

DESPITE HARDING'S INFAMOUS
'TRAGEDY OF THE COMMONS',
COMMUNITY MANAGEMENT
OF RESOURCES IS A PERFECTLY REASONABLE WAY OF MANAGING RESOURCES
A TRANS-DISCIPLINARY PERSPECTIVE

Published by



International – Curricula Educators Association

A shared responsibility with
ICEA Academic Resources UK LTD
Published online for open access February 2016
Copyrights© 1 October 2015

Sustainability Cybernetics Journal

Volume 1 | Issue1 | February 2016

Introduction

Two pieces of work have influenced economics - as we know it today, to the greatest extent. The two of them have circulated to the highest possible level among academics (and non-academics), even after being heavily critiqued. They were, both, often misrepresented, misinterpreted and thus misjudged by many scholars and economist, as they spontaneously interlinked. One is Hardin's (1968) the "*Tragedy of the Commons*" and the other is Darwin's "survival of the fittest" paradigm, explained in his famous book the *Origins of Species* (1871) and the *Descent of Man*. In this essay I explore the historic links between the two concepts and the rationale of their interlinkage, while elaborating their influence on Economics from a transdisciplinary perspective. I will elaborate that in spite of the "*tragedy of the commons*" and the often misrepresented "*survival of the fittest*" - underpinning neo-classicism, human societies have managed to create innovative approaches to cooperate and manage common resources efficiently, that we have become one of the most successful species on earth – so far (see IUCN red list on *Homo sapiens*), with a prospect to maintain a sustainable (and prosperous) future.

"*The Tragedy of the Commons*," published in 1968 has justifiably been labelled as a seminal work, as it was *reprinted over fifty times; the "tragedy" of potential destruction of any openly-shared resource(s)* (Jane and Cox, 1985). A short story of some English medieval herdsmen sharing a grazing spot, where each of them is "normally expected" to want to add more sheep/cows limitlessly, regardless of the long-term common good. The number of sheep/cows is only kept down by conflict, diseases and war, but when the long sought "stability" arrives, the grazing common area fails to provide for all the additional successful sheep/cows, then eventually becomes over-grazed and ruined for all (Hardin, 1968).

Hardin's concerns can hardly be dismissed as improbable. So often resources come to depletion by over exploitation. Some have criticised Hardin, though, for the "historic

inaccuracy” (see Jane and Cox, 1985) and some claimed the fallacy of the “tragedy” arising from the over ‘politicisation’ of the story so as to promote privatisation and justify the levy of extra taxes (Lee et al., 2012), both underpinning neo-liberalism and free-market trends, but not many – to my knowledge, have challenged the assumption that selfish behaviour being unperceptive of others and the environment, is actually “rational”!

At this point, it is not hard to see how Hardin’s proposed solutions - to conserve the commons, while reserving its surroundings, connect to neo-liberalism or Adam Smith’s “the Invisible Hand” (cited in Lejano & De Castro, 2014). The mysterious “hand” capable of maintaining the free market in a state of equilibrium based on game-theory speculations, among which is the “prisoner’s dilemma”. In game theories two players are invited to make critical decisions, without having (or having been allowed - in this context) to communicate with each other. They have to depend on weighing probabilities of success to maximise one’s own good based on expecting the responses of the other player. In a free-market context this mean that market players, don’t need to communicate among themselves, but act solely upon the publicly available information on prices and business-plans of the opponents. The Invisible Hand theory, in short, is that when individuals act to maximise their own benefit, the wealth of the whole economy subsequently (and amazingly) increases. It is worthy to note here that the Invisible Hand theory, requires setting the right environment for the free market by privatisation and enforcing the “right” policies/legislations. (Lejano & De Castro, 2014)

To highlight the interlinkage between the “survival of the fittest” (or the so called “Social Darwinism”) and the *tragedy of the commons* (in its obvious link to neo-liberalism), one has to ask a question: How did Hardin’s account of such selfish behaviour - inconsiderate of neighbours or the environment, pass as “rational”, or simply “expected”? In other words: At what point in history has selfishness become a standard human behaviour, on the way to the common good?¹ Here, the inconspicuous link between Hardin’s socio-economic perspective and the so called “social Darwinism”

¹ This question, as the discourse will show, has no real answer! It seems that this kind of purely selfish ‘rationality’ has crawled - through misinterpretation, to the background of economy, socio-biology and social sciences, and just stayed there.

begins to glow! Although neo-liberalism has not been frankly associated with Social Darwinism, it was the American liberal utilitarian Herbert Spencer, who first established the “survival of the fittest” natural fallacy, by trading heavily in the evolution paradigm, so as to explain how the liberal utilitarian logic of justice justifies. (Stanford Encyclopedia).

Today, those three interlinked concepts may be challenged in more than one way as they disregard the highly sophisticated communicative structures of human civilisation. What Hardin introduced as rational has hardly been considered rational throughout modern history. The *tragedy of the commons* introduces a very rather static perspective of nature, natural resources and human societies. Almost too simplistic in defining the limits of our resources as it disregards the role of cooperation, effective communication and collective intelligence (see Foerster, 1979; Wilson & Wilson, 2007; Schwaninger, 2004). Moreover, the concepts as commonly perceived, disregard the human capacity of observation (see Glasersfeld, 1980) which has opened a windows of infinite energy supply and thus potentially infinite (human) life-organisation capacity, as foreshadowed by Darwin (1849-1999) himself and as will be explained hereinafter.

Spirituality, religion and justice systems

Nature² has been said to work for the best of each "creature" (using Darwin's words). “She” (naturally) destroys the maladaptive traits and preserves the adaptive ones, leading to the continuation and amazing complexification of life. Individual organisms (including micro-organisms) often produce costly common goods and are preferential on whom would benefit from them. Most organisms would help relatives because that is likely to perpetuate the kindness traits, otherwise, the common good would get plundered by “cheats” and “free-riders” who would not (by definition) contribute to the perpetuation of the genome/kind/species of the donor³. This discrimination in itself ensures a sort of "justice" which often benefit the whole community/species/kind. The success of any species is tied up, surprisingly, to such

² Nature in a Darwinian sense is the aggregate of natural laws and process addressed as a singularity (Darwin, 1849-1871;1999)

³ This does not imply pre-determinism (see Park et al, 2006)

discriminatory kindness. West et al (2006), explains an interesting experiment conducted on microorganisms communicating for the purpose of cooperation - necessary to perform several essential multicellular processes such as nutrient acquisition and dispersal. Some individuals in this bacteria groups namely *Pseudomonas aeruginosa* produce a common good for the benefit of the group (siderophores scavenging iron in this example), however, such production might be open to plunder by cheats within the same group, who don't produce such beneficial organic products but who would use the plundered siderophores to out-number the altruistic productive (hard-working) individuals. When selfish individuals out-number the altruistic ones beyond the capacity of the patch/colony to provide nutrition and other essential organic products, the group inevitably perishes. West et al (2006), then explain how the altruistic bacteria uses two mechanisms to insure the siderophores will be utilised exclusively by relatives (who according to the Kin selection theory, must be carrying the same altruistic traits and are thus likely to keep producing beneficial products for the survival of the colony), which may in turn, result in a potential inclusive fitness for the whole group. Those two mechanisms are the limited dispersal", and –kin discrimination (the repression of competition). Kin recognition and kin discrimination in this example occur beyond the perception of the individuals, while in higher organisms occur consciously, through the sensory system (based on physical characteristics such as the smell, features or location, as relatives tend to live in the same vicinity) (West et al, 2006).

The success of kin-discrimination would naturally lead to the growth in number of the connected group and a gradual advancement of the organisation (Darwin, 1849; 1854-1999), leading in turn to more growth in productive population (inclusive fitness). Now! In case of humans, this has to happen the other way round. Humans tend to think of the *purpose* of their actions and are capable of weighing possibilities of contextual and situational factors, relating them to past experience and future probabilities (and opportunities). This is called the faculty of "*steermanship*", strategic planning, (Weiner, 1948) or Cybernetics.

So while we are (hopefully) doing the same thing - in principle, the results are pretty much different. Humans' contribution to the welfare of their community do not always

take the form of economic activities or biological production. How often do we exchange materialistic/economic possession (represented in money) for recreational, spiritual, humanistic or artistic values. How often do we feel estranged to some family members while related to strangers? Due to the faculty of observation, education and the use of cognitive artifacts, the human behaviour is no longer governed by instincts but is rather - as Darwin affirmed, a blend of natural dispositions ("social instincts"), social learning ("imitation and reinforcement") and values (morals), resulting in the evolution of morals, religions, education, cultures, social contracts, game theories, etc.

Great lawgivers, the founders of beneficent religions⁴, great philosophers and discoverers in science, aid the progress of mankind in a far higher degree by their works than by leaving a numerous progeny.

(Darwin, 1854-1999)

From this argument we can see that species tend to work, consciously or unconsciously for the benefit of their kind, as part of their struggle to survive. In a human context, *justice* as (defined in light of collective-survival values) has replaced kin discrimination, and as "man advance in civilisation....

...., and small tribes are united into larger communities, the simplest *reason* would tell each individual that he ought to extend his social instincts and sympathies to all the members of the same nation, though personally unknown to him. This point being once reached, there is only an artificial barrier to prevent his sympathies extending to the men of all nations and races.

(Darwin, 1854-1999)

Monetary system and credit

Money for example has been one of the greatest cooperative projects in the human history. It allows us to store and exchange value through a promise notes (John Maynard Keynes, 2003; McDowell et al., 2006; Wray, 2014)). Adam Smith thought of money as a more efficient alternative to the Barter system, so as to avoid "the double

⁴ Caution must be practiced as we interpret the meaning of "beneficial religion". Evolutionary-wise, any moral system (or religion) that imposes a fixed code of conduct rather than a set of values, is maladaptive and pathogenic on the long run.

coincidence of wants' challenge required for barter, but David Graeber – an anthropologist, has provided historic evidence that “measuring value” emerged out of communities' need to resolve disputes through “non-reciprocal gifting” of commonly valued goods such as coffee grains, silver or gold. This began gradually to formalise as societal systems grew in complexity. Coinage, on the other hand, were introduced for the payment of soldiers as wars intensified, while the traditional credit system failed to provide for the large number of fighters kept by kings. The early form of modern fractional reserve banking system emerged when goldsmiths issued receipts as a demurrage-note⁵, which were used themselves as a mean to settle debts without needing to move the metal. This was all overseen by clerics and royal palaces, however, as technology developed, today's only 3% of the state centralised money are issued by the central banks, while 97% are issued as interest-bearing credit (debt). This has been perceived as damaging for communities benefiting the top 10% of population versus the other 90%. Neo-liberalism, as traditionally understood, has shifted the real power from politicians to bankers and big corporates (Lluis De La Rosa & Stodder, 2015; NEF). neo-liberalism, however, involves free value exchange; when values change, the dynamics of the game changes subsequently. Now, as the monetary systems – as inevitably works today – has been found to exacerbate household debt, harm small businesses, create economic bubbles, and slows down economies, many communities have started issuing their own (no-interest) local *complementary* currencies (*ibid*) whether in the form of e-currencies or vouchers or other forms, to increase local spending possibilities, unlock community potentials and capabilities (see Sen, 2005; Nussbaum, 2011), re-use under-utilised facilities, increase employability, and finally intensify community “solidarity and coherence” (Lluis De La Rosa & Stodder, 2015; NEF)⁶.

Enterprises and potentials of conservation

To understand how human life-organisations works in a more transdisciplinary perspective we need to understand what nature is. All systems according to James G.

⁵ Carrying cost of money.

⁶ This is not to suggest that all is well and perfect, but that our communities are evolving well, so far, with great potentials of success.

More about the growth is discussed in ‘.. a Madman, an economist or a cyberneticist’ for the same author.

Miller's (1978) Living System Theory (cited in Umpleby, 2004) process data, energy and/or matter (IEM). This applies to biological systems; such as cells, molecules, organs and organism, as well as man-made self-regulatory machines and social entities such as corporates and nations (Umpleby, 2004).

Einstein equation $E = mc^2$ illustrates the circular relationship between energy and matter. It proposes that energy and matter are inter-reversible *with a difference*. A second-order cybernetics would take the observer as a contributor the existence of the system though (Foerster, 1979:1991; Corning, 1997). I, here, add communication as an interdependent factor in any system to illustrate system in light of Corning's (1997) *Holistic Darwinism* which has replaced the traditional Social Darwinism perspective but has not yet been as popular.

hICEM = h (I [C ex + C en] X [Eⁿ] ± [ΣM - W]) = Real-life system;

according to the second law of thermodynamics

(Illustratin 1)

Where [I] is information/data and [Eⁿ] is energy, [ΣM] is the sum of integral matter - with a capacity. That is [ΣM] = [M1XM2XM3(capacity)Mz], and [C] is the aggregation of intrinsic and extrinsic communication allowing the communication with the environment and acquisition of energy/matter required for survival and work. While W is the energy exerted in work + natural system's entropy. [h] A relativity factor relating system fragments to each other purposefully in a *spatiotemporal* position to an *observer*.

[Cen] Intrinsic communication depicting the linkage among the system components - where control basically lies, and a necessity of synergy for internal equilibrium.

[Cex] Extrinsic communication depicting the "structural determinism" (Maturana & Valera, 1928) and a necessity of harmony with the environment. When C=0, the system obviously isn't living!

This shows that humans – in principle, have huge potentials of conserving energy and matter (see Kern, 1990) and increasing efficiency of economising time and space with no known definite limits (in spite of the second law of thermodynamics), by establishing low-entropy self-regulatory systems (illustration 2).

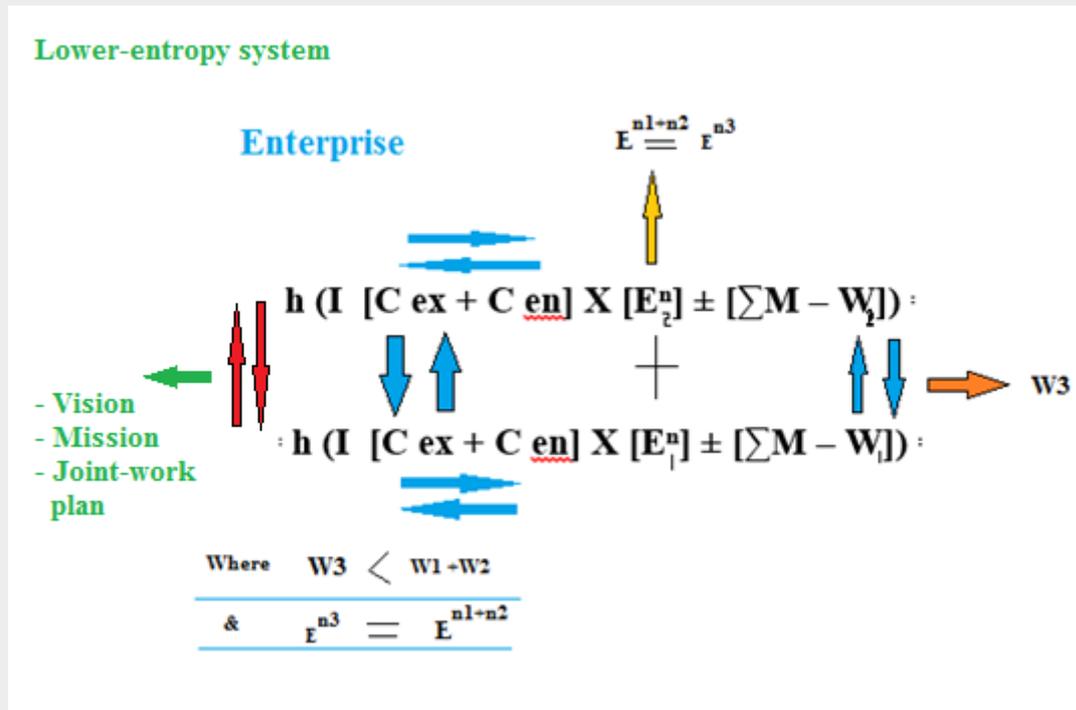


Illustration (2)⁷

As we advance into better knowledge of economics (see Daly, 2005); on how the monetary system works and ecosystems’ management, and we are advancing in utilising adaptive approaches of managing resources (Stankey et al., 2005), in addition to corporates, we are learning to establish cooperatives (AVRDC , 2007), multi-level governance enterprises (see Gruby and Basurto, 2014), community–interest ventures, green businesses, etc. Additionally, technology enabled us to realise - as we complain of the depletion of fossil fuel and/or global warming, that a little bit of sunlight falling

⁷ This illustration applies to human-human enterprise, human-group enterprise, human-machine enterprise and community-community cooperative enterprise.

on earth for just one hour meets world's energy demands for an entire year! (Maclamb, 2010).

To wrap up, the three interrelated paradigms of “the tragedy of the commons”, “the survival of the fittest” and the “Invisible Hand” - supporting privatisation and levying more taxes (“mutual coercion”), so as to protect common resources and averse the harmful effect of privatisation on the environment were not – as were traditionally interpreted, quite realistic in addressing human societies. Our human community has been successful so far in establishing highly sophisticated societal structures and great civilisations and has a prospect of a sustainable future by changing the “selfishness” perspective of the *struggle of survival* and cooperate more constructively and efficiency for the conservation of life and the preservation of natural resources as well as the advancement of human organisation. I have shown this in three examples relating to spirituality, economic growth and energy/matter conservation using two interlinked (self-created) illustrations: The real-living-system and the social enterprise.

(this) improvement inevitably leads to the gradual advancement of the organisation of the greater number of living beings throughout the world

(Darwin, 1999)

Reference List:

- Agarwal, N. & Zeephongsku, P. (1968) *Psychological Pricing in Mergers & Acquisitions using Game Theory* Vol. 162, No. 3859, pp. 1243-1248. 19th International Congress on Modelling and Simulation, Perth, Australi, 12-16 December
- Araral (2014) Ostrom, hardin and the commons - a critical appreciation and revisionist view. Elsevier
- AVRDC - The World Vegetable Center (2007) *Challenge Program on High value Crops – Fruit and Vegetables*. Pre-Proposal. Available at [http://www.cgiar.org/www-archive/www.cgiar.org/pdf/agm07/agm07_cp_highvalue_crops.pdf] accessed on 3/7//2015
- Bandura (1971) *Social Learning Theory*. Standford University, General Learning Corporation
- Beckworth, D. (2008) *Aggregate Supply-Driven Deflation and Its Implications for Macroeconomic Stabiliyt*. Avid Cato Journal, Vol. 28, No. 3
- CBDR (2002) *The Principle of Common But Differentiated Responsibilities: Origins and Scope For the World Summit on Sustainable Development*. Johannesburg.

Definition of the Principle of Common but Differentiated Responsibilities The principle of 'common but differentiated responsibility' evolved

Corning P. (1997) *A Holistic Darwinism "Synergistic Selection" and the Evolutionary, Process*, Institute for the Study of Complex Systems, JAI Press

Costanza, R. et al. (2003) *Complementary Currencies as a Method to Improve Local Sustainable Economic Welfare*", University of Vermont, Draft

Cox, S. J. B (1985) *No tragedy on the commons*. Cambridge University press. Discussion papers. Environmental ethics vol.7. Environmental Science & Policy 36. Elsevier

Darwin, C. (1871) *the Descent of Man, and selection in relation to sex*, New York: D. Appleton available at [https://www.andrew.cmu.edu/user/jksadegh/A%20Good%20Atheist%20Secularist%20Skeptical%20Book%20Collection/(e-book)Darwin%20-%20THE%20DESCENT%20OF%20MAN%20(1).pdf] accessed on 16/11/2015

Dixon, H. (1990) *Equilibrium and explanation*. Chapter 2 of Surfing Economics. Originally published as: "Equilibrium and Explanation", John Creedy (ed) *The Foundations of Economic Thought*, Blackwells, , chapter 13, pp.356-394

Darwin, C. (1999) *On the Origin of Species by means of Natural Selection*, 6th Edition, available at [https://www.andrew.cmu.edu/user/jksadegh/A%20Good%20Atheist%20Secularist%20Skeptical%20Book%20Collection/Charles%20Darwin%20-%20The%20Origin%20of%20Species%20-%206th%20Edition.pdf] Accessed 16/11/2015

Doebeli M. and Hauert C. (2005) *Models of cooperation based on the Prisoner's Dilemma and the Snowdrift game*, Ecology Letters, 8:748-766

Encyclopedia Britannica. Homo sapiens. Available at

[http://www.britannica.com/EBchecked/topic/1350865/Homosapiens]

Encyclopedia Britannica. *Homo sapiens*. Available at

[http://www.britannica.com/EBchecked/topic/1350865/Homosapiens]

Etzioni, A. (2010) *Behavioral economics. Discussion Forum II. Socio-economic Review*. 8,337-397 Advance Access Publication. Published by Oxford University Press and Society for the Advancement of Socio-Economics

Foerster H.V. (1979) *Cybernetics of Cybernetics*, University of Illinois, Urbana.

Gallopín G. (2003) *A systems approach to sustainability and sustainable development Sustainable Development and Human Settlements Division ECLAC/ Government of the Netherlands. Project NET/00/063 –Sustainability Assessment in Latin America and the Caribbean*||, 64 Santiago, Chile, March.

Gardiner, S. (2006) *A Perfect Moral Storm: Climate Change, Intergenerational Ethics and the Problem of Moral Corruption*.

Giest & Howlett (2014) *Understanding the pre-conditions of commons governance - the role of network management*. Elsevier

Gruby and Basurto (2014) *Multi-level governance for large marine commons - politics and polycentricity in Palau's protected area network*. Elsevier

Glanville, R. (2004) *The purpose of second-order cybernetics*. Kybernetes. Emerald Group Publishing Limited Vol. 33 No. 9/10. pp. 1379-1386 0368-492X. DOI 10.1108/03684920410556016

Glaserfeld, E.V. (1980) –*Viability and the concept of selection*., American Psychologist (vol.35, 1980, 970–974)

Gaspar, D. *What is the capability approach? Its core, rationale, partners and dangers*

Groffman, P.M et al. (2006) *Ecological Thresholds: The Key to Successful Environmental Management or an Important Concept with No Practical Application?* Ecosystems 9: 1–13 DOI: 10.1007/s10021-003-0142-z. The Journal of Socio-Economics 36 (2007) 335–359

Hardin, G. (1968) *The Tragedy of the Commons*. Science, New Series, Vol. 162, No. 3859, pp. 1243-1248. American Association for the Advancement of Science available at. [<http://www.jstor.org/stable/1724745>]

Herman E. Daly, Joshua (2004) *Farley Ecological Economics, Second Edition : Principles and Applications*

*Herman E. Daly (2005) *Economics in a full world*, available at

[[http://steadystate.org/wp-content/uploads/Daly_SciAmerican_FullWorldEconomics\(1\).pdf](http://steadystate.org/wp-content/uploads/Daly_SciAmerican_FullWorldEconomics(1).pdf)]

Investment Dictionary". Carbon Credit Definition. Investopedia Inc. Retrieved 2010-09-11.

John Maynard Keynes (2003) *The General Theory of Employment, Interest, and Money*. Available at [<http://cas.umkc.edu/economics/people/facultypages/kregel/courses/econ645/winter2011/generaltheory.pdf>]

Jones and Nemeth (2005) *Cognitive Artifacts in Complex Work*, Redesign Research, USA, The University of Chicago, USA

Kenter, J. O. et al (2015) *What are shared and social values of ecosystems?* Ecological Economics Analysis

Kern, W.S. (1990) *The Law of Conservation of Matter and Energy in the History of Economy Thoughts*. Journal of the History of Economic Thought, History of Economics Society

Lee, M. V. et al (2012) *Resilience: The fallacy of the tragedy of the commons*. Published by The Daly News.

Original article: <http://steadystate.org/the-fallacy-of-the-tragedy-of-the-commons/> (2014) the potential role of boundary organizations in the climate regime.

- Elsevier. Available at
[<http://web.mit.edu/12.000/www/m2018/pdfs/resilience.pdf>] accessed on
6/11/2015
- Lejano and de Castro (2014) *Norm, network, and commons - the invisible hand of community*
- Lluis De La Rosa, J. & Stodder, J. (2015) *Community Currency Research*. Volume 19. Section D 114-127. On Velocity in Several Complementary Currency.
- McDowell et al. (2006) - *Principles of Economics - chapter 23 Money* (p648-p657)
- cfadden, D. (1999) Rationality for Economists? *Journal of Risk and Uncertainty*, 19:1-3; 73-105. Kluwer Academic Publishers
- Maclamb (2010) *The Secret World of Energy, Ecology Global Network*. Available at
[<http://www.ecology.com/2010/09/15/secretworld-energy/>], accessed on:
1/3/2014
- Maturana and Valera (1928) *Autopoieses and Cognition: The realization of the Living*, Boston studies in the philosophy of science; v.42), available at
[http://topologicalmedialab.net/xinwei/classes/readings/Maturana/autopoiesis_and_cognition.pdf]
- McLeod, S.A. (2007). *Maslow's Hierarchy of Needs*. Available at:
[<http://www.simplypsychology.org/maslow.html>]
- Merriam Webster Online Dictionary (2014) *Cybernetics*, Merriam Webster, Inc. Available at [http://www.merriamwebster.com/dictionary/cybernetics], accessed on; 5/7/2013
- Mindell, D (2000) *Cybernetics: Knowledge domains in Engineering systems*. MIT. Available at [http://web.mit.edu/esd.83/www/notebook/Cybernetics.PDF].
- Nussbaum, M. (2011) *Creating Capabilities. The Human Development Approach*. The Pelknap Press of Harvard University Press.
- Available at [http://www3.nd.edu/~ndlaw/prog-human-rights/london-symposium/CreatingCapabilities.pdf] Accessed on 16/10/2015
- New Economics Foundation (NEF) *ScotPound: digital money for the common good A new socially inclusive payment system for Scotland*. Available at [http://neweconomics.org/publications/entry/scotpound-digital-currency-for-the-common-good].
- Nisan, N. & Amir (2001) *Algorithmic mechanism design. Games and economic behaviour*. Ronen academic press 35, 166-196
- Stankey, G. et al. (2005) *Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions*. United States Department of Agriculture. Forest Service Pacific Northwest Research Station. General Technical Report PNW-GTR-654 available at [http://www.fs.fed.us/pnw/pubs/pnw_gtr654.pdf] accessed on 11/11/2015

- Nowak et al (2010) *The evolution of Eusociality* Macmillan Publishers Limited.
- O'Neil d (1998-2013) *Early Theories of Evolution: Darwin and Natural Selection*, Anthro-palomar available at
[http://anthro.palomar.edu/evolve/evolve_2.htm]
- Park, J.H.(2007) *Persistent Misunderstandings of Inclusive Fitness and Kin Selection: Their Ubiquitous Appearance in Social Psychology textbooks*. *Evolutionary Psychology* – ISSN 1474-7049 – Volume 5(4). 2007. -861-available
at [<http://www.epjournal.net/wp-content/uploads/EP05860873.pdf>]
- Parra-Luna F, (2009), *Systems Science and Cybernetics: The Long Road to World Sociosystemicity* - Francisco Parra-Luna ©Encyclopedia of Life Support Systems (EOLSS)
- Preston, C. J. (2012) *Beyond the End of Nature: SRM and Two Tales of Artificity for the Anthropocene*. *Ethics, Policy and Environment*. Vol. 15, No. 2
- Pinto, A. C. (2009) *Agricultural Cooperatives and Farmers Organisations. Role in rural development and poverty reduction*. Stockholm, April. Swedish Cooperative Centre, Development Director. Agricord (network of international agro-agencies).
- Rankin D. J. et al. (2007) *The tragedy of the commons in evolutionary biology*. *Trends in Ecology and Evolution* Vol.22 No.12. Science Direct. Elsevier
- Rachlin H (2002). *Altruism and selfishness*. *Behavioral and Brain Sciences* 25, 239–296
- Ruddick et al (2015) *Complementary Currencies For Sustainable Development In Kenya: The Case Of The Bangla-Pesa*
- Sanchez, A. et al (2005) *Altruistic behavior pays, or the importance of fluctuations in evolutionary game theory. Modelling Cooperative Behavior in the Social Sciences: English Grandana Lectures*. American Institute of Physics
- Schwaninger M. (2004) *System Dynamics and Cybernetics: A Necessary Synergy*, International System Dynamics Conference, Oxford, July 2004.
- Sen, Amartya (2005). "Human rights and capabilities". *Journal of Human Development* (Taylor and Francis) 6 (2): p. 158
available at [
[http://www.unicef.org/socialpolicy/files/Human Rights and Capabilities.pdf](http://www.unicef.org/socialpolicy/files/Human_Rights_and_Capabilities.pdf)]
accessed d on 17/10/2015
- Sifa, C. B. (2002) *Role of cooperatives in agriculture in Africa. Role of cooperatives in Agricultural Development and food security in Africa* available at [
<http://www.un.org/esa/socdev/documents/2014/coopsegm/Sifa--Coops%20and%20agric%20dev.pdf>] accessed on 18/10/2015].
- Silvio Gesell (2009) *A strange, unduly neglected prophet'? A reappraisal of forgotten pioneer of monetary theory*. CAWM Discussion Paper No.23. Cordelius Ilgmann

Stankey, G.H. (2005) *Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions*. United States Department of Agriculture Forest Service Pacific Stodder, J. (2009) Complementary Credit Networks and Macro-Economic Stability

The IUCN Red list of threatened species™ Homo sapiens available at [<http://www.iucnredlist.org/details/136584/0>]

Umpleby, S.A. (2007) *Physical relationships among matter, energy and information* (Reprinted from *Cybernetics and Systems* _04, 2004). *Syst. Res. Behav. Sci.* 2007, 24, 369-372.

UNEP (2009) *Global Food Losses and Food Waste* - FAO, 2011, the environmental crisis: The environment's role in averting future food crisis –

UNFCCC (2008) *Kyoto Protocol Reference Manual On Accounting of Emmisions and Assigned Amount*. ISBN 92-9219-055-5. Information Services of the UNFCCC secretariat

Varese F.(2001) *Altruism and the Theory of Rational Choice: an Empirical Exploration*, in collaboration with Meir Yaish.

Weathreall, D. J. (2001) *Genotype-Phenotype Relationships*. Encyclopaedia of Life Sciences. Nature Publishing Group

West et al (2006) *Altruism, Institute of Evolutionary Biology*, School of Biological Sciences, University of Edinburgh *Current Biology*, Vol 16 No 13 R482

Wilson & Wilson (2007) *Rethinking the Theoretical Foundation of Socio-biology*, *Quarterly review in Biology*, press, Vol. 82, No. 4, December, available at

[<http://www.jstor.org/stable/10.1086/522809>]

Wilson E. O.(1998) *Consilience: The Unity of Knowledge*, New York, Knopf, 1998, p. 13.

World Food Program Website, *Fighting Hunger Worldwide*, Hunger, Hunger Statistics; available at

[<http://www.wfp.org/hunger/stats>] accessed on: 2/3/2014]

Wray, L. R. (2014) *From the State Theory of Money to Modern Money Theory: An Alternative to Economic Orthodoxy*. Levy Economics Institute of Bard College. Working Paper No. 792. ISSN 1547-366X