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CAN GRI LIGHT UP THE FUTURE OF MANKIND?

Abstract:

There is strong evidence across the media that humanity has finally come to recognize the certainty and imminence of a global environmental crisis due to man-triggered ecological alterations. This widespread recognition of what is happening around us has matured even further as studies acknowledging that everything on Earth is interconnected begin to mount across various branches of learning. The appreciation of this simple linear and two-dimensional relationship implies enormous consequences for economic and management studies, as alternative business models will eventually have to supersede the old practices that still govern major industry sectors (e.g. energy, cement, agriculture, automotive, pharmaceutical, etc.). This paper argues that traditional knowledge found in developing countries can sometimes harness the potential of sparking genuine alternatives to established business practices. With a focus on the most fundamental geochemical cycles on Earth − nitrogen, water, and carbon − and the primary resources they govern (soil, water, and air), three case studies are presented to illustrate how traditional knowledge in the context of GRI (Grassroots Innovation) projects can lead to challenge the dominant logic, when allowed to thrive in terms of adoption and scalability.

Keywords:

Developing countries, geochemical cycles, environmental changes, interconnectedness, traditional knowledge.

JEL Classification: Q01, Q51, Q54

Introduction

Understanding and managing complexity is a very difficult endeavour for the human brain. We are not programmed to think in a way that is non-linear, circular, high-dimensional, accounts for time lags, etc. The literature on the topic is vast, ranging from systems theory (Bertalanffy, 1975) to chaos theory (Levy, 1994), constantly reminding us of our limits, as even the most intelligent and devoted minds of our time still cannot fully comprehend apparently simple matters such as natural events, animals' behaviours, diseases, and many other phenomena that surround our daily lives. Yet humanity acts as if it had a complete understanding of extremely complex schemes like natural ecosystems. We are clearly unable to control our own little domain (e.g. peace, poverty, crime, politics, discrimination, hunger, clean water, etc.), but at the same time act freely and carelessly against Nature with the illusion − at best − of knowing the consequences of our actions (Deb, 2009).

The natural tendency of modern society exemplified in the actions of MNCs (Multinational Corporations) − being them a manifestation of us consumers, shareholders, entrepreneurs, and employees − is to consider only one issue at a time, as need presents itself, and this gradual process of losing sight of the wholeness to concentrate on the detail of the moment has led to an extreme specialization (Shepard, 1969; Rosen, 1983) which is the chief reason of why we failed as a race to understand the environment on countless occasions and are now on the brink of irreversibly destroying it. So, is there a solution to the predicament caused by human behaviour over the last few centuries? Should we stop progress all together and go back to being a primitive society (Zerzan, 1998)? Even if it was possible to rewind human history, this would be a very painful exercise and it is not the purpose of this paper to idealize primal societies. Instead, the researchers join forces with those who attempt to *redirect* human development on the right path, one characterized by being environmentally sustainable and socially more equitable.

Today's society has finally acknowledged the big environmental challenges it faces and has also deconstructed most of these critical threats identifying their primary causes, which almost entirely relate to an uncontrolled production and consumption by man of goods and services. Therefore looking at how major industries could improve their business practices is an area of research that cannot be overlooked. However, most of the current studies look at how MNCs can make their existing processes more sustainable through CSR best practice (Carroll and Buchholtz, 2014) or how government policies can promote positive change (Schmalensee, 2012), but very little research has looked at changing the rules of the game, the possibilities of challenging the dominant logic to transform entire industries (Prahalad, 2004).

In a utopic society that searched for the common good, rational thinking would imply a voluntary change of direction by all actors involved, hence mainstream research and innovation efforts would be most appropriate for both, ideas development and their implementation. However we are conscious of the fact that human arrogance, corruption, and greed will continue to endure sustaining processes of production that are flawed and have a negative impact on the planet. Therefore the need to search for significantly different know-how capable of producing radical innovations with the potential to transform entire industries is paramount. One type of knowledge that has been validated for centuries and could represent the foundation for a more conscious development of humanity is the one retained by indigenous communities (Corry, 2011; Leach et al., 2012). Hundreds of them still exist around the globe (Grim, 2001) − though relentlessly threatened by government repressions, economic interests of large corporations, or simply the allure of modern ways of life − and have nurtured traditional knowledge aimed at maintaining a balance between human actions and natural resources.

In an attempt to make a case for GRI (Grassroots Innovation) this paper concentrates on the primary resources of our planet (soil, water, and air) and the most fundamental geochemical cycles that govern them: nitrogen, water, and carbon. For each one of these three domains, the researchers elucidate how the cycle functions and what parts of it have been mostly exposed to the industrial specialization that modern society has progressively fostered in order to push economic growth. Next, the methods of this study are discussed, and the preliminary results presented: an update on the main pollutants of the three geo-chemical cycles is given and 10 GRI cases are ranked based on expert opinions concerning their degrees of innovation, adoption and scalability. Finally the three most relevant case studies are discussed, in connection with each cycle, to illustrate how traditional knowledge in the context of GRI projects can hold the potential of challenging the dominant logic, hence capable of changing widely accepted industry practices.

Literature Review

In the past 10.000 years humanity has witnessed an unusually long period of steady environmental conditions (Rockstrom et al., 2009; Folke et al., 2011). This era of ecological stability − known as the Holocene − has been characterized by a favourable functioning of three geochemical processes: nitrogen, water, and carbon cycles, which have played a pivotal role in preserving and maintaining a stable and relatively warm climate on Earth. As such, the Holocene has fostered human expansion and development and has been remarkably conducive to the hitherto incessant population growth and technological advancements. Until 1800 AD, the relationship between man and the natural environment had not been significantly altered. However, over the period that goes from the first Industrial Revolution up to modern times − and particularly during the *'great acceleration'* of the last 60 years (Steffen et al., 2007) − the world has experienced unprecedented transformations: human population has more than tripled, material consumption has literally boomed in most countries and global connectivity has evolved at an astonishingly fast rate (Steffen et al., 2011). This last period of time has been referred to as Anthropocene, from the Greek roots anthropo- meaning *'human'* and -cene meaning *'new'* (Crutzen and Stoermer, 2000), in light of the understanding that the profound influence of human actions on the Earth's ecological functioning could have determined the coming of a new geological epoch.

As a matter of fact, what distinguishes the Anthropocene from previous geological eras is that for the first time in history many geologically significant conditions and processes are undergoing major changes almost exclusively due to human enterprises. According to scientists investigating the soundness of these assumptions (Steffen et al., 2011; Slaughter, 2012; Gowdy and Krall, 2013), the list of impacts would also comprise significant alterations of the *nitrogen*, *water* and *carbon* cycles, the primary global (bio-)geochemical processes central to making the Earth a place where life can spring, grow, and thrive. Essentially these cycles consist of natural circulation pathways through the atmosphere, hydrosphere, geosphere, and biosphere for the basic elements of living matter. Along their journey, these elements take various forms and continuously flow back and forth from the nonliving (abiotic) to the living (biotic) components of the biosphere (i.e. the part of the Earth that is capable of supporting life and in which living organisms exist). Apart from their close connection with climate and related environmental concerns, the three cycles are strongly correlated with the three natural resources that are of great importance for man-centered activities: soil, water, and air.

The *nitrogen cycle* plays a pivotal role in preserving healthy ecosystems, notably with regard to vegetation. Soil bacteria and humus are critical natural ingredients of the nitrogen cycle, however, with the advent of Industrialization, man has introduced massive amounts of nitrates into the environment in the form of fertilizers – urea, ammonia, ammonium salts and nitrate salts – to meet growing food demand (Nishio, 2002). While fertilizers may be beneficial to plants, they are not always as healthy for the rest of the environment as indicated by groundwater contamination and the annihilation of marine life.

Humans add today more nitrogen to ecosystems than the total amount produced by all natural processes combined (Galloway et al., 2008; Rockstrom et al., 2009). The amount of nitrogen fertilizers that is not absorbed by plants – which on average is one-half of the nitrogen fertilizer applied – ultimately breaks down into nitrates and penetrates the soil. Here, being nitrates water-soluble, can remain in groundwater for decades and the addition of more nitrogen will have an accumulative effect. When nitrogen wind up into waterways has similar dire effects such as the poisoning of aquatic life. In fact, massive quantities of nitrogen in water can trigger giant algae blooms – an event commonly referred to as *eutrophication* – and when the algae die they decompose in a process that subtracts oxygen from the water. A great deal of aquatic species – including fish – can't survive without oxygen and consequently either perish or migrate to new underwater territories.

Main human activities impacting the transfer of nitrogen encompass:

- Fossil fuel combustion which releases nitrogen oxides (NOx), a well-known greenhouse gas, into the atmosphere.
- Use of artificial nitrogen fertilizers: on average, plants utilize less than one-half of the nitrogen fertilizer applied by growers with much of the remaining nitrogen fertilizer leaching into the soil and altering the natural intake.
- Release of nitrogen in wastewater sewage produced by human waste.

Water on Earth gets always recycled as it continually moves through the cycle of evaporation, condensation, precipitation, and runoff. In other words, salt water of the oceans is the fresh water of rain, ice caps and glaciers, surface runoff, rivers, aquifers, and groundwater discharge: an extremely precious resource. While safe drinking water is essential to humans and other life forms, WWF (2003) and FAO (2014) estimate that approximately 70% of the fresh water used by humans goes to agriculture – more than twice that of industry (19-23%), and dwarfing municipal use (8-11%). Apart from a misuse of water resources, there are also concerns about pollution of freshwater ecosystems and a projected decrease of precipitations due to climate change in already relatively dry subtropical areas, potentially causing 47% of the world's population to live under severe water stress by 2050 (OECD, 2012). Main human activities that alter the water cycle include:

- Agriculture, contributing to water pollution from excess nutrients, pesticides and other various pollutants.
- Industrial water pollution triggered mainly by the manufacturing sector in developing countries where production sites are generally based. But also ammonia from food processing waste, heavy metals from acid mine drainage, sediment in runoff from construction sites, logging, slash and burn practices or land clearing sites.
- Daily consumer products like detergents, disinfectants, insecticides, chemical compounds found in personal hygiene and cosmetic products, all of which contain organic water pollutants.
- Construction of dams cause the deterioration and loss of river deltas, ocean estuaries, and irrigated terrestrial environments, leading to reduced water quality because of dilution problems.

- Urbanization alters the natural amount of water that seeps into the soil, resulting in increased volumes and decreased quality of surface water.

Carbon dioxide is a constituent of air, with a very low concentration of less than 0.04%. Being transparent to most of the sun's radiation, the higher the carbon dioxide in the air the larger the proportion of solar radiation that is retained by the earth as heat, causing global warming. The inputs and outputs of carbon naturally move in and out of the soil and water via the photosynthesis (the process that connects plant with the atmosphere) and respiration processes (NASA, 2001), but anthropogenic activities are increasing levels of carbon dioxide in the atmosphere faster than ever recorded (Metz et al., 2005). Main human activities causing alarming increases of carbon dioxide in the atmosphere encompass:

- Burning fossil fuels (factories and vehicles), which transfers carbon from the geosphere into the atmosphere.
- Deforestation practices that remove forests to make land available for agricultural or urban areas. Forests store carbon dioxide and help to control climate. By cutting trees, humans cease their carbon absorption and allow dead trees to release stored carbon into the atmosphere as CO2.
- Agricultural and land use practices leading to higher erosion rates, washing carbon out of soils and decreasing plant productivity.
- Coral reefs – highly sensitive ecosystems that contribute to the ocean's ability to absorb carbon from the atmosphere on a regional scale – suffer the effects of changes in the chemical composition of oceans due to acid rain and polluted runoff from agriculture and industry.

The current debate between the multilevel perspective (Rip and Kemp, 1998) and social practice theory (Bourdieu, 1977) – the most prominent theories to address how society could reconnect to the natural environment (Hargreaves, Longhurst and Seyfang, 2013) – is reserving a special place for the strategic management of green niches, where networks of actors experiment with and mutually adapt greener organizational forms and eco-friendly technologies (Smith, 2007). Within this context, a few scholars (Seyfang, 2013; Tonelli and Cristoni, 2013) have recently argued that the know-how on which to concentrate and build upon for scalable sustainable solutions should be the sort of knowledge that has maintained for centuries a balance between human actions and natural resources − namely indigenous wisdom.

When applied to today’s social problems, these forms of conservative and traditional knowledge take the name of GRI as they are in fact innovative for a ‘modern’ mind-set desperately seeking environmental sustainability. Opposite to the work of MNCs, which do not have a local outlook, GRI projects refer to the development of environmentally sustainable bottom-up solutions that meet the local needs, interests and values of the communities involved. In this work, drawing from the insights of Seyfang and Smith (2007), who argue that bottom-up initiatives might succeed where top-down approaches have routinely failed (e.g. the EU Emission Trading Scheme or the Rio +20 Conference on Sustainable Development), the authors explore instances where GRI may hold the key to overcome the impasse in which human development has wound up.

Research Methodology

This paper is the first output of a study that investigates the potential impact of a widespread use of sustainable GRI practices. The overall research project started with a review of the academic literature combined with a range of mixed sources − which included reports from national as well as international agencies (e.g. NASA, WMO, UNEP) and recent articles from leading newspapers with a strong emphasis on sustainable business practices (e.g. the Guardian, The New York Times, EcoWatch, and BusinessGreen) − to find confirmation, or otherwise, of how industrial activities impact the primary global (bio-)geochemical processes. Strong evidence for each cycle was collected from a comparison of the different accounts. This article presents a reconstruction of the relevant data to derive a comprehensive understanding of each of the three cycles, their functioning, and the industrial processes that most jeopardize them.

The next step of the study was to find evidence − among indigenous communities worldwide − of traditional knowledge being utilized in the form of GRI that could represent real substitutes to existing 'modern' practices. This was accomplished in three stages. First the researchers had to track down indigenous communities and significant GRI projects worldwide. This was accomplished through an extensive web-based search which provided a total of 32 relevant cases covering a comprehensive range of sophistication, purpose, location, and way of commencing. Next, the researchers reduced the sample to those projects that had some sort of relevant connection with the geochemical processes under scrutiny. The exercise meant a further cut down to just 10 highly significant cases ranked in terms of their innovation, adoption and scalability potential. A variant of the Delphi technique (Linstone and Turoff, 1975) was used to elicit expert opinion over the relevance (to the geo-chemical cycles) and potential of each GRI.

The choice in favour of a Delphi survey was made to avoid problems of bias raised by group dynamics and to give experts the possibility of reviewing their judgements. While 40 experts were invited, the final panel comprised 18 participants, a size still deemed appropriate for the application of the Delphi method (Hasson et al. 2000). Participants were invited by e-mail and then telephoned. The invitation letter, sent a month ahead of the telephone call, explained the nature of the study and provided sufficient information for the prospective participants to self-assess their suitability (Dalkey, Brown and Cochran, 1970). While each expert had a Master degree and a minimum 5 years of expertise in either CSR or sustainable business practice, the panel was heterogeneous in terms of backgrounds, thus allowing for a range of opinions to arise. Apart from an even mix of males and females, experts also represented different age groups, countries (Italy, France, USA, and Singapore), and industries covering education, healthcare, natural resources, mining, banking, automotive, energy, construction, and agriculture.

The experts answered questionnaires in two rounds, with replies measured using a five-point Likert scale. A set of 9 open ended queries, regarding the participants' professional background and views on specific subjects, was also included in questionnaire one. The relevance of each comment was assessed by the proportion of experts that raised that specific comment and the level of agreement over it (De Franca Doria et al., 2009).

The terms innovation, adoption and scalability were so defined:

INNOVATION : referred to eco-innovation, *"the development of products and processes that contribute to sustainable development. It means applying the commercial application of knowledge to elicit direct or indirect ecological improvements" (*Lambin, 2014, p.102)*.* The interviewee was asked to judge how ecologically innovative each product/concept/idea/process was and whether it had the potential of being considered a radical "breakthrough" capable of changing established industry practices.

ADOPTION : alluded to the process of diffusion by *which "an innovation is communicated through certain channels over time among the participants of a social system"* (Rogers, 1995, p.5). The interviewee was asked to evaluate if the innovation had already been used in multiple places or what was its potential based on factors such as government regulations, comparable products already on the market, implementation costs (cost effectiveness), general attitude towards change, etc.

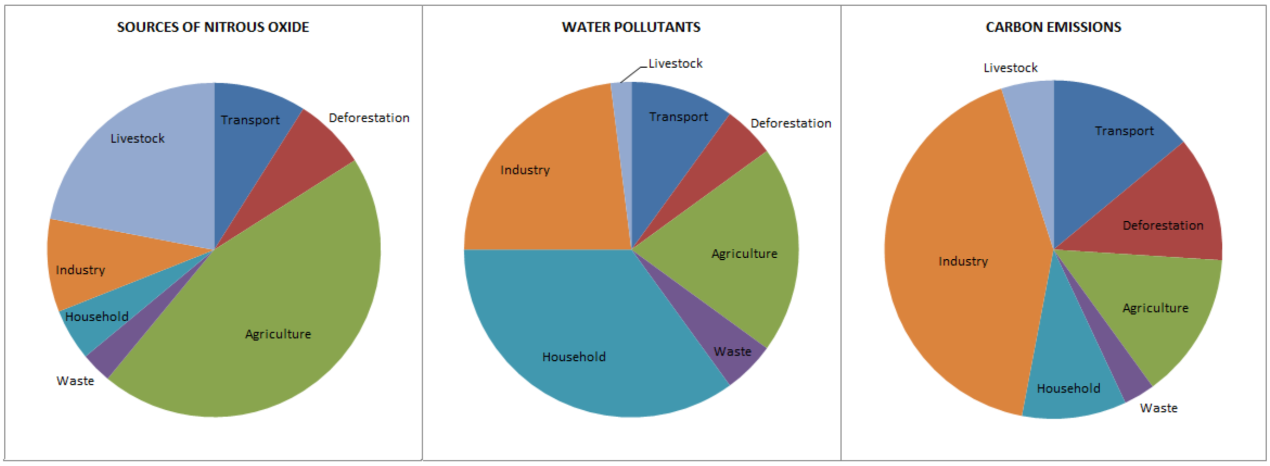
SCALABILITY : was regarded as *"the ability of a system, network, or process to handle a growing amount of work in a capable manner or its ability to be enlarged to accommodate that growth"* (Bondi, 2000, p.195). The interviewee contributed in assessing how capable each idea was of reaching a critical mass and how feasible its implementation would have been on a large scale.

After analysing all the responses, 3 cases – top ranked, based on expert opinions concerning their degree of innovation, adoption and scalability − were selected for further discussion of GRI projects that can change widely accepted industry practices in an effort to help restoring balance in geo-chemical cycles.

Results

The study gathered sufficient evidence to determine that each cycle is vitally important to maintain life on earth and is currently jeopardized by industrial processes. A cross analysis of the collected data led to the identification of the following human activities as the most damaging for each cycle.

Figure 1: The largest pollutants of the three geo-chemical cycles



As illustrated in Figure_1, agricultural activities are by far the primary cause of the increased nitrous oxide concentrations in the atmosphere. Together with livestock manure, they account for 67% of total emissions. In the case of water pollutants instead, the impact of agriculture drops to 20%, leaving the lead position of this sad classification to household consumption with an estimated 35%, followed by industry at 23%. The third diagram depicts carbon emissions, which are primarily caused by industry, in particular oil and gas production (6.4%), cement (5%), chemicals (4.1%), iron and steel (4%). Agriculture plays again a main role together with transport, deforestation, and household consumption.

With regard to traditional knowledge currently employed around the globe in ways that are environmentally sustainable, the preliminary results of this study are promising. Of the 32 cases of GRI initially encountered, 10 were selected to be the most significant for the geochemical processes. The findings are summarized below (Figure_2) as each GRI approach was given a value (on a scale 1 to 5) in connection with the geochemical processes and along the dimensions of innovation, adoption and scalability.

Figure 2: Top 10 Cases of GRI

Case #	Name / description	Variables			Connection to Cycles		
		Innovation	*Adoption*	*Scalability*	*Nitrogen*	*Water*	*Carbon*
1	SRITI - Nitrogen-free Fertilizer	3	3	3	4	3	2
2	System of Rice Intensification	3	3	4	3	4	3
3	Bamboo Architecture	4	4	3	2	3	4
4	Aboriginal Fire Management	3	3	3	2	2	3
5	Elephant Dung Paper	3	2	3	2	2	3
6	Ecuadorian Rainforest Protection	3	3	3	3	3	3
7	Recycled Solar Owens	3	3	3	2	2	3
8	Tassa Cultivation Method	3	3	3	2	3	2
9	Dry Bath	3	3	3	2	3	2
10	Recycled Hydropower Station	3	3	2	2	3	3

A short account of each of the top three ranked cases follows next to more clearly illustrate the nature of the innovations and their potential.

GRI to reduce man-made nitrogen input

Nitrogen is a scarce commodity in the natural environment and farmers have cultivated land for centuries solely relying on natural composted manure and other natural ingredients, as well as crop rotation. Their in-depth knowledge of soil ingredients coupled with the ability to predict weather patterns have enabled them to successfully continue cultivating land under extreme climatic conditions without damaging the environment.

In an attempt to curb man-made nitrogen release into the soil, an India-based GRI organization has been able to leverage Indian farmers' unique knowledge and local embeddedness to develop a range of 100% pure, natural and organic agro products that contribute to the growth of crops without disturbing the environment. The Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), was born in 1993 with the primary objectives of *"systematically documenting, disseminating and developing grassroots green innovations, providing intellectual property rights protection to grassroots innovators, working on the in situ and ex situ conservation of local biodiversity, and providing venture support to grassroots innovators"*[1].

Over the last few years, SRISTI has been particularly active in developing natural products through a dedicated laboratory. SRISTI's unique ability to design and produce high-quality herbal formulations for agricultural purposes stems from the open-source approach it takes to product development. Indeed SRISTI's core activity is the establishment of knowledge networks by connecting innovative minds and bearers of traditional knowledge with centres of excellence and innovation. As a result, SRISTI has been able to furnish its web of farmers with a vast range of environmentally-friendly products to boost crop yields at a reasonable price. These products are extracted from natural herbs and can be standardized as per the specific type of crop or soil. It is

[1] http://www.sristi.org/cms/en/about_us

because of these reasons that experts in the current study were unanimous in assessing SRISTI as a successful example of both product and process innovation.

SRISTI innovations are now well-known locally and being purchased by Indian farmers in large quantities. Even more importantly though, some of these products have been recognized as scalable solutions to overcome agricultural and related poverty issues in Africa. In October 2013, the United States Agency for International Development (USAID) has announced a partnerships to share SRISTI natural fertilizer (and other SRISTI low-cost agricultural innovations and technologies) with African countries – initially Kenya as a pilot country – to promote local sustainable development. The overall goal of this program is *“to improve agricultural productivity and food security in Africa by fostering agriculture mechanization among the small-holder farmers using Indian grassroots innovations”*.

Of course nitrogen-free fertilizers cannot be regarded as a one-size-fits-all solution for the multitude of water and soil contamination issues, yet its global spreading may play a pivotal role in reversing the detrimental effects to the environment of unsustainable cultivation methods.

GRI to use water more efficiently

Water is life! Rural smallholders have always relied on natural methods for maintaining their land healthy and fruitful. Generation after generation, these populations have fine-tuned their cultivation methods without altering their intimate relation with the surrounding environment and as such have succeeded in finding sustainable techniques to boost crop yields. No human community would ever achieve so without being deeply connected to nature dynamics and secrets. In modern times, the System of Rice Intensification (SRI) has gained the attention of the international community as it has proved to be one the most outstanding examples of agricultural innovation triggered by farmers’ ancient wisdom and connectedness to the natural environment.

SRI is the outcome of a successful collaboration between Malagasy farmers and the French Jesuit and agronomist engineer Henri de Laulanié, who in 1981 embarked on a project with the rural communities of Madagascar to find ways to overcome poverty and improve outdated cultivation practices. SRI was devised in 1983 as an organic, fully sustainable and ultra-productive crops cultivation method which can dramatically increment rural farmers’ yields whilst at the same time reducing crops’ reliance on water, seeds and chemical fertilizers. To achieve this, SRI alters altogether the way plants, soil, water and nutrients are managed by the farmer throughout the whole farming process. Essentially, SRI methodology is based on four main principles that interact with each other:

1. Early and quick plant establishment
2. Reduced plant density

3. Enrichment of soil with organic matter
4. Reduced water usage

SRI's local adoption was possible by virtue of the relentless work of SRI's founder, Fr. Laulanié, who in 1990, set up the "Association Tefy Sainaan", an indigenous non-governmental organization which aimed at spreading SRI technique across the country. Thanks to SRI, Malagasy farmers previously averaging 2 tons/hectare of produce started to average 8 tons/hectare, and such outstanding results attracted the interest of the international community, primarily in the person of American scientist and professor Norman Uphoff, then director of the Cornell International Institute for Food, Agriculture and Development at Cornell University. In the years that followed Dr. Uphoff and its staff became some of SRI's most passionate advocates setting themselves to disseminate SRI's revolutionary practices across the underdeveloped world. Thanks to the support of USAID, Uphoff initially brought SRI to Asia and given its success he extended the project to Africa and the South American continent.

Interestingly enough, what most struck Uphoff (2003) about SRI was the key role rural farmers played in bringing SRI throughout Madagascar, as an impressive example of *farmer-to-farmer extension* that supported the spreading of this innovation even despite resistance from some established institutions. And 'adoption' was also the main concept captured by interviewees in this study.

Today, according to SRI official website[2], more than 10 million farmers across 55+ countries worldwide harness SRI with remarkable results: 25-50% reduction of water use, 80-90% less seeds applied, overall cost reduction by 10-20% and increased yields of 50-100%, on average. It is perhaps for this reason that SRI's adoption is nowadays being pushed forward globally by all major development organizations. USAID, IFAD, FAO, the World Bank all encourage SRI adoption through local training, on-line best practice sharing and awareness programs.

In terms of its connection to the water cycle, SRI stands out to be an effective, low-cost and easily scalable solution to the world's pressing concern over freshwater scarcity. Throughout the vegetative growth period, in fact, only a little amount of water is applied by SRI farmers if compared to traditional crops management techniques. During flowering in particular, only a superficial layer of water is kept, followed by alternate wetting and drying before draining the whole paddy up approximately 2-3 weeks before harvest, a method known as "Alternative Wetting and Drying" (AWD).

GRI to reverse the carbon cycle

Global warming is one of the biggest environmental challenges of our time and the construction industry uses building materials which are energy-intensive to produce, and therefore induces a large amount of greenhouse gases indirectly (ABS 2001).

Bamboo is considered to be one of the most ancient building materials ever used by mankind. Traces of bamboo utilized as construction material in China date back to more than 5,000 years. The tensile strength of bamboo was initially appreciated in the development of bridges, but also other types of ancient bamboo infrastructures can be found in South East Asia, India and South America – in the territories once occupied by the Incas.

Differently from other common building materials, such as concrete or cement, bamboo is a 100% natural and renewable resource, appreciated for its rapid growth that can avoid long term depletion of natural resources (i.e. deforestation). Unlike wood, the vast majority of bamboo types used for construction purposes takes in fact just a few years to mature to the stage when it can be harvested – typically no more than six. Moreover bamboo takes little time to regenerate: the quickest genus can reach full growth within two months, growing up to one meter per day on average. Besides being 100% recyclable, having unique regenerative abilities and a rapid maturation, the prime environmental benefit of bamboo is its low environmental impact when developing the actual building material: bamboo requires only 0.02% mega-joules/m3 of the total energy required by steel, 12% of what is required by concrete and 40% of what is needed by timber.

Being one of the most ecological choices amongst building materials, bamboo has recently been re-discovered as a result of the sustainability trend in modern architecture. Major designers from China, South East Asia and Central America are exponentially incorporating bamboo in their projects, from luxury homes and holiday resorts to churches, bridges and housing compounds. Global spreading of bamboo architecture is occurring rapidly even because bamboo grows basically everywhere in the world.

Bamboo architecture was chosen by the panel of experts that participated to this study as being the GRI most beneficial for the carbon cycle and air quality. It is widely known today that construction sites deploying concrete, cement, wood, stone and silica on average produce high levels of dust. This dust is classified as PM10 – i.e. Particulate Matter less than 10 microns in diameter that can linger in the air for long periods of time and be particularly dangerous for living beings and natural ecosystems at large. Because processing bamboo creates no dust, large scale adoption of such natural material is positively encouraged and seen as a powerful force to restore the fragile balance of the carbon cycle.

[2] http://sri.cals.cornell.edu

Discussion and Future Research

This study brought to light a number of important considerations. First of all, while we acknowledge the critical environmental challenges that surround us there is still a prevalent ignorance over what the geochemical processes are and how they operate. This aspect is crucial to initiate serious change in the human-nature relationship. It is our responsibility to know how each cycle works, what are its main constituents, what human activities alter its natural process, and be able to debate over what solutions could be viable.

Connected to the need for widespread knowledge over environmental concerns is the recognition that change on a global scale can occur only through improved global green policies. Unfortunately, MNCs – entities that behave according to pure economic imperatives and prosper from a general ignorance in the wider society over environmental issues – can clearly exercise a great deal of power in delaying and restricting the scale and efficacy of such polices. Several of the experts interviewed in this study manifested the belief that GRI can help exiting the current worldwide stagnant economic situation in a concrete and farsighted manner, because living harmoniously with Nature − which is an incredibly old concept − could sadly be considered quite innovative these days (Leach et al., 2012). Even those who are sceptic about the latent power of GRI, perceive grassroots campaigns as instrumental to bring about the cultural changes necessary to really drive the implementation of green policies.

In terms of the word ‘innovation’ attached to the practices of indigenous communities, experts perceived it to be appropriate, especially in the sense of inspiring approaches that are truly sustainable because respectful and mindful of the local ecosystem. As part of this project, ongoing research is now aiming to establish what constraints would mainly impede a spreading of the GRI success from a local level to a large scale. In other words, having established thus far that GRI could hold the latent potential to *"light up the future of mankind"*, the study now seeks to determine if this could actually be accomplished by revealing thematic categories of concerns that would then need to be analyzed and weighted. It is anticipated that, given the uncertainty of the subject under investigation, due to its novelty and lack of available data, this task will still be carried out with the backing of expert opinions (Linstone and Turoff, 1975). The Delphi method will allow to synthesize different opinions while assessing uncertainty around those views and control for biases.

Conclusion

Human alterations of the geochemical processes are progressively being identified, acknowledged and measured with greater certainty and precision (Rockstrom, 2009). In the interim however, they are also exponentially gaining global scale and increasing their harmful impacts. As a result, whilst the scientific community continues to amass evidence about the necessity of a global re-examination of business-as-usual human relationships with the environment, very little is done by governments and business leaders alike to re-align human enterprises with the primary processes that sustain life on Earth.

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