

This essay will first explore the ontological aspect of the sustainable development concept and question the logic behind the creation of the sustainable development concept. After giving the key understanding of the historical event popularizing the concept in the twentieth century, the three main pillars of sustainability will be explored through elements of answers to broad questions developed along the course. Finally, the challenges and limits explored during the lectures series will be highlighted and the tools promoting sustainability will be investigated.

Life, its meaning, its apparition, its evolution has many explanation and definitions, from religion to biology, from philosophy and astrophysics, the consensus on one unique definition is barely impossible and might be useless (Cleland, 2002). Thus, according to NASA, there is some agreement regarding 'living things' characteristics; "Living things tend to be complex and highly organized. They have the ability to take in energy from the environment and transform it for growth and reproduction. Organisms tend toward homeostasis: an equilibrium of parameters that define their internal environment." These characteristics dictate our behaviors and shape the environment in which we are evolving.

For the sake of this exercise we will borrow the Darwinian definition (Cleland, 2002) presented in the online Oxford dictionary:

The condition that distinguishes animals and plants from inorganic matter, including the capacity for growth, reproduction, functional activity, and continual change preceding death. (Oxford dictionary, n.d.)

In this Darwinian definition of life, we apprehend the capacity of organisms to evolve and reproduce. The idea of 'sustainable development' seems embedded in this definition. The capacity of organisms to evolve and reproduce allows any being to survive generation after generation. The idea of 'development', growth, evolution in a reasonable or 'sustainable' way, without consuming all the resources available is the natural progression of life in order to subsist. If one organism were to consume all the resources available, it would cease to exist and run toward its species extinction. In other words, we understand life as a self-sustained system capable of adaptation through evolution and reproduction.

Under those circumstances, if we Human are complex living organisms and if it is our nature to self-sustain why did we have to create words such as "sustainable development"? and why do we need to design "sustainable development goals"?

To answer these questions, we need first to understand the words independently, and secondly to understand the context in which the concept of sustainable development was established. The word 'development' means the action of evolving, of passing from one state to a greater state. The word 'sustainable' gives the quality of such change, the evolution should sustain the pace indefinitely. Such type of dynamic change associated with a stable state seems, according to the second law of thermodynamic impossible to achieve, it can only be considered as a utopic future, a guide, a notice. However, some believe that it is the direction toward we should transform our Humanity. The concept was spread in the twentieth century when the global impact of social organization had drastically transformed the environment. The popular definition still used today comes from the 'Report of the World Commission on Environment and Development: Our Common Future' or

'Brundtland report' developed in 1987 under an urgent call from the United Nations (U.N.) to propose and implement long term strategies toward sustainable development.

Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. (Brundtland, 1987)

It is not the basic traits that define human beings that pushed us to invent a concept giving us the ability to sustain. It is the form of organization and the recent choices depicting the modern history that pushed international organizations to design a framework enabling Human beings to adopt a sustainable behavior for prosperity. The call for action by the U.N. came from a simple but sad finding. The twentieth century's technologies allowed human beings to see for the first time the Earth from the space. From up there, this planet is one fragile ball within a larger universe. Earth is not dominated by human civilization but by patterns of clouds, oceans, large portions of soils and forest. The inability of Humanity to fit its activities within these patterns changed planetary systems fundamentally. Therefore, the concept of sustainable development and the goals set up were needed, to inform, reform and maybe transform Humanity.

However, the Brundtland report adopts an optimistic approach foreseeing Humanity's ability to change. Interestingly, this definition highlights the 'needs' of each generation. This is assuming that there is one global generation equally spread on Earth. It is a normal discourse coming from the U.N. which mission is primarily to bring peace and equity on Earth. The reality shows that there are different intergenerational needs but also different intragenerational needs (Galan, 2019), and the gap distinguishing the intrageneration needs between each nation, state, regions is widening since the U.N. call in 1983. The Environment obviously changes from one place to another around the planet, but what changes even faster is our cultural, political, economic societies. The changes in socio-economic models between the post-war times to the actual neo-liberal paradigms influenced the perception that Humanity had to the Environment, from meeting our 'needs' to being our 'rights' (Redclift, 2005).

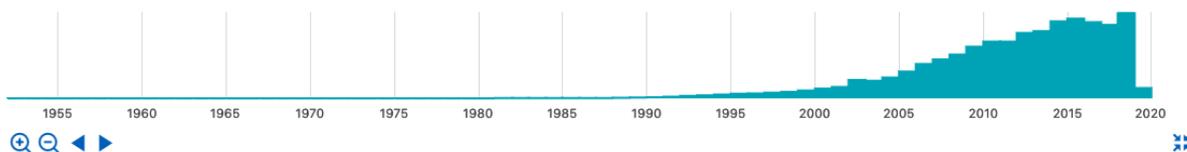


Fig1. Chart synthesizing the amount of scientific publications citing the expression "sustainable development" since 1955

Today, thirty years after the report of the World Commission on Environment and Development, a long path has been made in order to implement this hope in Humanity that the commission had. The definition on sustainable development is still valid as a general notice, World Nations agreed on goals and agenda (UN, n.d.; Lähteenoja, 2019) and an increasing scientific community worldwide is actively working on spreading and implementing these goals (fig1). However, this optimistic

view is not shared by everyone, some criticism movements question the 'what is to be sustained' and argue that the use of non-renewable and finite resources in a sustainable way is an oxymoron. Nowadays, the concept of 'sustainable development' is also used as an umbrella word in every possible field for greenwashing purposes and usually describe processes oriented toward a better greener future. However, this use of the concept is not meaningless and illustrate a society in which people are sensitive and aware of the actual degradation of the environment by our social and economic organization. The use one makes of the concept is very different according to one's relation with the Environment, Economic interest, Socio-cultural background and vision for the future.

This short ontological and historical introduction to sustainable development brings us to the point when we can question independently the three main pillars of sustainable development.

- 1- What type of connection exists between the sustainable development concept and the Environment? What does nature say about Human actions? What are the tracks to find an equilibrium in between the Environment and Human settlements?
- 2- What types of Economic models are proposed to reach sustainable production and consumption?
- 3- Who is the 'we' behind the word Humanity, and what do 'we' want? Optimist, pessimist, believer, criticism, reformist, activist, what is the portrait of the sustainable development face? What type of society would rise from the equilibrium found by a sustainable Economics on the consumption of our Environment?

1- Sustainable development and the Environment

The Environment comprises organic and inorganic matter organizing the Earth biosphere. Our knowledge of this Environment reveals different eras with mass life extinction events followed by renewal over the last four billion years. The long period of adaptation and evolution allowed ecosystems to reach a certain equilibrium. Homo sapiens appeared only a fraction of second ago regarding the age of Earth. Like any other animal, Humans takes what it needs from nature, air, water, food, and shelter. However, the modern history of Human settlements reflects an unprecedented impact on the Environment by one species. We account the deterioration of many ecosystems and an alarming extinction of biodiversity to Human activities (Kotze, 2019). The extensive use of non-renewable resources to create energy, the industrial agriculture or the wide amount of chemicals spilled in the natural environment are some examples of actions that changed fundamentally the Earth biosphere. Furthermore, Human actions are also endorsing climate change and its undeniable harmful impact on terrestrial life. The ecosystems equilibrium is modified by the invasion of domestic species for the needs of human beings. Accordingly, certain studies reveal that the carrying capacity of the earth is also degraded by human activities (Chefurka, 2012). In other words, Human recent evolutions do not fit with the Environment, we live an unsustainable way. However, the amount of knowledge we have today on the Environment, the awareness of these alarming facts and the Human technological capacity allows us to uncover the certain type of relationships with the nature that can be beneficial for the most. Protection, conservation, and management of ecosystems take many forms and are one way to implement some of the sustainable goals. Many examples of protection and conservation are monitored and inform policymakers worldwide (Jalas, 2019; Barbier, 2004). Other management or uses of ecosystems in a sustainable way co-benefiting human settlement and the Environment were presented in the lecture series such as the Ecosystem Services, Green Infrastructures and the Nature-based solutions (Raymond, 2019; Galan 2019).

Ecosystem services (are free benefits human gets from natural ecosystems. These services, in order to be identified and used, are categorized into different types of services such as Supporting services, provisioning services, Regulating services and Cultural services. Wisely used in urban environments they permit minor degradation of the Environment and large amounts of effective benefits within a smaller natural patch. Similarly, Nature-based solutions are engineered enhanced solutions 'inspired and supported' by nature to manage and restore ecosystems. They are supposed to simultaneously benefiting the Environment and the Human societies and help build resilience. They are classified according to the level of intervention and their social impact is currently being assessed, in order to give them more efficiency.

2- Sustainable development and Economics

As the global population increase, the need for food supply increase consequently. Land pressure becomes an increasing problem. The largest good consumed by Humans is the space to allow us to feed ourselves. It is now common to talk about the amount of planet we would need to feed the expected population if we consume like this or that country. In addition, the inequity resulting from the production, distribution, and consumption of food worldwide is disturbing. Some nations

sacrifice space and labor to feed the other side of the world where people consume irresponsibly. Cheap energy and neoliberal global markets allow such insanity and widen the gap between southern and northern hemispheres. If the liberalism was a necessity until the twenty-first century to allow us to arrive at the actual socio-technological peak, it is today widely admitted that this type of economy is unstable and that infinite growth on physical finite matters is unsustainable. It is interesting and challenging to think of our generational responsibility to design and implement a totally new world economy. I believe that the growth economy will be decentralized and extend its immateriality until it closes itself around data information and knowledge and a local a circular economy based on physical matters will develop at different scale around the world creating two completely parallel and different economic paradigm.

During the lecture programmed throughout the course, we discussed two types of economics dealing with sustainable development. Environmental economics and ecological economics were presented, and these two approaches shared the same goals of understanding the socio-economic-environmental interactions and promote a transformation toward sustainability. However, the two approaches were using different analytical tools and methodologies to understand the global systems and propose strategies (Stojanovic, 2019; Venkatachalam, 2006).

My superficial knowledge in economics does not allow me to understand the subtleties of each alternative model proposed by the most recent economists. However, it doesn't forbid me to understand that if 'we' want to run toward a more sustainable future, we need to severely change our mode of consumptions, our means of transportation, our energy consumption, our food distribution, and our territorial activities, or we need to reduce drastically the world population and postpone the behavioral transformation. One thing is sure, the game will be played in the city. Therefore it is interesting to question the type of post-liberal sustainable society can rise, and what are the strategies.

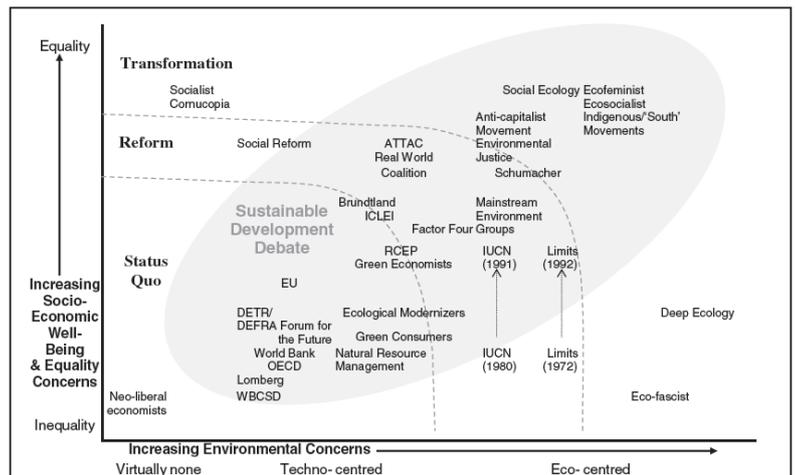
3- Sustainable development and Social theories

As mentioned by almost all the lecturer during the series, with 70% of the population leaving in cities by 2050, the most relevant social organization patterns to work with are cities. "The war on climate change will be won or lost in cities" (Rowe, 2017) One of the fundamental question to ask when dealing with complex concepts such as 'Humanity' or 'Sustainable Development Goals' is who are we talking about when referring to these concepts. Some of the goals toward sustainable development are justice, equity, abolishing hunger and poverty. This portray a variable Humanity where we have to understand that to achieve a common goal, we will all have to take different paths with different challenges. The way 'we' experience these challenges will depend on who do we consider as 'we'. Does the 'we' define my close family, my community, my city, my region, my country, my continent? This is a difficult position to take and it depends on each of our ability to interact with political systems and governance institutions. In Namibia, simple policies wouldn't counter poaching and extinction of wildlife species because survival under extreme poverty is more important than wildlife protection. An interesting and controversial program funded the leisure hunting of rare species and allowed education and employment of local communities transforming in a few years the interaction between the society and the environment. Other countries in Europe or America in democratic programs and expert develop sets of policies and laws which are implemented and respected. However, democratic elections and strong political institutions do not guaranty the path toward sustainability to be complete. These types of government have too short agendas and build a program for the reelection few years later, not to change Humanity, the perfect example is the actual United States of America, president Donald Trump withdrawal from the Paris agreement ratified by the former president and reject the scientific consensus on climate change. Thus, even the nations whom ratified the agreement were supposed to propose strategies for implementation and so far, each of them has failed the agreement. Such observation can push us to question the legitimacy of democratic systems to implement such complex and lengthily processes. An article in *Sustainable Development* was proposing a map of the different approach to sustainable

development and was dividing them into three big categories around two axes (fig2) the supporters of a "status quo", the "reformist" and the "transformationists". Each of them being placed between the two axes of increasing socio-economic concerns and increasing Environmental concerns.

The supporters of status quo recognize the need for change but do not consider it an insuperable effort. The reformists believe that reforms in one or the other concern will enable to implement sustainable development. The transformationist believe that only fundamental transformations of our behavior can reduce the anthropocentric impact (Hopwood, 2003).

Fig2. Chart displaying the view toward sustainable development (Hopwood, 2003)



There is also to notice the beliefs toward sustainability. If we understood earlier that sustainability as a whole is a utopic state to achieve, we also noticed that the U.N. has an optimistic viewpoint regarding the achievement of more sustainable development. On the one hand, certain social theories tagged as Cornucopian because they believe that cutting edge knowledge and advance in technology will allow Humanity to find the resources to adapt and evolve like one gigantic organism. These theories believe in the resiliency of Humanity to

tackle any major event by definition. On the other hand, the more pessimists (known as Malthusians) are said to follow the prediction of Malthus in what growth in population and limited resources will only end with major extinction level events potentially ending life on Earth (White, 2016). Paul Chefurka (fig3) is one of these people that lost hope in our generation to solve major sustainability issues.

Fig3. Screenshot of article list on Paul Chefurka's webpage.

Factual Articles	Hopeful Articles
<ul style="list-style-type: none"> The Many Faces of Denial (November 14, 2013) Thermodynamics Reading List (November 9, 2013) A Thermodynamic Answer to Fermi's Paradox (October 29, 2013) A Thermodynamic Critique (October 19, 2013) The Evolutionary Psychology of Fukushima (September 13, 2013) Paradise Lost (July 25, 2013) The Dawn of Cybernetic Civilization (July 16, 2013) Looking at the Limit (May 27, 2013) No Really, How Sustainable Are We? (May 16, 2013) Thermodynamic Footprints Updated (March 23, 2013) Climbing the Ladder of Awareness (October 19, 2012) Carrying Capacity and Overshoot: Another Look (May 12, 2012) A Taxonomy and Epistemology of the Human Predicament (May 24, 2011) Responding to Peak Food, Oil and Population (February 24, 2011) Is Peak Population Almost Here? (February 22, 2011) The Oil-Fired, Grain-Fed Global Food Crisis (February 17, 2011) How tight is the link between oil, food and population? (February 15, 2011) Connecting the Dots: Food, Fossil Fuel and Population (January 31, 2011) Our Interactive Ecological Predicament (January, 2011) Population Redux (January, 2011) Food Prices and Oil Prices (November, 2010) Decarbonizing Civilization (November, 2010) The Footprints of Consumption (December, 2009) Population, Consumption and our Ecological Footprint (December, 2009) The 2012 Meme (November, 2009) From the Head to the Heart (PDF of presentation, Oct. 2009) The Guardian Institutions of Hierarchy (July 2009) The Limits to (Population) Growth (July, 2009) How the heck did it come to this? (March, 2009) Homo Economicus, Homo Ecologicus (December, 2008) Approaching the Limits To Growth (PDF of presentation slides, Oct. 2008) The Ecology of Overpopulation (September, 2008) None of the Above (September, 2008) Political Will, Political Won't (September, 2008) Who Am I? (Jan. 2008) Energy Use and Population Growth (August 2008) The View From the Peak (Mar. 2007) A Peak Oil Story on CBC TV (Mar. 2007) The Converging Crisis (radio interview - Jan. 2008) The Converging Crisis (PDF of presentation slides - Feb. 2008) A List of Countries with Energy Supply Problems (Feb. 2008) Why I am Against Biofuels (May 2007) Mexico: Peak Oil in Action (Sep. 2007) The Saudi Peak - a Hypothesis about the Iraq War (May 2007) Oil Prices in 2012 (May 2008) 	<ul style="list-style-type: none"> Finding The Gift (September 29, 2012) A Postcard From the Path (June 6, 2012) Introducing the Cultural Psychomop (February 14, 2012) The Destiny of Species by Means of Natural Progression (October 15, 2011) Creating a new "Natural Order" (May 18, 2011) Reality and Illusion, Awareness and Love (April 23, 2011) Slaying the Hydra (March 14, 2011) Enough! (November, 2010) Finding Peace of Mind (February, 2010) Reflections on a Non-Theistic Spirituality (January, 2010) Transfiguration (Oct. 2009) Attachments, Connections and Love (Oct. 2009) The Story of my Vision Quest (Aug. 2009) Reflections on the Vision Quest (Aug. 2009) What is Enlightenment? (July, 2009) The Importance of Enlightenment (June, 2009) The Message of Overconsumption (June, 2009) A Way of Seeing (June, 2009) Hide or Seek? (May, 2009) The Awakening (May, 2009) The Global Movement that Barack Obama Isn't Leading (May, 2009) Meat Computers with Cultural Programs (April, 2009) Sacred Demise (March, 2009) The Parable of the Marriage (November, 2008) Gathering Momentum (November, 2008) From Despair to Hope (November, 2008) Separation, Awakening and Revolution (November, 2008) Changing the Dream (October, 2008) The Twelve Suggestions (October, 2008) The Spiritual Effects of Comprehending the Crisis (Aug. 2008) Don't Worry About Collapse (July, 2008) Solutions or Responses? (July, 2008) The Potential for Conflict (July, 2008) Cultural Change at the Limits to Growth (May 2008) Fighting Despair (Feb. 2008) Population Decline - Red Herring and Hope (July 2007) What Can I Do? A Personal Action Plan (June 2007) An Acronym for the Times: I HELP (Apr. 2007) Recommended: The Awakening the Dreamer Initiative Recommended: The Ascent of Humanity (online book)
Less Hopeful Articles	Abandon Hope, All Ye Who Enter Here
<ul style="list-style-type: none"> A 50,000-Foot View of the Global Crisis (July 8, 2011) Bearing Witness to Collapse (April 26, 2011) Urbanilemures (January, 2010) The Neuropsychology of Climate Change (December, 2009) The New Normal (December, 2008) Is Fusion the Answer? (August, 2008) Time Horizons, Overshoot, Genetics and Resilience (Jan. 2007) Why We Don't See Risks: The Hyperbolic Discount Function (Mar. 2007) Demographic Transition Through Increased Energy? (Aug. 2007) Why Tinkering Won't Fix It (Jan. 2008) 	<ul style="list-style-type: none"> Population: The Elephant in the Room (May 2007) World Energy and Population: Trends to 2100 (Oct. 2007) <p>A multi-part analysis of the near future:</p> <ul style="list-style-type: none"> Part 1: World Energy to 2050: Forty Years of Decline (Oct. 2007) Part 2: Energy Intensity and GDP: To Have or Have Not (Dec. 2007) Part 3: Can Wind Power Plug the Energy Gap? (Feb. 2008) Part 4: Africa in 2040 (HTML) (PDF) (Feb. 2008)

Challenges, Limits, and tools

This simple understanding of the three pillars or sphere of sustainability reveals how much they are fundamentally connected; how to talk about sustainable agriculture without talking about environmental impact and production, consumption and distribution issues? How to talk about a sustainable city without talking about green infrastructure and system of governance?

This chapter will tend to describe the limits and challenges when dealing with complex systems, it will also present the tools available to deal with complex systems introduced during the lecture series.

One of the first challenge when dealing with sustainable development is the scale or the scope of the system to study. Indeed, the characteristics of a complex system such as an organization, a city, a region, is that they are not closed systems but linked and interdependent to other systems in order to work. Therefore, it is often necessary to scale up, scale down to understand the scope of the study and to try to find boundaries. As we have seen in many examples during the lecture series, what is true at one scale can be irrelevant when you change the viewpoint (Bell, 2019; Kotze, 2019; Candy, 2019).

One other type of boundary which is difficult to understand when dealing with these complex systems affecting socio-economic-environment interconnection is the time scale. As human beings, we are programmed to think according to our lifespan, and it is a difficult exercise to think at the scale of the ecosystems for example. Even shorter, the lifespan of our political systems changes in less than a decade and each of them is competing with each other forgoing logical intragovernmental continuity.

Finally, the large field of expertise required to grasp and understand the issues we are dealing with when working with sustainability is tremendous. For instance, the 17 goals and 169 targets developed by the U.N. needs a gigantic number of experts and resources in order to be managed and implemented worldwide, it is not the task of independent governance but the work of a planetary network working together like an anthill.

Along the lecture series, different types of tools used to grasp, manage and implement sustainability were highlighted, assessment tools, analytic tools, and implementation tools (presented in the Environment paragraph). In order to assess the environmental impact of human settlements and activities, an analysis of the carbon emissions enables to compare and improve Human activities. This assessment method called carbon footprint, analysis the amount of carbon dioxide rejected in the atmosphere by an individual system, individual, machine, organization, activity, event, household, city... its antonym is the carbon handprint that analysis independent form of carbon offsetting (Kuittinen, 2016, 2019), the carbon foodprint is similar to the carbon footprint but it focuses on the food industry (Sheridan, 2016; Candy, 2019). This assessment is possible thanks to a common unit present in or processed by each organism on earth, the carbon.

...at least terrestrially, all known organisms seem to share carbon-based chemistry, depend on water, and leave behind fossils with carbon or sulfur isotopes that point to present or past metabolism. (NASA, n.d.)

Of course, the most classic quantitative study in any field of the sciences (and who knows of the arts and culture) can help to inform the citizen, the politician, and the practitioner and shape better behavior and practices, the lecture from Johan Kotze was an excellent example. It gave clear hands-on results allowing for instance landscape architects to better use trees to sequester carbon in urban parks and walk one step closer to sustainable development.

I remember two analytical tools allowing us to bypass the challenges in order to grasp and understand complex systems. The introduction to system thinking by Pia Fricker displayed a new field of theory to me enabling us to understand patterns of systems and to reveal replicable effects to find solutions to different problems with the same patterns. Additionally, the Introduction to urban metabolism was an excellent example of practical and inclusive analytical tool making possible

the study of the complex flows and systems of a city in a synthetic way. This type of Material Flow Analysis (MFA) is a performing and flexible tool allowing a global understanding of a certain system. The limit of such analysis is the necessity of analyzing closed systems with clear boundaries. The excellent example of the IADR work in Rotterdam display the potential uses of MFA to develop strategies and scenarios. (Galan, 2019; Tillie, 2014).

In fact, regarding these two analytic tools, in order to propose efficient strategies worldwide to reach sustainability; we could, categorize the Earth under a certain number of existing patterns and proposed solutions to similar patterns or element of systems. Or, we could run a mega MFA of the complex system composed by the planetary system, monitor and analyze all the flows and develop scenarios. Both utopic propositions would require totally different governance system at a planetary scale and technology yet to come.

By the same token, and in order to counter the scale challenges, we could also imagine some extremely complex models following the game theories. We could imagine a sequential game model with decisions tree running in four dimensions (space and time) all the potential decision made from the individual agency to the worldwide policies. Each branch of the tree would describe a different political framework, economic paradigm or social organization. This science fiction model could then tell each individual and institution the best option to follow (best being in our case toward sustainability). If the performance of such a decision tree can be theoretically interesting, it poses major technological and ethical problems and is absolutely not into any democratic framework. Each of these tools wisely used could inform policymaker but also planners, designers, engineers, farmers and citizens in order to co-define a sustainable future.

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Bell S. What do we mean by a sustainable landscape, lecture, Aalto University, delivered in 2019.

Lähteenoja S. The evaluation of sustainable development policy in Finland – methods and findings, lecture, Aalto University, delivered in 2019.

Kuittinen M. *Carbon footprints and handprints*, lecture, Aalto University, delivered the 12 February 2019.

Fricker P. Patterns – Systems Thinking Part2, lecture, Aalto University, delivered the 05 February 2019.

Kotze J. *Study questions and data analysis in urban ecological studies*, lecture, Aalto University, delivered the 19 February 2019.

Jalas M. *Sustainability transitions Form-giving and back-casting*, lecture, Aalto University, delivered the 05 March 2019.

Candy S. *Assessing Sustainability - Foodprint and CoPP projects*, lecture, Aalto University, delivered the 12 February 2019.

Raymond C.M. *The co-benefits and (social) costs of nature-based solutions*, lecture, Aalto University, delivered the 19 February 2019.