questionable. According to UNEP studies in Africa, organic or near-organic agricultural practices outperformed chemical-based conventional farming systems (UN 2008).
- *Peak fisheries*: Currently global fisheries are overexploited at four times the sustainable rate. Half of the biomass from seas has been consumed already, and an extrapolation of fishing trends would result in no fisheries left by 2050. For a large share (30%) of the fish stocks the "peak fishery" is already here. Additional 50% are fully exploited without room for increasing catches.

Furthermore, resource depletion will alter the availability of industrial materials:

- *Non-renewable materials*: higher demand for steel and other metals as well as for kaolin, gypsum and other industrial minerals because of infrastructure and consumption growth of developing economies.
- *High quality minerals*: decreasing mineral reserves cause transition to less easily accessible and less energy efficient sources. Supply of newly mined metals decreases due to poorer ore grades and consequently larger amounts of waste rock removed during the extraction process.
- *Raw material*: imports are threatened with political and commercial interference and interruptions, as recently evidenced by export restrictions of difficult to substitute and geographically very localized high grade rare-earth mineral reserves.

Resource depletion is also expected to produce rapid, substantial impairments in ecosystem services and increased vulnerability of ecosystems to invasive species. Ecological feedbacks may accentuate human modifications of ecosystems and eventually increase risks to human health.

- Expanding agriculture results in the loss of ecosystem services of natural forests and grasslands.
- Freshwater extraction deteriorates water quality and results in the loss of ecosystem services provided by clean freshwater systems.
- Pollination of many crops is done by bees. In recent years there have been massive die-offs of bee colonies, which seem related to environmental and climate changes. Reduced bee populations constrain agricultural production.

Contrarily to climate change, resource depletion will deeply hit societies and markets by 2020, which are therefore in need of quick and efficient solutions to this challenge.

6. CHANGE DYNAMICS

The four challenges impacting global societies (i.e. climate change, resource depletion, globalization, societal change) cannot be solved autonomously because of their interdependence. Change dynamics would certainly deserve a longer discussion, which is out of the scope of this paper. However, it is useful to illustrate how such interdependencies have been conceptualized in our study (Figure 2).

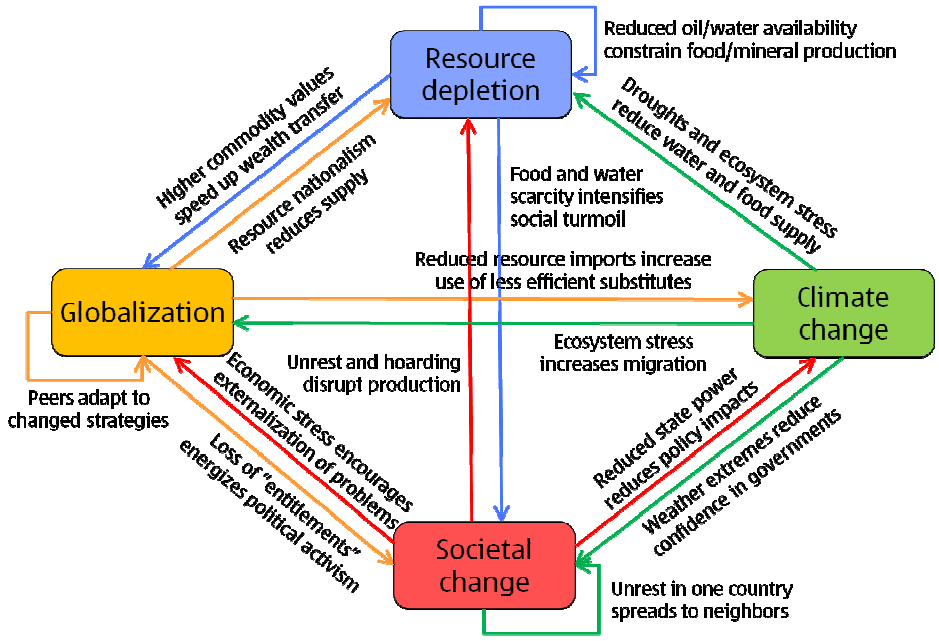

Figure 2. Examples of interdependencies between changes.

7. SCENARIOS FOR 2020

Scenario analysis (Swart R.J. 2004 and Wiek A. 2006) is a useful tool for enhancing the resilience of current societies and business environments by considering plausible materializations of the interdependent changes dynamics in political, economical, social, technological and environmental domains. In drafting scenarios, two main dimensions were considered, namely the characteristics of governments and the scope of people's solidarity. The nature of governments strongly affects the shape of possible futures by proactively leading the development or only adapting to inevitable changes in a reactive way. However, citizens' behavior, values and attitudes have also significant effect on the development paths: people may demonstrate empathy and social solidarity to each other at a global level or make the existing distinctions between the "us" and the "other" even more marked in the attempt to pursue their self-interest and help only their trusted peers.

By taking into account the possible configurations of the two main variables, five possible scenarios are likely to emerge (see Figure 3).

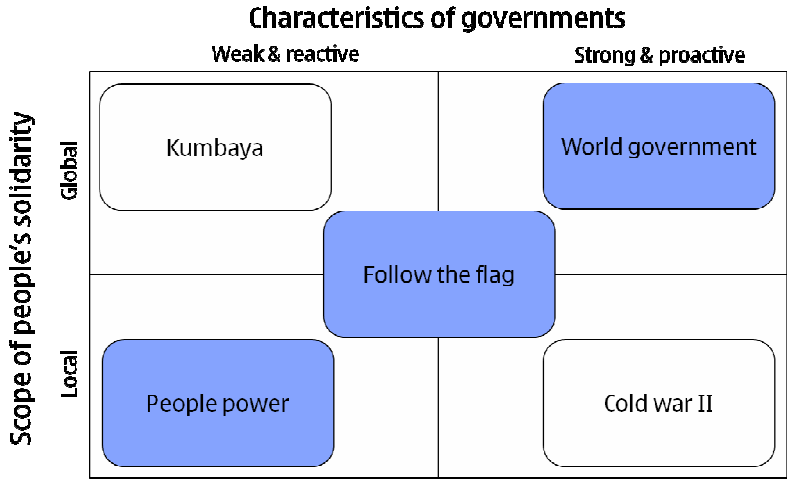

Figure 3. Scenarios derived from how societies will respond to changes.

1. *World government*: if people feel solidarity to each other at a global level and grant powers to strong, proactive governments, the world can be governed through a global consensus. The existing political and economic mechanisms of global governance make the current globalized economy not too far from this scenario;
2. *Follow the flag*: instead of pursuing global interests and objectives, people may feel threatened by the competitive behavior of other nations supported by relatively strong national governments. To keep satisfied their own citizens, such governments would try to pursue their interests by constituting blocs of nations with states with aligned objectives;
3. *People power*: because of the inefficacy of primary governing mechanisms, citizens lose confidence in weak governments. The existing structures dependent on such top-down hierarchies may fall like dominoes and be substituted by new and more responsive bottom-up mechanisms activated by individuals and communities.
4. In addition to these three scenarios, which are the most probable, we also considered two less likely scenarios:
5. *Kumbaya*: traditional top-down mechanisms of global governance and decision-making are replaced by grass-roots altruistic governance of individuals and groups mobilized on a global scale;
6. *Cold war II*: conflict between nations escalates to a proactive fight for scarce resources, supported by increasingly nationalist attitudes among citizens.

8. DISCUSSION: FROM CHALLENGES TO SOLUTIONS

Through environmental scanning (Choo C.W. 1999 and Jogaratnam G. 2005) and scenario analysis (Swart R.J. 2004 and Wiek A. 2006), we have first identified four main change factors, describing in detail climate change and resource depletion, and then illustrated possible scenarios that are likely to emerge during this decade. Instead of discussing these findings using a business thinking mindset, we apply the principles of resilience thinking that would allow achieving two major objectives, namely adapting to a changed socio-ecological environment and turning threads in opportunities.

The resilience thinking approach consists of two main steps: first, stakeholders need to elaborate a resilience plan for the period 2010-2020 in which they analyze the multitude of obstacles that threaten survival and development. Providing realistic answers and setting up related schedules allows becoming aware of these critical problems, but it represents only the starting point. In the successive phase, it is essential to implement the required resilience solutions.

8.1. Resilience planning

The ongoing crises and the need to address global challenges have recently led to a strong critique to the current mechanisms for global governance, such as G8, G20, EU, USA, World Economic Forum. For instance, Falk R. (2010) recently underlined the need for addressing the 'radical world order challenges' to be able to solve global challenges such as climate change. In his view, existing mechanisms of global governance are no longer suitable because they operate to stabilize and legitimate the status quo. There are able to promote gradual change through a traditional top-down approach, but they cannot implement the radical changes needed to overcome the multiple ongoing crises (political, financial, economic and environmental). The persistence of these crises demonstrate that market forces dominate political forces and that in the long run the current mechanisms of global governance will be increasingly perceived as illegitimate, not adequate and non sustainable. The failure of Copenhagen negotiates for reducing the impact of global change represents an early signs of this trend.

In the long term, climate change mitigation and oil consumption show a clear correlation: the more oil and energy is saved the less carbon is emitted. However, in the short term (2010-2020) there are less obvious conflicting elements. One of them has been clearly demonstrated by the discordant international climate negotiations and the inability to agree on binding carbon emission quotas. In other words, decision makers will prioritize short term energy security and stable society over long term climate actions, if these two are in conflict. A concrete implication of this tendency concerns the inevitable substitution of oil by coal as the supply of the former peaks, in parallel to difficult investment in the renewable energy sector due to volatility of oil price and lagging legislation lobbied by fossil fuel locked-in energy incumbents. Therefore, the acknowledgement of the change factors is a necessary but still an insufficient condition for successful resilience planning. Understanding the interests of the stakeholders is critical in keeping the planning realistic.

The rebound or boomerang effect, known also as Jevons' paradox or Khazzoom-Brooker postulate, is another important factor stating that increases in energy efficiency - the other pillar of climate mitigation solution in addition to renewable - cannot cut the overall consumption. Indeed, increased energy efficiency lowers the price of a given critical commodity, which again accelerates consumption. Again, increasing energy efficiency is a necessary, but insufficient condition in the pursuit for resilience. To solve this paradox in the most conventional way, the consumption of the commodity should be limited. From a top-down perspective, this action can be seen as an attempt in placing industry sector and national quotas for carbon emissions. Regarded from bottom-up, it resembles personal or tradable quotas that have been already proposed in the past. The quota based solution would appear optimal, but it is very complex to put in place. However, following economists' laden premise of constantly growing market would result in a limited set of less realistic solutions. On the other hand, if we accept the possibility of contracting economy driven by resource scarcity, then the carbon leak following from Jevons' paradox is of a lesser threat. Even though the Jevons paradox itself is undeniable, our claim is based on the assumption that after a certain threshold is reached the scarcity of a critical commodity remains high enough a barrier to reduce the average consumption. In other words, increasing energy efficiency in the face of fundamental scarcity for a critical commodity would make energy cheaper, but not enough to induce increased consumption as it has been the case up to that point. Naturally, the relation presented here is overly simplified and the couplings are in reality much more complicated. For instance, the purchasing power available for one commodity may be affected by a scarcity of another more critical commodity such as oil. This does not mean that the international climate negotiations would be meaningless, but that it is necessary to have an alternative plan if such negotiations fail or are accomplished too late. The development of energy and material efficiency are found to have intrinsic value in time of expected scarcity.

Discussions with various experts during the project made us realize that *silos of expertise* appear to be surprisingly common. If a given factor falls out of their area of expertise it is assumed to bear little significance. Economists, consultants, military representatives appear to share a very narrow view on the change forces. We claim that the comprehension of the whole is difficult to obtain but of critical importance. On the other hand, concentration on the creation of possibly overly detailed holistic models of the complex systemic change dynamics may impede the creation and implementation of a clearly focused strategy.

8.2. Resilience solutions

"*I believe that only the companies that develop products and services that address global challenges such as energy supply and access, climate change, pressure on ecosystems, or water, will be around for the long haul.*" *- Jorma Ollila, World Business Council, Sustainable Development, 2009*.

Companies may contribute to resilience in societies in two forms: first, by adhering to the regulations and minimizing the environmental impact of the company itself and secondly, by creating profitable solutions for its customer to reduce their energy and material consumption. Concerning the first type of behavior, the level of company's myopic concentration is inversely proportional to the relevance of its offering and its life-expectancy in the long run. The question is not arguing whether, but when crises induced by resource depletion will occur. For example, the ICT sector can choose whether to focus on minimizing its 2% share of the global annual emissions or on creating solutions for the remaining 98% of the problem – in time. The greater the solution potential of a corporation or an industry sector the better this claim holds. Solving the 2% is a necessary condition for a company to be taken seriously, but still an insufficient condition to create viable sustainability related business in the long term.

The change drivers we identified put pressure on the political forces that have to answer both to the public and to the market forces. Public and private organizations are not able to respond by maintaining the status quo/BA and the pressure keeps building up. It is likely that the regions with lowest resilience thresholds will break first, possibly creating a cascade effect leading to a more or less uncontrolled systemic change. Hence, if global governance mechanisms are not able to change radically in the timeframe 2010-2020, the transition from *World-Government* scenarios to *Follow the flag* or *People Power* could be only a matter of time.

Companies need to rapidly enhance their resilience by overcoming the current reasons of 'corporate myopia'. There is a large window of opportunity for companies in the consumer market, which may be closed by either carbon taxation and/or regulation or a by a transition process caused by scarcity of a critical resource. The former action has a tendency to render customers passive and reduce interest in purchasing that so called 'green products' that have mainly aspirational value. However, carbon taxes act also as a cost cutting driver for concrete solutions. The true resilience of a company will be truly tested by the latter change factor, in which resource depletion impacts the economy and starts to erode customer's purchasing power. Companies able to offer concrete and effective solutions to their customers will differentiate themselves and prevail. Others are expected to experience more limited success.

The reasons for corporate myopia vary from company to another, but we will take the opportunity here to speculate on some common factors based on our insights. They have similarities with existing work (Liu j. et al. 2007).

Engineer thinking: Acknowledging the difficulties of extending a mobile devices' battery life is a commonly shared fact in the ICT industry. After all, pulling an extension cord behind you is not a possibility. For example, a discussion on macro level renewable energy problems with some mobile battery experts revealed that they did not see any problems in the horizon as technology will solve them all. In a small scale and limited setting the opinions converged but in a seemingly unlimited setting (the world) also the number of solutions seemed infinite to these engineers despite the unavoidable increase in complexity (scalability, geopolitics, economics, population growth etc.).

Blind spot: Some companies are fortunate in that their offering is relevant and matching the basic needs following natural resource scarcity. Others have to adapt. One survival strategy is to focus the attention to a faraway target date such as 2050 by which time even modest changes in the existing products can be claimed to make a difference then. There is a thin red line between this strategy and green washing. As politicians very well know it's relatively safe to talk about world in 40 years as anything is possible and the actors do not need to answer for the consequences. Another approach is to wait until the need to react hits the corporate radar screen a couple of quarters from the present. For meeting the challenge from present competition the corporate machine is usually well tuned and its strategy and implementation effective. What is left in between could be called that blind spot. It is defined by temporal scope and content. The impact from the external world might be considered to be force majeure with little need to make changes to existing, i.e., the whole industry boat is rocked by the same wave but the competitive setting remains relatively static and no alarm is sound. On the other hand, the identified global problem could be in the passing decade but too far for business strategy

planning to react to, and still so close requiring already significant investments to scale up competitive offering, and stretching the existing business models.

Adapting to customer needs: Market intelligence tools are good at creating a view of the present day consumer needs, expectations and desires. However, the usefulness is questionable in case one would be asking for their hypothetical preferences on the other side of a potentially upcoming systemic change. A valid answer on their needs for low-carbon-society solutions would require them to go through Elizabeth Kubler-Ross's 5 stages of grief (denial, anger, bargaining, depression, and acceptance) over the changed world. Clearly, this is difficult to achieve *apriori.* Additionally, companies are accustomed to produce revenues by addressing the mainstream consumers. Stating the relevant questions to probe future needs would also require accepting certain premises regarding possibly reduced standards of living for their customers, which would not be an appealing scenario. Moreover, this line of reasoning would question the value of their current legacy assets in a transitioned state. "*It's difficult to get a man to understand something if his salary depends upon him not understanding it.*" - *Upton Sinclair*

Internal conditioning: Humans suffer from the natural fallacy, i.e., not being able to differentiate between reality and wishful thinking. The target problem could be quite unintentionally defined in a way and fashion to meet with the capabilities of the existing offering: "If we don't have assets to solve it, it's not an opportunity for our company. People inside the company may become conditioned to do what is possible in the organization and not to find out what should be done to meet the new reality outside the company. This is analogous to the proverbial frog in the pot setting, where an unfavorably developing economic situation conditions people. There may be a threat of financial hardships and no one dares to rock the boat. Instead people may be incentivized to concentrate in incremental improvements in what they have been doing so far. If you are in charge of creating green products, you would logically make them greener still. The solution here would be to understand that only relevant real-life sustainability problem solving offering is sufficiently profitable in the long run.

Accounting bias: Corporate decisions, as well as most of the decisions concerning investments and budgeting in both private and public sectors, rely on discounting costs and revenues based on extrapolations from the present trends. Resource depletion and climate change present such fundamental systemic changes that the validity of existing trends becomes questionable. This results in a variant of the *Internal conditioning*, where instead of technology development, it is the financial planning that cannot properly discount the coming changes but instead continues to assume a deterministic and predictable environment. Therefore, as long as the changes are not visible in the accounting process, they cannot be used as a basis for any significant actions.

Conformism: An evolutionary path paved by group thinking has driven the green product markets starting from merely adhering to regulation, emphasizing design aspects and next becoming necessity addressing tools. The first wave was about managing the manufacturing process of products (How Green can it be?). In the second wave, the appearance and perception became important (How Green can you be?). In the third wave, yet to emerge, the concrete interaction with the physical world will become the measure of relevance (What Green can we do?).

Various actors may create solutions in collaboration. A solution is defined here as a concrete method or tool that solves a significant problem. Naturally, the significance is relative to the users need. However, we consider it to be proportional to the Maslow's hierarchy of needs. That is, needs on lower layers bear more significance in systemic change scenarios. To be successful the solutions should meet with the following proposed criteria:

1. Adding value (e.g. cutting costs) to users already in Business As Usual (BAU) scenario
2. Optimal in systemic change scenario maximizing the resilience impact
3. Aligned with both short term (resource depletion) as well as long term (climate change) drivers
4. Adapt to main change dynamics
5. Acknowledge the interests of various stakeholders (competition, incumbents, regulators, investors, nations, customers etc.)
6. Acknowledge the finite time window of opportunity

Once a desired solution is identified, more detailed planning criteria can include, but not be limited to, technology, economics, usability and design dimensions.

9. CONCLUSION

The objective of our study was to provide input for strategic decision making to improve the resilience of societies and businesses to future disruptions in socio-ecological operating environment within the 2010-2020 timeframe. By combining environmental scanning (Choo C.W. 1999 and Jogaratnam G. 2005) and scenario analysis (Swart R. J. 2004 and Wiek A. 2006), the key change factors were identified and discussed, and change dynamics leading to alternative future scenarios evaluated. Among the change forces, climate change is an undeniable and significant threat, for which mitigation and adaptation actions should be undertaken already in this decade. However, due to the general assumption of the weak or quite delayed linear impacts of climate change by 2020, the resource scarcity and energy security are assumed to be comparatively even stronger drivers. Through resilience thinking, the current global challenges, which threaten the sustainability of societies and a decrease in material well-being, can be addressed all together. Although traditional business thinking believing in the possibility to pursue continuous secular growth is still dominant, stakeholders adopting an approach based on resilience thinking will be able to smoothly adapt to a changed environment and develop sustainable business solutions. The understanding of various human fallacies, change dynamics and possibly conflicting interests of stakeholders affecting the solution development is a prerequisite for realistic planning. At this phase, the change dynamics and scenario parts lack a solid theoretical base and empirical data. Instead, they result from our subjective interpretation of the recent reports, and existing work with our aim to create a starting point for an iterative process to improve our study.

The conceptual framework introduced in this study will support the development and design of sustainable business solutions, which will be illustrated in future extensions of this study.

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