The role of universities as entrepreneurship ecosystems in the era of climate change: A new theory of entrepreneurial ecology

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Abstract
Using a systems approach to biology and ecology, and combining spatial analysis with material flows analysis, this paper aims to connect entrepreneurship, climate change and university education through the generalised notion of 'ecosystems'. After discussing the inter-relationship of climate change and entrepreneurship in Asia, the paper goes on to discuss the general outlines of a theory of entrepreneurial ecology. Entrepreneurial ecology is a function of the econosphere embedded in the sociosphere, which are both embedded in the biosphere. People, planet and profits are highly intertwined. The focus is on 'entrepreneurship as if the planet mattered'. This approach leads to the analysis of a 'university-based entrepreneurship ecosystem', a powerful new construct that can facilitate a university's conversion into an entrepreneurial university focused on sustainability and climate change. The paper finishes with a discussion of 'landscape analysis' to determine the nature and scope of conversion into an entrepreneurial university.

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Climate change; entrepreneurship; universities; ecosystems; Asia

1. Introduction

My intention in this paper is to take an expansive view of the word 'ecosystem' and to discuss how a seemingly biological concept works at the level of society and at the level of the private sector, which includes business entrepreneurs. My ultimate aim is to connect the role of universities with entrepreneurs and the planet by introducing the concept of **entrepreneurial ecology**. Entrepreneurs are more related to the planet than one might on first thought imagine. As one example, I launch this paper with a status report on climate change in Asia and its relation to entrepreneurs. I then develop a promising framework to describe what we mean by 'positive entrepreneurship' and its relationship to the biosphere. I finally make the connection to the role of the university within the Triple Helix framework to climate change and entrepreneurial activity, and conclude with a call for 'landscape analysis' of a university's readiness to become an entrepreneurial university.

As I generate a new approach to knowledge, I find myself relying on a variety of approaches. In the first instance I take a **systems approach** in examining the linkages between particular environmental phenomena and the social system known as entrepreneurship. I also must rely on **biological analysis** with special focus on balance, competition, and the ecological processes of invasion, succession, and dominance, also well-known characteristics of entrepreneurial activity. One such principle is 'perturbation', which is similar to what Schumpeter calls 'creative destruction'. Another approach I find myself taking is **ecological analysis** which looks at resilience, resistance, persistence, and variability. S**patial analysis** is also a necessary characteristic of the present research in focusing on the extent and scope of physical infrastructures that influence entrepreneurship in the age of climate change. Finally, I also use **material flow analysis**, which looks at the flows of materials and energy, metabolism studies and ecological footprints that entrepreneurs leave behind and that affect the current climate change crisis.

2. Climate change entrepreneurship in Asia

Climate change is already having an impact in Asia. Every year there is a burning season in Indonesia. Across the vast archipelago, **swathes of** rainforest **are cut down and burned off by small-scale entrepreneurs** and large corporations to make way for palm oil production and other commercial activities. Thousands of Indonesians are employed and many entrepreneurial families are coming out of poverty because of the enterprise.

However, the result is an environmental disaster. Deforestation accounts for 20% of global carbon emissions, and Indonesia's own forest clearing, the largest in the world, represent almost half of the total global carbon emissions from deforestation — almost twice as much as Brazil, and more than three times Malaysia. Indonesia ranks fourth in the world in terms of total carbon emissions — behind the U.S., the European Union and China, and ahead of Brazil. Deforestation and forest degradation account for more than 83 percent of Indonesia's carbon emissions (Carbon Dioxide Information Analysis Center, 2011; World Wildlife Federation, 2011). Around the world, economic growth and entrepreneurial activity are inextricably linked to **global warming**. We are now engaged in a great war against climate change, testing whether the human race can long endure. Entrepreneurs must take a share of the responsibility for global warming, but they are also agents of change for the good.

The first decade of our century was the warmest on record (NOAA, 2010). Asia's mega-cities and densely populated areas are threatened by the rise of sea levels and surface temperatures, intensification of cyclones, extreme waves and storm surges, altered precipitation and runoff, and ocean acidification (World Bank, 2010). The combined effects of accelerating climate change, population growth, and land-use pressures are likely significantly to damage Asian ecosystems that comprise some of the richest biodiversity on Earth. Increase in global mean temperatures will produce net economic losses in many developing countries for all magnitudes of warming, and the condition is most extreme among the poorest people in these countries.

3. Some examples of how entrepreneurship and climate change are related

How do our age's great climate changes affect or are affected by entrepreneurs? Let us name the five big themes and mention how entrepreneurs are involved.

3.1 Biodiversity

Of the calamities facing entrepreneurs today, the ongoing extinction of species is probably the worst. Again, entrepreneurs are responsible for a large part of this extinction. The worst thing that can happen is not energy depletion, economic collapse, or even nuclear war. They can all be repaired within a few generations. The one process that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats (Wilson, 2002).

The immense biological diversity on our planet took billions of years to evolve and only a fraction of today's species have been identified. The Earth cannot function properly without biodiversity because a well-working ecosystem provides the environment with essential services such as purification and protection of air and water resources, soil formations, nutrient storage and recycling, stabilisation and moderation of climate, food, medicines, genetic diversity, future resources, leisure and cultural, aesthetic and intellectual benefits.

The problem is that humans have savagely damaged the Earth's biodiversity. Scientists have called this the Holocene extinction event, the ongoing mass extinction of species during the Holocene (modern – last 10 000 years) epoch. About 10 000 years ago when humans developed and spread, the extinction of species started to accelerate – dramatically so since the 1950s.

Paradoxically, the reasons for this new mass extinction is derived from human inventiveness and the **enterprising spirit** as the creation of cities and industries made previous living space uninhabitable for thousands of species. Entrepreneurship and inventions led to higher consumption of resources, which nature could not replace quickly enough. As adventurers criss-crossed the planet, they carried with them the technological means of mass destruction and the threat of introduced, alien species that disturb the balance of ecosystems. This is not what Schumpeter had in mind when he called entrepreneurs the agents of 'creative destruction'.

The greatest damage to biodiversity has likely been done by **necessity entrepreneurs** in the 'lungs of the Earth' – the rainforests. Rainforests continuously process vast quantities of carbon dioxide into oxygen and support tens of millions of species of plants, insects and animals. A bio-fuel entrepreneur who cuts down the rainforest to plant oil palms in Malaysia or Indonesia may well bring his family out of poverty, but his factory upsets the environment's equilibrium and results in a considerable loss of plant and animal species.

3.2 Population

Asia, with almost 4.0 billion people, now accounts for over 60 per cent of the world's total population, with China and India comprising 37 per cent. As of 2011 world population is estimated to be about 7 billion(U.S. Census Bureau) having risen by one billion in just 12 years. This is the shortest period of time in history for a billion person increase in the world's population. Each year, 78 million people are added to the world's population. That is the equivalent size of Egypt or Iran! This means there will be millions more entrepreneurs (Khanna, 2007). If they follow the path of other previous generations of enterprising people in developed countries, they will clear the forests, burn coal and oil, and freely scatter fertilizers and pesticides. In other words, today's and tomorrow's entrepreneurs could simply continue the trend to unsustainbility.

The nature of entrepreneurial activity is correlated to population and age characteristics and to level of development. At 22% of the total adult population counted as entrepreneurs, the larger, factor-driven economies have highest levels of entrepreneurial activity. Efficiency-driven

economies have about half that level (12.7%), while the innovation economies have a global average of 5.6% of the population counted as entrepreneurs.

Asian economies have a range of entrepreneurship levels (see Table 1). As expected, the populous, factor-driven economies (China, India, Indonesia, Philippines, and Thailand) have some of world's highest levels of entrepreneurial activity. Malaysia's level of entrepreneurial activity is much lower, in the league of South Korea and Japan, two innovation economies.

Table 1 Asia – populous and entrepreneurial

Looking more deeply at these entrepreneurs, larger, factor-driven economies tend to have more necessity entrepreneurs. Necessity entrepreneurs are those who have entered self-employment because they have no better options for work. (Opportunity entrepreneurs start businesses out of opportunity, even when they have other employment possibilities.) China, Pakistan, and Philippines have some of the highest rates of necessity entrepreneurship. An interesting anomaly is South Korea, which has a high level of necessity entrepreneurship.

Let's have a look at the impact on shifts in ageing on the entrepreneurial population, taking Japan and Malaysia as example. The 'lifecycle of entrepreneurship' follows predictable patterns. Near 60 per cent of entrepreneurs are active between ages 25-44 (see 'Global prevalence rate' in Table 2). This varies widely due to ageing or youthful populations. Both Malaysia and Japan have relatively low levels of entrepreneurial activity, yet Japan has an amazing 21.3% of its entrepreneurs in the 55-64 age group, compared to only 7-8% for Malaysia. The rate of Japan's youth entrepreneurs (1.9%) pales next to the 18.5% of the youthful population of Malaysia. In some countries, such as Japan, Australia, and the USA, the proportion of **seniorpreneurs** is growing. In Australia, a third of small business owners are over 50 years of age, and their numbers are growing faster than in many younger age cohorts (Australian Bureau of Statistics). In the USA, Americans between the ages of 55 and 64 had a one-third higher rate of entrepreneurial activity than those aged 20 to 34 (Stangler, 2009).

Table 2 Ageing population effects on entrepreneurs, comparing Malaysia and Japan

Summarising, we might say that population pressures have differing effects on entrepreneurial activity. But the most populous, factor-driven countries in Asia have some of the highest rates of entrepreneurial activity and highest rates of necessity entrepreneurship.

3.3 Water

Our planet is facing a severe water crisis. All the signs suggest that it is getting worse and will continue to do so. Though water is scarce, the crisis is actually one of water governance – caused by the ways in which we mismanage water – rather than supply. The real tragedy is the effect that the water crisis has on the everyday lives of people who are blighted by waterborne disease, who live in degraded and often dangerous environments, and who cannot get enough to eat due to water scarcity.

We examine its inter-relation with entrepreneurship. Enterprising engineers, entrepreneurs and innovators early on developed transport and storage facilities for fresh water (such as aqueducts and artificial lakes) that made it possible to have bigger cities further away from freshwater access (again, causing population pressures). Meanwhile, food and agricultural entrepreneurs created high-yielding crops and animals that consumed astonishing amounts of water.

Nonetheless, within the water crisis, there are numerous business opportunities for entrepreneurs. Investment in safe drinking water and sanitation contributes to economic growth. Numerous

water ‘policy entrepreneurs’ have are tackling this wicked problem (Hughes & McKay, 2009). For each $1 invested, the World Health Organization (WHO) estimates returns of $3 to $34, depending on the region and technology (D. Clark & Unterberger, 2007, p. 350).

It is worth noting that other water entrepreneurs are also responsible for one of the most egregiously wasteful commodities in the world today: bottled water. Bottled water is more expensive than petrol and contributes greatly to greenhouse emissions through the production of plastic bottles made from petroleum, most likely at a factory that burns fossil fuels. Also consider the emissions involved in shipping the bottles long distances (water is quite heavy), keeping them refrigerated and finally, transporting them for recycling or land-fill (yet another ecological impact). In developing economies bottled water increases the gap between the water haves and the water have-nots.

3.4 Food

Food – or lack of it – is where a changing climate will exert some of its most troublesome effects in the 21st century. Because of droughts, shifts in rainfall patterns and higher temperatures, we are likely to see major changes in where and when food is produced on the planet’s surface. The rich world looks set to reap the benefits while crop yields in the tropics, home to hundreds of millions of subsistence farmers, are likely to drop due to shifts in weather.

Food production is the most widespread enterprise in the world. Yet one in nearly seven people does not get enough food to be healthy and to lead an active life. This makes hunger and malnutrition the main risks to health worldwide –greater risks than AIDS, malaria and tuberculosis combined.

Food entrepreneurs have the potential to play a much more significant role in achieving the Millennium Development targets of growth and social justice, inasmuch as these constitute a crucial link between agriculture and industry. Entrepreneurs now need to judge a particular country’s or region’s vulnerability to climate change when making business decisions. Vulnerability is a function of exposure, sensitivity and adaptive capacity.

3.5 Energy, pollution, and climate change

The Earth has warmed about 0.85 degrees Celsius in the past 100 years. 2010 was the warmest out of 131 years of records. Where a lot of the big economies are—the United States, Western Europe, Japan—it was cool, but the world as a whole is quite warm (NASA Goddard Institute for Space Studies, 2010)

Problems such as resource depletion and overpopulation are in part the consequence of energy-intensive agriculture, pollution and other environmental problems. Highly developed entrepreneurial economies such as the three high-emitting developed countries, Australia stands out for having the highest emissions per capita, and the greatest importance of coal in both domestic energy supply and exports.

4. Toward an entrepreneurial ecology

We see that climate change, particularly the five themes of biodiversity, population, water, food and energy, have their implications for entrepreneurs. It is complex relationship. Entrepreneurs have in part caused global warming, and can also help solve it. So let us now consider in a more theoretical fashion how entrepreneurs are connected to the global ecosystem. Combining entrepreneurship with the environment, we call this new field **entrepreneurial ecology**.

Already in 1987, a group led by Norwegian Prime Minister Gros Harlem Brundtland was established by the UN's World Commission on Environment and Development (WCED) to explore the state of the world's natural systems and provide an outlook for global environmental health. The report, entitled *Our Common Future*, outlined an ominous situation wherein the world's population was living well beyond the means of the planet to replenish natural resources, absorb pollution and regulate important climatic conditions such as temperature. The long-term solution would be for human society to become *sustainable*, a term which the commission defined as: '*Meeting the needs of the present generation without compromising the ability of future generations to meet their needs*' (Brundtland & World Commission on Environment and Development., 1987; Starke, 1990). We then must consider how entrepreneurs can achieve that.

The **Brundtland Report** led to the idea that markets were both the cause and the potential solution to the sustainability puzzle. It also has led to a rethink of the concept of entrepreneurship. While climate change economics may lead us to the conclusion that environmental degradation results from the failure of markets, entrepreneurship literature argues that opportunities are inherent in market failure. Combining these two positions we see that *market failures represent opportunities for achieving profitability while simultaneously reducing environmentally degrading economic behaviours*. It also makes us look at how entrepreneurs seize the opportunities that are inherent in environmentally relevant market failures (Dean & McMullen, 2007; Grisham, 2009; Larson, 2000; Rodgers, 2010).

In the era of **industrial entrepreneurship**, from the 19th century through to the new millennium, entrepreneurs were not obliged to consider the environment in their planning and design. They focused on extraction of scarce resources with little regard to their replenishment, on global distribution without regard to distance, on rampant construction without regard to environmental consequences and on supply-chain shortcuts without regard to equity. Entrepreneurs were usually not oriented towards the prevention of negative effects, to the reversal of degradation, or to net improvement in the physical and social universes. In the age of industrial entrepreneurs, waste was not a design consideration. In the end these entrepreneurs had a negative impact on the environment and society.

Now, in the age of **sustainable entrepreneurship**, we need to think ecologically about the **biosphere** and to consider the waste embodied in products. We need to move beyond simplistic input–output analysis without regard to the consequences and to apply new concepts that take into account the living dimension of the products and services that we produce. In essence, we need to create net positive **entrepreneurial impact loops** because the biosphere is linked to the **sociosphere** and the **econosphere**. These entrepreneurial impact loops can trigger effects that can amplify the degradation or the restoration in the biosphere.

'Sustainable entrepreneurship' is a rather recent term. In their definition, Dean and McMullen emphasise market failures--"the process of discovering, evaluating, and exploiting economic opportunities that are present in market failures which detract from sustainability. . ." (Dean & McMullen, 2007). Cohen and Winn focus on opportunities. Sustainable entrepreneurship is "how opportunities to bring into existence future goods and services are discovered, created, and exploited, by whom, and with what economic, psychological, social, and environmental consequences" (Cohen & Winn, 2007). Most recently, Shepherd and Patzelt give the definition a distinctively conservationist colour: "Sustainable entrepreneurship is focused on the preservation of nature, life support, and community in the pursuit of perceived opportunities to bring into existence future products, processes, and services for gain, where gain is broadly

construed to include economic and non-economic gains to individuals, the economy, and society (Shepherd & Patzelt, 2011).

I believe that the concept of sustainable entrepreneurship draws upon three intersecting ecosystems. I use the word 'ecosystem' in its most expansive sense to mean a community of interacting organisms (be they flora and fauna, business enterprises, or social institutions) that produce or extract value one from another. They co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central organisms (J.F. Moore, 1993a; James F. Moore, 1996; Townsend, 2009).

Ecology is the study of the reciprocal relationship between organisms in their environments. This can be done at the intersection of the sociosphere, the econosphere and the biosphere (Kenneth E. Boulding, 1970). The **biosphere** consists of all of the living and non-living things on Earth. The **sociosphere** consists of all the people in a social system, all the roles they occupy and all their patterns of behaviour, all their inputs and outputs relevant to other human beings and all the organisations and groups they belong to. The **econosphere** consists primarily of the segment of the sociosphere that is organised through exchange, especially commodity exchange, where the exchange is mediated through prices. Diesendorff and Hamilton defined the econosphere as 'the total capital stock, that is, the set of all objects, people, organisations and so on, which are interesting from the point of view of the system of exchange' (Diesendorf & Hamilton, 1997).

From a material point of view, we see objects passing from the biosphere into the econosphere in the process of production, and we similarly see products passing out of the economic set as waste as their value becomes zero (Kenneth E. Boulding, 1966). Modifying Braungart, we might say:

> The biosphere and econosphere are both closed, never-ending cycles, in which materials can get reused over and over again, because they remain valuable. They contribute something valuable to either the biosphere or the econosphere. And then we ask, which sphere do its components belong to? If they belong to the biosphere then the question is whether you can give it back to nature: Is it biodegradable, does it leave only nutrients that organic systems can feed on? If it's meant for the econosphere, then the key issue is how easily the product can be dismantled and materials can be reused (Braungart).[i]

We might see these concepts in an equation:

$$EE = f\,(B + S + E)$$

The elements are arranged in order of historical sequence. If we use 'ε' to mean 'embedded in or a subset of', we get

$$EE = f\,(B \;\varepsilon\; S \;\varepsilon\; E)$$

Or, better said, the field of entrepreneurial ecology is a function of the econosphere embedded in the sociosphere, which are both embedded in the biosphere (See Figure 1)

Figure 1 Toward an entrepreneurial ecology

Entrepreneurial ecology focuses on the sustainable combination of the social and physical environment with entrepreneurship, itself part of the economic sphere of activity. The central idea is that there is a parallel between the natural system and the entrepreneurial system. Entrepreneurial ecology shifts the entrepreneurial process from linear (open loop) systems, in

which resource and capital investments move through the system to become waste, to a closed loop system where wastes become inputs for new processes.

Figure 2 Impact Loops of Entrepreneurs with the Biosphere

In this model (Figure 2), we see how are Earth, people and the economy are connected. The flow of energy and materials taken from and returned to the biosphere is called *throughput*. For the most part this is an uneven exchange. The figure shows that unsustainable entrepreneurs extract huge resources thus depleting Earth (negative sign). Normally they return them as waste in devalued form.

Sustainable entrepreneurship means returning resources in value-added form (dotted line to the positive sign). All three spheres share a struggle for survival. They extract a constant source of energy and materials to maintain their self-organised state of a rate of low degradation. Otherwise they would run down to the point of zero energy. In physics we call the degradation **entropy** and the state of zero energy is called **inertia**. All three systems must engage in a continuous process of want-satisfying. This provisioning involves identifying, extracting and processing of value. The problem is that entrepreneurs of the past have devalued this process with wanton extraction (Schroedinger, 1967; Underwood, 1998).

Another thing that unites the three spheres is the way they process materials. In the biosphere, natural processes create biomass, which is the mass of all living organisms and dead matter such as wood, leaves and other organic matter. Assuming no human intervention, these processes are optimised regarding the use of energy and materials. Redundancy enables the biosphere to deal with changes, in this case the degradation of materials. There are repair mechanisms that reverse degradation. If too many materials or processes are degraded, this leads to **mutational breakdown**. Darwin has shown that there are 'repair kits' to correct for such errors. There is a huge amount of diversity created by variation and natural selection. Species appear and disappear in the course of evolution. Nonetheless, their superior evolved characteristics may remain. This enables the biosphere to react to changes. It creates a robustness that can survive major disasters.

Doesn't this sound like the economy? Indeed, the econosphere has analogous repair mechanisms. Let us take a group of industrial processes as an organism of sorts. Then marketplace also has a process of 'Darwinian' natural selection in the services and products that it produces. The econosphere has memory. It can revive old processes such as windmills. It copes with degradation through repair mechanisms. Errors that occur at reproduction are like a failed start-up business. It has various 'repair kits' such as law enforcement, environmental policy and education.

Up until the present, some entrepreneurs have greatly undervalued the biodiversity, ecosystems and means of survival that nature provides, including resources such as energy, water, free space and materials. We have not valued nature as a living ecosystem. Rather than adding value to living materials we only aim to reduce (for example, through recycling) the quantity of dead resources. In the end, society has to implement complex regulations, incentives and tools to penalise entrepreneurs or to encourage them to reduce waste and mitigate the effects of **negative entrepreneurship**. What **positive entrepreneurship** can do is generate positive impacts through value adding and eliminating designed waste, duplication, disposability, planned obsolescence and wasteful end purposes. Positive entrepreneurs create net positive-impact loop systems and innovations that create levers for biophysical improvements and social transformation.

5. The ecosystem of the entrepreneurial university

At the top of this paper I mentioned that I would be concentrating on a particularly instance of ecosystems, namely The University. Where does the university fit in? The themes are connected through the concept of 'ecosystem'.

Let me briefly describe the emergence of the concept 'university-based entrepreneurship ecosystem'.

By some counts, eighty percent of leading new industries derive their knowledge base from university-based research (Atkinson & Pelfrey, 2010). This contribution to economic and social development lies at the core of the concept of the entrepreneurial university. Not only do universities have a commitment to integrating sustainability within their curricula and operations, they are on the forefront of producing academic research on sustainability

Universities around the world are increasingly adding a new role to their traditional primary roles as teachers and researchers. *This third role is one that that consciously contributes to the development of the society and the economy* (Etzkowitz, 2004; Etzkowitz et al., 2000; Etzkowitz & Leydesdorff, 2000; Etzkowitz et al., 2008). Around the world, more than sixty universities (own count) have adopted this 'university-wide entrepreneurship education' approach.[ii] The literature on the entrepreneurial university has grown to be a broad and deep body of knowledge in the last twenty years.[iii]

5.1 The emergence of the concept of entrepreneurial university

A well-known early work is Burton Clark's (1998) effort to categorise what is meant by entrepreneurial university as well as to outline the internal and external processes through which it came to being. Clark undertook a series of case studies on what were regarded as exemplar institutions. These cases were used to derive inductively what are described as five 'pathways of transformation' to create entrepreneurial universities. They are a strengthened steering core; an expanded developmental periphery; a diversified funding base; a stimulated academic heartland; and an integrated entrepreneurial culture. His main finding was that in order for a university to be entrepreneurial, the organisational culture must facilitate entrepreneurship in a combined top-down bottom-up fashion, including a high tolerance for risk-taking and high threshold for failure. In his subsequent book, Clark (2004) stressed that transforming into an entrepreneurial university requires the simultaneous presence of a number of (sometimes contradictory) factors that taken together signify that the status quo is to change continuously.

As Thorp and Goldstein (2010) wrote in *Engines of Innovation: The Entrepreneurial University in the 21st Century*, 'this moment in history makes unlocking the innovative potential of our research universities a national imperative, and an entrepreneurial mindset is key to achieving this objective'. Thorp and Buckstein believe that an entrepreneurial university is not a trade school designed to train students how to start or run a commercial activity. It does not mean that it necessarily adopts commercial methods and values. It is not an assembly line creating new companies. Finally, it is not economic development authorities. Economic development is only part of its mission.

There have developed three broad schools of thought in relation to the entrepreneurial university.

5.2 Universities and corporate entrepreneurship

The first school of thought, along the lines of Clark, is to view the *entrepreneurial university as an organisational form* (for example, Cooke & Leydesdorff, 2006; H. Etzkowitz, 2003; Etzkowitz, 2004). This is closely related to the 'corporate entrepreneurship' literature as the basis for developing entrepreneurial universities, ideas that have their roots in commercial organisations.[iv]

Using the principles of corporate entrepreneurship to create entrepreneurial universities has been widely reported in the literature. The university is regarded as a particular organisational context on an entrepreneurial institution (Kevin Hindle, 2010). The view here is that the university is a form of 'collective entrepreneurship'. Entrepreneurship need not be carried out by 'rugged pioneer' self-maximising, ideal-type, individualistic entrepreneurs; it can often be carried out collectively, as communities that share the risks and rewards associated with the discovery and exploitation of new businesses (Schumpeter, 1976, p. 260) (Reich, 1999, p. 24).

5.3 Universities and commercialisation

The second body of literature takes a narrower view and *equates university entrepreneurship to the commercialisation of science and knowledge* (O'Shea, et al., 2007; M. Shattock, 2000; Siegel, et al., 2007; Swinburne University of Technology, 2000; Treasury, 2004). This refers to the context of spin-outs and patent licensing from 'research intensive' universities. Swinburne University's original concept (2000, p. 5) was typical of this approach: 'The entrepreneurial university is one which responds to declining government operating rants by actively seeking other forms of funding'. Serious problems arise with this narrow interpretation when one sees that only a small portion of university activity could possibly lead to spin-offs/patent licences. For some institutions, there is no relevant activity at all. This view overlooks the wide influence that universities can have on regional economic development beyond the 'mere' commercialisation of science (Bramwell & Wolfe, 2008; Charles, 2006; Coenen, 2007; Feng, 2009; C. Gunasekara, 2006; CS Gunasekara, 2011; Huggins & Johnston, 2009; Johnston, 2010; LIN & CHEN, 2010). Particularly amongst academics, there is a widespread perspective that the 'start-a-firm activity' may be valuable to creating new firms and jobs in society but is of limited academic value (K. Hindle, 2007) (Bager, 2011).

6. Universities and the Triple Helix

A third school of thought—one which the present author uses--enters the metaphoric realm of theory. It is known variously as either the *entrepreneurial ecosystem* or *the Triple Helix approach*. Both cases provide a 'framework [that] allows private sector and social actors, often with different traditions and motivations, and of different sizes and areas of influence to act together and create wealth in a symbiotic relationship' (Prahalad, 2010, p. 91). Let us examine these two approaches.

Just as an ecosystem in the physical environment is a balanced, interdependent quasi-stable community of organisms living together, so its industrial analogue is the 'business ecosystem', which is a 'balanced, quasi-stable collection of interdependent firms belonging to the same economy' (Allenby, Richards, & National Academy of Engineering, 1994, p. 36). Business ecosystems condense out of the

original swirl of capital, customer interest, and talent generated by a new innovation, just as successful species spring from the natural resources of sunlight, water, and soil nutrients (J.F. Moore, 1993b).

Similarly, the word '**metabolism**' usually refers to the internal processes of a living organism that are necessary for the maintenance of life. Using a biological analogy, industrial metabolism (IM) was first proposed by Ayres (1994; Ayres & Ayres, 1996)as 'the whole integrated collection of physical processes that convert raw materials and energy, plus labour, into finished products and wastes'. Just like a living organism, industrial metabolism deals with the integration of physical processes that convert raw material, energy, and labour into finished products and wastes.

Combining ecosystem metaphor with entrepreneurship, we can refer to geographical environments that influence an entire group of actors engaged in entrepreneurial activity and potentially the economy as a whole (Cohen, 2006). The importance of how these actors interact is central to this view (Villasana, 2011). Dunn (2005) in MIT's *Technology Review* may have been the first to use the term 'entrepreneurship ecosystem'. Neck et al. (2004) represents this view of seeing new venture creation as an entrepreneurial system, especially through its communication networks, physical infrastructure and community culture. According to Isenberg, entrepreneurs are most successful when they have access to the human, financial and professional resources they need, and operate in an environment in which policies encourage and safeguard entrepreneurs. This network is described as the 'entrepreneurship ecosystem' (Isenberg, 2010). Aulet (2008) describes the relevant components of a successful innovation ecosystem as individuals, organisations and resources, specifically including government, demand, invention, funding, infrastructure, entrepreneurs and culture.

Etzkowitz (2004) believes that universities are passing from revolution to revolution. Originally, since the Middle Ages, universities were dedicated to teaching and conservation of knowledge. This meant that the 'first academic revolution' added research as a major mission was added to teaching. The second revolution sees the academy taking on another mission to promote economic and social development, as he says, the role of 'regional innovation organiser' (Etzkowitz, et al., 2000). Under the Triple Helix Model (THM), proposed by Etzkowitz and Leydesdorff (1998), the university is part of a reciprocal relationship with industry and government. This model emphasizes the regional level in which each actor, maintaining the independence of its own sphere, enhances the performance of the other. A dynamic triple helix implies different degrees of independence and interdependence in which one sphere may play the role of another. For example, the university may play the role of industry by forming firms (spin-offs or start-ups) and transfer technology, but may never become a firm in the whole sense (Etzkowitz, et al., 2008).

The THM views the university as the main actor in new knowledge production (Laredo, 2007), and its new mission as 'entrepreneurial'. That is, the traditional pursuit of knowledge is 'combined with and reinterpreted as compatible with commercially oriented research (Etzkowitz, Webster, & Healey, 1998). Here, research universities experience a growing demand to transfer knowledge not only to industry, but also through government to society (Cooke & Leydesdorff, 2006). In sum, THM acknowledges that the "third mission" of the university is to contribute to

economic and social development through transferring technology (Etzkowitz, et al., 2000). In a knowledge-based economy, the university becomes a key element of the innovation system both as human capital provider and seed-bed of new firms. Three institutional spheres--public, private and academic--that formerly operated at arms length in *laissez faire* societies are increasingly interwoven with a spiral pattern of linkages emerging at various stages of the innovation and industrial policy-making processes.

6.1 University-Based Entrepreneurship Ecosystem

This confluence has latterly been called a '**University-Based Entrepreneurship Ecosystem**' (U-BEE) (Fetters, et al., 2010).

The organisms in this ecosystem are known as stakeholders, including government, schools, universities, private sector, family businesses, investors, banks, entrepreneurs, social leaders, research centres, military, labour representatives, students, lawyers, cooperatives, communes, multinationals, private foundations, international aid agencies, and the like .

Fetter et al. examined six universities that have adopted this approach and constructed a matrix of components that can make up a University-Based Ecosystem of Enterprise (U-BEE). These include: senior leadership sponsorship; strategic vision; entrepreneurship academic division; entrepreneurship as subject; entrepreneurship work integrated learning; entrepreneurship concentration or minor; entrepreneurship integrated in core requirements; entrepreneurship courses for non-business majors; ongoing curriculum innovation, development of innovative pedagogies and teaching materials; student-led initiatives / progressive education; alumni incorporated as speakers and guest academics; extension educating in corporate / social / family space; entrepreneurship research centre with funded research program that crosses disciplinary boundaries; entrepreneurship activities centre; networking events; entrepreneurship student club(s); business plan competitions; student venture investment fund; links to angel and venture funds; business incubator; social incubator; web portal; student residence floor; technology transfer office; entrepreneurship endowed chair; and a centre or program endowment. Even great entrepreneurial universities such as University of Southern California or National University of Singapore do not have all of these elements.

U-BEE refers to the elements of a particular university's environment that help or hinder a person from developing his or her enterprising personality and launch a successful social or business venture. The components of the ecosystem are any entity that has an interest, actually or potentially, in there being more entrepreneurship in the region. Entrepreneurship stakeholders may include government, schools, universities, private sector, family businesses, investors, banks, entrepreneurs, social leaders, research centres, military, labour representatives, students, lawyers, cooperatives, communes, multinationals, private foundations, international aid agencies, and the like. This approach allows us empirically to examine which elements are present and which are not because isolated and uncoordinated elements in the ecosystem are rarely sufficient to sustain the ecosystem. In universities that have extensive amounts of entrepreneurship, many of the ecosystem elements are strong and typically have evolved more or less simultaneously.

7. The need for landscape analysis

Taking the environmental metaphor one step further, we can speak about a 'landscape analysis' of a university's preparedness to become an entrepreneurial university. Landscape analysis

involves the assessment of features of an entrepreneurial landscape in relation to any of a group of factors such as the physical spaces where entrepreneurs interact; the alignment of institutional objectives; access to university resources like laboratories, researchers and knowledge transfer; market-driven orientation for research; participation of the business community; participation of venture capital firms; active participation of state and federal government in creating the necessary legal framework and assigning economic resources to job creation and the establishment of new companies. An entrepreneurial landscape may be considered as an area larger than a business enterprise but smaller than a regional economy. As such, the scope of landscape analysis may encompass multiple disciplines, but the questions asked are typically at a scale that is relevant to individuals or groups of entrepreneurial agents.

Landscapes bridge the gap between micro-level and macro-level entrepreneurial activity. The scaling of entrepreneurship and its potential effects on economic and social well-being is a key problem in current landscape analysis research. Landscape analysis involves the evaluation of entrepreneurship patterns and linkage of patterns to underlying processes. How might entrepreneurial activity change in areas of high or low factor conditions such as entrepreneurship education, finance, culture, physical infrastructure, intellectual property rights, and economic openness?

How to conduct a landscape analysis of a university's readiness to become an entrepreneurial university? Australian entrepreneurship professor Kevin Hindle (Kevin Hindle, 2010; 2012 (Forthcoming)) outlines the eleven stages of such a landscape analysis.

Figure 3 Hindle's Bridge: A diagnostic tool for assessing entrepreneurial readiness

1. Describe and assess baseline physical resources: How big is the university's land and human footprint? What are its physical endowments? Which are controlled by the university and which controlled by external parties?
2. Describe and assess baseline human resources: Demographics and human capital demographic classification of the university's staff, students, researchers and teachers. Once a demographic tabulation is made, the profile it produces can be cross-tabulated with the skills inventory compiled under the heading of 'human capital'.
3. Describe and assess world-views and social networks overt listing and comparison of the different world-views that are of crucial significance to relevant individuals and groups within the community, taking special note of any strongly conflicting perspectives.
4. Describe and assess governance mechanisms and the nature and role of institutions / Define the governance structures and institutions which operate within the community and articulate the positive and negative effects that these rules and institutions are likely to have upon the conduct of the entrepreneurial initiative or initiatives under consideration. List all the relevant formal institutions that could affect the entrepreneurial process under consideration and describe the ways in which these institutions, alone or in combination, might influence the contemplated entrepreneurial process.
5. Describe and assess the property rights system and capital management regimes.
6. Describe and assess the mandates and possibilities of boundary Spanning / The first question is: what factors in the lists so far compiled may be regarded as positive forces (supporters and drivers) for the contemplated entrepreneurial imitative and what factors are negative (barriers and brakes) likely to impede the ability to perform this?

7. Define community context through synthesis of the six components / Action mandate. Use all previous data gathering and analysis, to provide a summary definition of the community as a context for the proposed entrepreneurial initiative.
8. Articulate any required facilitation initiatives and programmes.
9. Indicate any task specific tools required as fundamental prerequisites
10. Provide a contextualised summary of the required entrepreneurial Process / salient features of the diagnosis into a succinct overall re-definition of the previously a-contextual entrepreneurial process so that it takes overt account of the contextual issues likely to be most critical to success.
11. Articulate the implications for relevant stakeholders

8. Summary

My intention in this paper is to take an expansive view of the word 'ecosystem' and to discuss how a seemingly biological concept works at the level of society and at the level of the private sector, including entrepreneurs. My ultimate aim is to connect universities with entrepreneurs and the planet by introducing the concept of entrepreneurial ecology.

I began by discussing climate change in Asia and how climate change affects or are affected by entrepreneurs. I briefly examined how the top five climate change challenges are inter-related with entrepreneurship. Entrepreneurs are responsible for a large part of the loss in bio-diversity. Global population shifts are also associated with levels and nature of entrepreneurial activity. Enterprising individuals have altered freshwater access. Food production is the most widespread entrepreneurial activity in the world. Problems such as resource depletion and overpopulation are in part the consequence of energy-intensive agriculture, pollution and other environmental problems.

Combining entrepreneurship with the environment, we see new field emerging, which I call entrepreneurial ecology. In the era of industrial entrepreneurship, from the 19th century through to the new millennium, entrepreneurs were not obliged to consider the environment in their planning and design. Now, in the age of sustainable entrepreneurship, we need to think ecologically about the biosphere. We need to create net positive entrepreneurial impact loops because the biosphere is linked to the sociosphere and the econosphere. Entrepreneurial ecology focuses on the sustainable combination of the social and physical environment with entrepreneurship.

Next, I take the ecosystem metaphor one step further and concentrate on how physical and social environments can influence an entire group of actors engaged in entrepreneurial activity and potentially the economy as a whole. 'University-Based Entrepreneurship Ecosystem' (U-BEE) refers to the elements of a particular university's environment that help or hinder the emergence of an entrepreneurial university.

Finally, I use the metaphor of 'landscape analysis' to assess a university's preparedness to become an entrepreneurial university. Landscapes bridge the gap between micro-level and macro-level entrepreneurial activity.

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Table 1 Asia – populous and entrepreneurial

Popula-tion Rank	Country	Population (2010)	Level of development according to Global Competitiveness Index	Total entrepre-neurial activity, % of adults	Necessity entrepre-neurs as % of total entrepreneurs	GEM Survey Year
1	China	1,330,141,295	Efficiency	14.4%	42%	(2010)
2	India	1,173,108,018	Factor	11.5%	22%	(2008)
4	Indonesia	242,968,342	Factor	19.3%	14%	(2006)
6	Pakistan	177,276,594	Factor	9.1%	41%	(2010)
7	Bangladesh	158,065,841	Factor	na	na	(2011)
10	Japan	126,804,433	Innovation	3.3%	36	(2010)
12	Philippines	99,900,177	Factor	20.4%	46%	(2006)
13	Vietnam	89,571,130	Factor	na	na	(2012)
20	Thailand	66,404,688	Efficiency	26.9%	29%	(2007)
26	Korea, South	48,636,068	Innovation	6.6%	39%	(2010)
46	Malaysia	26,160,256	Efficiency	5%	12%	(2010)

Adapted from 'World's 50 Most Populous Countries: 2010' — http://www.infoplease.com/world/statistics/most-populous-countries.html#ixzz1d5F2HXOL;

Global Entrepreneurship Monitor, http://www.gemconsortium.org/about.aspx?page=gem_datasets

Table 2 Ageing population effects on entrepreneurs, comparing Malaysia and Japan

Country		Malaysia	Japan	Global prevalence rate of entrepreneurial activity of adults by age group
Population of country		28,334,135	127,170,110	
Total Entrepreneurial Activity		5.0%	3.3%	
Entrepreneurs ages 18-64	Total number of entrepreneurs	1,416,707	4,196,614	
Entrepreneurs ages 18-24	% of entrepreneurs	18.5%	12.6%	15.7%
	Total number of entrepreneurs	262,091	530,032	
Entrepreneurs ages 25-34	% of entrepreneurs	33.6%	26.4%	32.7%
	Total number of entrepreneurs	476,013	1,107,486	
Entrepreneurs ages 35-44	% of entrepreneurs	22.4%	18.9%	26.4%
	Total number of entrepreneurs	317,342	791,481	
Entrepreneurs ages 45-54	% of entrepreneurs	18.5%	20.9%	17.2%
	Total number of entrepreneurs	262,091	875,414	
Entrepreneurs ages 55-64	% of entrepreneurs	7.0%	21.3%	8.0%
	Total number of entrepreneurs	99,028	892,200	

Figure 1 Toward an entrepreneurial ecology

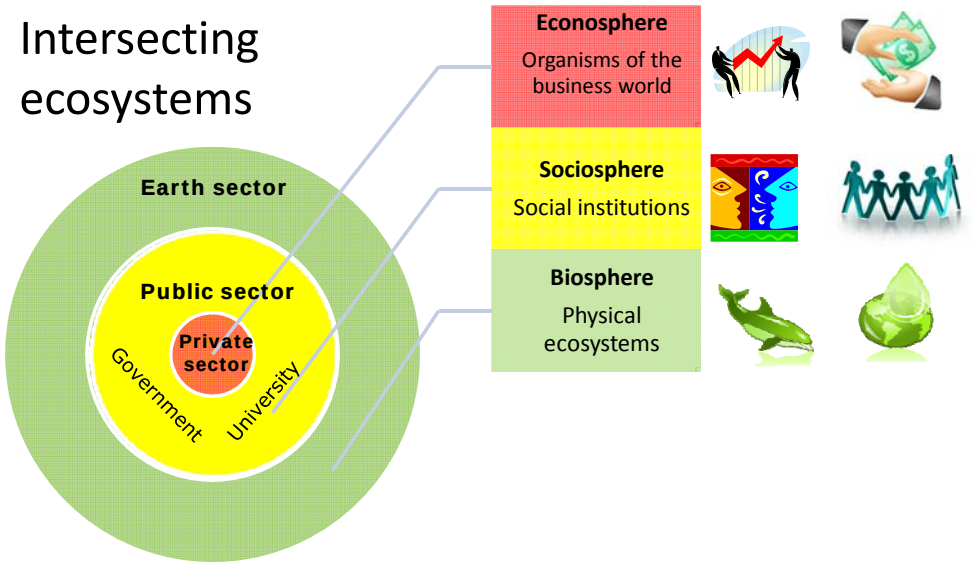


Figure 2 Impact Loops of Entrepreneurs with the Biosphere

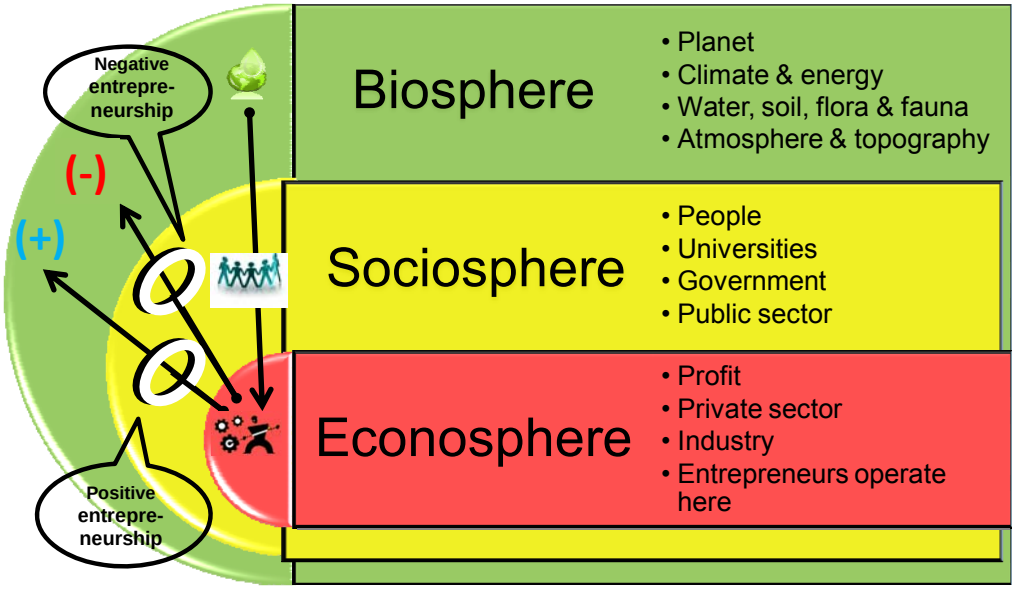
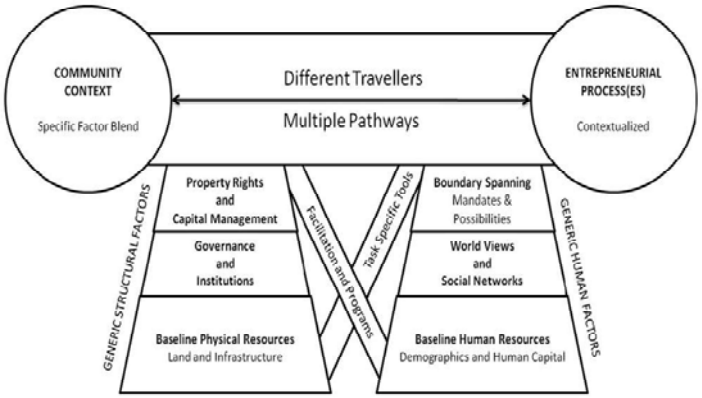


Figure 3 Hindle's Bridge: A diagnostic tool for assessing entrepreneurial readiness



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[i] I have taken the liberty of substituting the word 'technosphere' with 'econosphere' because I believe Baumgartner meant the same thing.

[ii] Notable among them are: Babson College; Bergische University Wuppertal ; EM Lyon Business School; Jönköping University, Sweden ; Leon Kozminski Academy of Entrepreneurship and Management, Poland; National University of Singapore (NUS), Singapore ; Pontifical Catholic University of Rio de Janeiro ; Stanford University; Strossmayer University of Osijek, Croatia ; Technical University of Munich (TUM), Germany ; Technologico de Monterrey, Mexico; University of Cambridge; University of Cape Town, South Africa ; University of North Carolina; University of Southern California; University of Texas at Austin

[iii] See for example (Armbruster, 2008; Atkinson & Pelfrey, 2010; Barsony, 2003; Berggren, 2011; Blenker, Dreisler, Faergemann, & Kjeldsen, 2008; Charney & Libecap, 2000; B.R. Clark, 1998; Conway, 2010; Culkin, 2009; Culkin & Mallick, 2011; Currie, 2002; H. Etzkowitz, 2003; Henry Etzkowitz, 2003; Etzkowitz, 2004, 2010; Etzkowitz, et al., 2000; Etzkowitz & Chunyan, 2006; Etzkowitz, et al., 2008; Etzkowitz & Viale, 2010; Etzkowitz & Zhou, 2008; Feldman et al., 2009; Fetters, Greene, Rice, & Butler, 2010; Allan Gibb, 2007; A. Gibb & Hannon, 2006; A. Gibb, Haskins, Education, & Robertson, 2009; Gjerding, Wilderom, Cameron, Taylor, & Scheunert, 2006; Guerrero-Cano, Kirby, & Urbano, 2006; Guerrero & Urbano, 2011; Hakala, 2009; Hancock, 2011; Harrison & Leitch, 2010; Hellstrom, 2007; K. Hindle, 2007; Jacob, Lundqvist, & Hellsmark, 2003; Kirby, 2006; Kyro & Ristimaki, 2008; Lam, 2010; Lazzeroni & Piccaluga, 2003; Lehrer, Nell, & Gärber, 2009; Lüthje & Franke, 2002; Mets, 2010; Mohrman, Ma, & Baker, 2008; Nelles & Vorley, 2010; O'Shea, Allen, Morse, O'Gorman, & Roche, 2007; Philpott, Dooley, O'Reilly, & Lupton, 2011; Rae, Gee, & Moon, 2009; Rice, Fetters, & Greene, 2010; Michael Shattock, 2010; Siegel, Wright, & Lockett, 2007; H. Thorp & B. Goldstein, 2010; University of North Carolina, 2010; Vestergaard, 2007; Walsh-Covarrubias, 2010; Wasser, 1990; Weaver, D'Intino, Miller, & Schoen, 2009; West, Gatewood, & Shaver, 2009; William Todorovic, McNaughton, & Guild, 2011; Wong, Ho, & Singh, 2007; Woollard, 2010; Woollard, Zhang, & Jones, 2007)

[iv] See (Burns, 2008; Chen, Zhu, & Anquan, 2005; Chung & Gibbons, 1997; Covin & Kuratko, 2010; Ireland, Covin, & Kuratko, 2009; D.F. Kuratko, 2007; Donald F. Kuratko, Hornsby, & Goldsby, 2004; D. P. Kuratko & Goldsby, 2004; Michael H. Morris & Davis, 1994; M.H. Morris, Kuratko, & Covin, 2008, 2010; Phan, Wright, Ucbasaran, & Tan, 2009; Wolcott & Lippitz, 2007; S. Zahra, 1991; S. A. Zahra, Nielsen, & Bogner, 1999)