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Water Imperialism: Politicising virtual water through entropy theory

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Water Imperialism: Politicising virtual water through entropy theory

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Abstract. This working paper explores the concept of virtual water within a framework of imperialism, political ecology and systems theory. The existing literature on virtual water has been largely optimistic, characterised by the conviction that an understanding of the rationale behind this concept can resolve water insecurity through trade. This paper challenges this position by applying the analysis to a water-rich country, within a core-periphery dichotomy. The thesis supported is that such optimism is unfounded, demonstrating a misapprehension of the imperialistic tendencies of the core in the world economy. To illustrate this proposition, the concept is applied to the trade of asparagus—a non-essential good—between the United Kingdom and the water-stressed Ica Valley in Peru.

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1. Introduction

> *"All crises begin with the blurring of a paradigm and the consequent loosening of the rules for normal research… Or […] a crisis may end with the emergence of a new candidate for paradigm and with the ensuing battle over its acceptance."*
> Thomas S. Kuhn – 1963

Accepting a new concept is a lengthy process. As Kuhn (1963) stressed, the scientific community does not readily recognise the validity and applicability of any innovative model. It is thus crucial to reflect upon new concepts—within the framework of the existing body of literature—to ascertain whether they are providing an innovative idea, angle or take on a familiar problem.

Since its emergence in the 1980's, virtual water has been steadily gaining acceptance. It represents a novel understanding of food trade, reframing questions of food and water security. Achieving food and water security is often a national ambition, therefore intrinsically linked with the country's political realm (Skoet and Stamoulis, 2006). Yet, virtual water has not usually been examined through a framework of political economy—or, better yet, political ecology. In fact, virtual water seems to operate in a political vacuum, implicitly denying the existence of power differentials in trade agreements.

This conundrum is perplexing. By not acknowledging the political element inherent in economic relations between different regions, virtual water's applicability is limited. The authors promoting the concept are restraining their potential field of study by foregoing an analysis of the political relations between the world's more or less influential nations. This has led to a highly optimistic approach, where virtual water is considered the solution to problems of water stress, rather than traditional approaches like water management. Nevertheless, this optimism might not be supported if the analysis is extended to a highly political environment. To address this issue, I propose an examination of virtual water within a decidedly political context: in the trade between the core and the periphery, where the periphery is more water-poor than the core. This analysis allows for certain questions to be answered:

1.Is virtual water an appropriate solution to water deficit within the study of development?
2.Is water scarcity a suitable indicator for trade relations between the core and the periphery?

1.1. Structure of the paper

In *Chapter 2*, I am presenting the concept of virtual water, underlying the term's history and deficits, and touching upon its compatibility with development. In *Chapter 3*, the paper's analytical framework is introduced: building on the core-periphery dichotomy and using systems theory, the paper presents the importance of the supportive feedback relation between the ecosystem and the socio-economic sphere. Using Malcolm Caldwell's (1977) work on energy and fossil fuels, the imperialistic relation between the core and the periphery is explained, vis-à-vis the aforementioned regulatory process. Finally, the model is enhanced by closing the feedback loop of entropy through the secondary effect of the deregulation of the socio-economic sphere of the periphery: the return of entropy into the core's system. In *Chapter 4*, the case study of the trade of asparagus between the United Kingdom and a rural area in Peru, near the desert in the Ica Valley, is used to illustrate the analytical framework. This case study allows the motivations of these regions in dealing with trade to be addressed, as it provides an example of two countries with diverging societies and economies, translating into particularly different positions in the global political arena as the richer country is more water rich than the one exporting asparagus. Finally, I am contrasting the contributions of Ricardo's (1973) comparative advantage theory and virtual water to uncover the driver of trade relations in a developmental context.

2. Virtual water for water scarcity: A critical approach

2.1. Understanding virtual water

As with any relatively new term, it is constructive to begin the analysis with its conception and early development, thus appreciating the concept's different components as well as the agendas of its creators and advocates. Tony Allan[1] has largely been credited for coining the concept (see for example Hoekstra, 2005; Moench, 2002; Wichelns, 2001; Chapagain and Orr, 2008) and it is true that he is responsible for its growing acceptance. However, Allan (2003) himself acknowledges the work of Israeli economists for stimulating his interest in the role of water in trade. Working in the 1980's, these economists recognised that the marginal economic cost of exporting water-intensive crops such as avocado caused additional water stress for Israel (Fishelson, 1994). Building on this analysis, Allan elaborated his paradigm of hidden—or embodied—water. The concept however did not gain prominence until 1993, when Allan renamed it *virtual water* for the purpose of a conference (Allan, 1998; 1999; 2001; 2003; 2011; Lant, 2003; Chapagain and Orr, 2008).

The epicentre of this concept is the idea that every crop[2] has a higher input of water than is contained in the final product. A famous equivalence often used by Allan is that a thousand tons of water are necessary to produce a ton of wheat (Allan, 2003; 2011). This water is used in every stage of agriculture, from the amount used at the site of production like irrigation—both from groundwater and other sources—to the water used in processing, refrigerating, transferring, etc. the harvested crop. It therefore binds water, food and trade in an innovative way. This is particularly significant since achieving food security[3] is high on the political agenda of countries across the world (Skoet and Stamoulis, 1996).

The logic behind virtual water trade is derived from Ricardo's (1973) theory of comparative advantage. In his prominent book *On the Principles of Political Economy and Taxation*, Ricardo suggests that trade can be favourable to both partners, provided that they each export the goods they have a comparative advantage in producing. It relies on notions of marginal costs and trade-offs between the production of different goods, and the idea that both actors can stand to win by trading. Ricardo also assumes that, as the market evolves, the comparative advantages of different regions will also be modified, with no economic or social loss during these periods of transition.

The analogy between the theory of comparative advantage and virtual water trade is essentially straightforward[4]. In the same way that Ricardo (1973) assumes that countries trade in the good they have an advantage in, virtual water affirms that water stress guides trade. In particular, an arid or semi-arid region exports goods that do no necessitate large inputs of water, while importing water-intensive crops from water-rich regions (Allan, 2001). Allan also believes that consumers can play a key role in this process by modifying their behaviour: they can forgo buying products coming from water stressed regions, or eating products necessitating large inputs of water, etc. (Allan, 2011). By emphasising the importance of the water content of crops, virtual water is shifting the focus of the discourse from "'local water use efficiency' at user level and 'water allocation efficiency' at river basin level" to "global water use efficiency" (Hoekstra, 2005: 536; Beadon and Page, 2010). The world's global resources are thus considered on an aggregate level as a common good.

2.2. The optimism in virtual water trade

Virtual water, and the subsequent idea of virtual water trade, has been surrounded by widespread optimism for its perceived potential to solve water insecurity while circumventing major political and social costs. In fact, as often repeated by Allan (1998; 2001; 2003; 2011), virtual water allows governments to conceal water scarcity—hence preventing the social unrest it would cause—by importing water-intensive crops. The destabilising effect of water poverty has oftentimes been documented, even beyond the realm of the discussion on virtual water (see for example Moench, 2002).

Trade in virtual water has been proposed as a viable alternative to other possible mitigation strategies to water scarcity—such as war (Thomson, 2005) or water management (Calzadilla, et al., 2011; Chenoweth, 2008; Chapagain and Orr, 2008). Although research shows that countries opt for cooperative solutions over water rather than engage in conflict (Barnaby, 2008), the threat of war—perhaps best represented by the ex UN Secretary General Boutros Boutros Ghali's quote[5]—remains very much in the popular imagination (Thomson, 2005). The advantage of trade over war seems evident. Improving water management also entails significant—

mostly economic—costs, and necessitates an organised effort to divert water from other activities into agriculture (Allan, 1999).

Given that the alternatives to deal with water scarcity are far from perfect and that virtual water trade is depicted as beneficial for all involved, the optimism could be justified. However, when looking closely at both the explicit and implicit assumptions made in the literature, this optimism fades away. Specifically, the lack of awareness of the political interplays inherent in trade is highly problematic

2.3. The politics of virtual water: The question of development

The reluctance of local politicians to admit their region's dependence upon water resources out of their territory is the only political dimension commonly deployed in the narrative of virtual water (Allan, 1998; 2001; 2003; Lant, 2003). It must be clear through the above discussion that the concept of virtual water trade essentially lacks notions of politics in the way it is being described. The trading areas are simply viewed as *regions A and B*, therefore similar in all respects but the area's water stress (Lant, 2003; Allan, 2003). To be clear, the authors do not necessarily comment on the fact that the regions are considered equal. Nevertheless, by presenting a country's indicators for water as the sole relevant data—disregarding for example economic indicators, poverty, urbanisation, political regime, to name a few—they are assuming that these are not relevant to trade patterns.

Since its creation, virtual water has mostly been applied to arid or semi-arid countries, and particularly countries in the Middle East and North Africa—a region called MENA (see for example Wichelns, 2001; Earle, 2001; Allan, 2003). While it is hard to argue that this optimism is not understandable in the case of this group, it is not necessarily the case for the rest of the developing world[6].

MENA countries are part of the developing world but are arguably more politically salient than many developing countries. For example, a favourite in Allan's analysis is the state of Israel (Allan, 1998; 2003). Israel has a GDP of over 238 billion dollars, ranking fifty-second amongst the world's richest countries (CIA, 2012a). This country therefore has alternative economic activities to support its population. When the export of avocados was deemed too costly water-wise, Israeli economists suggested ending this trade relation and replacing it with another activity (Fichelson, 1994). A developing country would certainly not have the same opportunities should an export activity be considered unsustainable.

It is therefore safe to assume that given the characteristics of the MENA, the success of virtual water trade in warding off water scarcity-induced political instability might not be universally reproducible. Developing countries have not been at the centre of virtual water analysis. Yet this paper supports that it is vital to shift the focus in order to investigate the validity of the predictions made in the literature. To test its applicability in the context of development, a case study within a politically charged framework is presented, starting with a historical analysis of the study of development, then analysed through the lens of political ecology and entropy theory.

NOTES TO CHAPTER 2

1. The literature review of the use of virtual water relies heavily on the work of Tony Allan as he popularised the term, spending over thirty years of his career researching it.
2. The analysis of virtual water is by no means restricted to the production of food and foodstuff. Researchers assert that there is virtual water in any consumer product—including furniture, clothing and cars for example—or services—including financial services. In his latest book, Allan (2011) presents a comprehensive report of the water consumption of different cultures and people—for example vegetarians versus non-vegetarians. Yet for the scope of this paper, I will restrict the analysis to the virtual water cost of producing food and foodstuff.
3. Food security refers to the objective of ensuring that the totality of the population always has access to "sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Skoet and Stamoulis, 1996).
4. However, there is a crucial difference between the two. While Ricardo (1973) theorised that both countries would benefit from trade, he made no assertions on *how much* they stood to gain. At no point does Ricardo assume that all actors have the same profit margins through trade. On the contrary, virtual water has a normative element, as well as notions of morality. For example, Allan (2011) prescribes vegetarianism to alleviate water stress and food insecurity; given the complexity of such problems however, this solution seems oblivious to the workings of the political economy. Targeting consumers—as Allan (2011) clearly does in his latest book—has an element of paternalism and is unlikely to change international patterns of trade.
5. The last three UN Secretaries General have warned the public about the potential destructive role of water scarcity in world politics (Water Online, 2011). Most famously, in 1985, Boutros Boutros Ghali stated that "[t]he next war in the Middle East will be fought over water, not politics" (Sticklor, 2013).
6. Allan has recently broadened the scope of his analysis, particularly concerning the countries examined. In *Virtual Water* (2011), he explored the water footprint and virtual water trade of countries in Asia, Europe, North and South America and Africa. However, the majority of the countries examined are affluent, enjoying a wide array of benefits from trade.

3. Analytical framework

To build the analytical framework, I begin by contextualising the origin of the concepts of core and periphery. Then follows a qualification of the relation between the two, both from a historical perspective and using the concept of imperialism as employed by Caldwell (1977). A model using systems theory and the notion of entropy to explore the interactions between the socio-economic and natural spheres of these two regions is finally built, using virtual water as the hidden content of food trade.

3.1. The origins of the core-periphery relation: A historical approach

Any investigation on the relations between the North and the South must originate from a historical understanding of how this theme has been approached. The end of the colonial era marked a turning point in international relations. Rising from the fallen empires, the newly decolonised countries emerged as a seemingly homogenous group, clearly at a different developmental stage than the North, thus raising questions on how progress occurs (Steans and Pettiford, 2004). In the 1950's and 1960's, modernisation theory was the discourse addressing issues of growth; it rid developed countries of any potential blame for the South's underdevelopment, while maintaining an advantaged position for the North as a success story, an example to be followed. The central idea of modernisation theory is that the South needs to pursue development—and hence prosperity—following the path established by the North. Development, as characterised by economic growth, is seen as a linear process leading from a 'backward' traditional society to a modern and wealthy one[1] (Biel, 2000). Modernisation theory predicts that 'things will get worse before getting better', thus explaining poverty and inequality as a necessary evil on the road to development[2].

Perhaps unsurprisingly, the Northern bias[3] and hardly concealed political agenda[4] of this school of thought came under scrutiny and increasing criticism. Dependency theory emerged as a Southern alternative to modernisation. It gave development a much-needed political component, centred on the power differentials of two main groups: the core and the periphery. Authors like Gunder Frank (1966), Baran (1957) and Rodney (1973) contested the idea that underdeveloped countries were simply at an earlier stage of development, claiming that such a belief disregarded the historical experience of these regions. They argued that underdevelopment and development were inversely linked: as the North developed and the capitalist system engulfed the rest of the world, it caused the South to serve the interest of the North, thus impeding its own development. "Historical research demonstrates that contemporary underdevelopment is in large part the historical product of past and continuing economic and other relations between the satellite underdeveloped and the now developed metropolitan countries" (Gunder Frank, 1966). The most important contribution of the dependency theory school of thought was the thorough rethinking of the North-South divide. By looking at historical patterns, the blame of underdevelopment fell on the North's imperialist pursuits, hence creating the notions of core and periphery. The idea of a core-periphery dichotomy remains relevant and has later been used in numerous Marxist theories[5].

Yet, dependency can still not adequately explain the relations between the core and the periphery as it ignores the importance of the environment[6]. It now seems difficult to imagine omitting the environment from any analysis of trade, particularly given that pollution, environmental degradation and climate change are omnipresent concerns for a large part of the world. Trade patterns have a significant effect on the environment since they alter the location and intensity of environmental degradation by dictating the location of production activities, including agricultural production (Anderson and Blackhurst, 1992). For example, Western Europe exported pollution by outsourcing its production activities away form its territory (Anderson and Blackhurst, 1992). Dependency theory, however, would remain silent when faced with environmental concerns since the outlook is social in nature.

There is also a gross simplification when it comes to inputs and outputs to the world economy. Here, again, it is clear that the environment is missing from the analysis. Trade is a two-way process but it is not self-sustaining. When looking at the trade in food and foodstuff for example—the concern of this paper—it is clear that other factors come into play. Growing crops necessitates an input of nutrients, water and seeds—at the very least. Additionally, the waste generated needs to be absorbed at the point of production. Moreover, food production noticeably modifies the physical environment it takes place in, with deforestation being the most infamous example of this process[7] (DeFries, et al., 2010; Kaimowitz, 1997).

The ecosystem and the economic system need to be examined in relation to one another—through trade, particularly since the environment is central in supporting the socio-economic system. If the analysis is limited to economic and social factors, as is done in dependency theory, then a central component of the core-periphery relationship is neglected. To further examine this idea, a working understanding of systems theory and the Second Law of Thermodynamics is necessary.

3.2. Systems theory and Thermodynamics in social science

Defining systems theory can be daunting. Indeed, there exists no definition all scholars agree on[8], even though there are certain properties shared by all systems (Maturana, 1975). Maturana (1992), for example, stresses the importance of feedback loops—a process where parts of the output return into the system as inputs—in sustaining a regulatory process within a system. In this working paper, however, it is not necessary to dive into the intricacies of complexity science. Systems theory will therefore only be examined through the interactions between the economic and environmental spheres.

A good starting point to delve into the use of systems theory in social science is the work of Nicholas Georgescu-Roegen, a pioneer in reflecting upon the repercussions of the capitalist mode of production on the ecosystem. In his 1971 magnum opus *The Entropy Law and the Economic Process* (1971), he applied Thermodynamics to economics, thus shyly inserting nature in the analysis for the first time (Georgescu-Roegen, 1971; 1975). The First Law of Thermodynamics is based on the idea of energy and matter conservation, or, more specifically, the idea that "man can neither create nor destroy matter or energy" (Georgescu-Roegen, 1971: 76). Georgescu-Roegen argued that while this First Law has been accepted by economists of the time, it did not push them to include the environment in the analysis of economic activities. In fact, this process was seen as a closed system with energy going from production to consumption. Georgescu-Roegen extended the analysis by arguing that "what this *material* [economic] process does is simple: it neither produces nor consumes matter-energy; it only absorbs matter-energy and throws it out continuously. […] What goes into the economic process represents *valuable natural resources* and what is thrown out of it is *valueless waste*" (Georgescu-Roegen, 1971: 76-77). This qualitative aspect of matter is where the Second Law of Thermodynamics comes in to make a distinction between exergy, the high quality initial material, containing high levels of usable energy, and entropy, the low quality end product of matter or energy after it has been used.

The natural system thus has a double function in supporting the socio-economic system: it serves as a source of exergy and a sink for entropy, using the quality in between to function and sustain itself (Figure 3.1). In looking at inputs and outputs, it therefore becomes important to judge their qualitative distinctions.

Using virtual water allows for unmasking what is hidden within the object exchanged. Nature provides us with resources, including food and foodstuff. Yet the final product, the harvested crop, does not contain all the elements used to produce it. Particularly relevant to this paper is obviously the content of water, no longer available at the final stage of production, when the crop reaches the consumer.

A contentious issue with this analysis is immediately apparent: looking at these interactions while considering a country a closed system is highly problematic. As mentioned in the previous section, it is undeniable that the capitalist economic system is a highly globalised one. In fact, Lenin (1996) argued that "under capitalism the home market is inevitably bound up with the foreign market. Capitalism long ago created a world market" (Lenin, 1996: 67). Since production and agricultural activities can be relocated, the impacts on the environment might not necessarily affect the country where the goods are consumed. To further address this concern, the work of Caldwell is pivotal.

3.3. Caldwell's imperialism

Writing in the 1970's from a fundamentally Marxist position, the British scholar Malcolm Caldwell (1977) analysed the new form of imperialist control over the periphery. Looking at fossil fuels and energy, he noticed that the North's development and the South's underdevelopment were inversely correlated. Building on the core-periphery divide, the author offers a thorough analysis of the advent of capitalism and the development of free-market trade in the twentieth century. He goes on to complement the existing literature on underdevelopment with an additional, yet symmetrically opposite categorisation: overdevelopment. He explains that a central characteristic of an overdeveloped country is being "a net importer of proteins and hydrocarbons over time if it is to maintain or improve upon a certain level and type of consumption per head of its population" (Caldwell, 1977: 98). There are therefore some countries—or, better, a block of countries—which import large portions of the calorific intake needs of their population. Logically, it follows that they must import food and foodstuff from less developed countries. In fact, Caldwell focuses on the historical trend which led to the now "unquestionably privileged position" of overdeveloped countries—that is, of the core—vis-à-vis the rest of the world. He maintains that one of the central reasons why this position is maintained is the import of large quantities of food. To ascertain their position and ensure that the im-

Figure 3.1. Interactions between the socio-economic and natural systems within a closed system (Author's interpretation of existing literature)

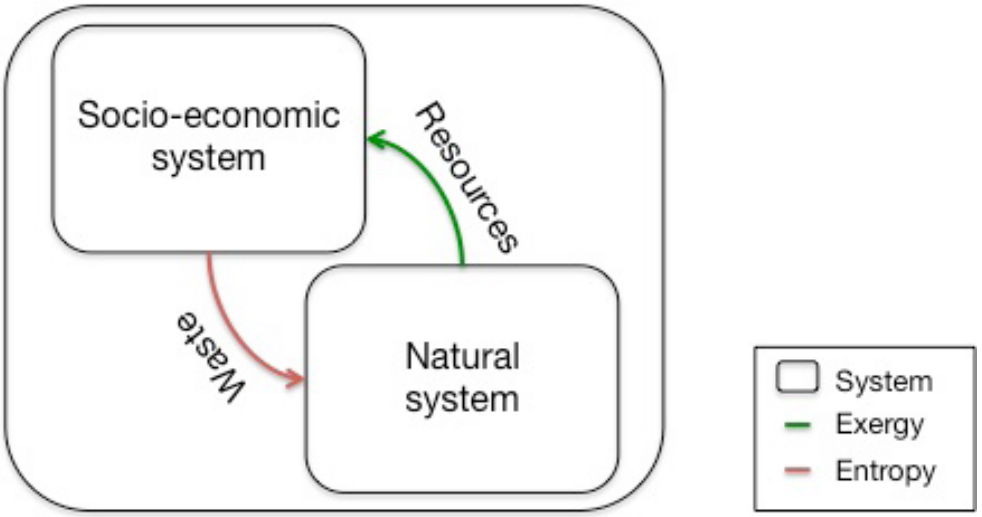
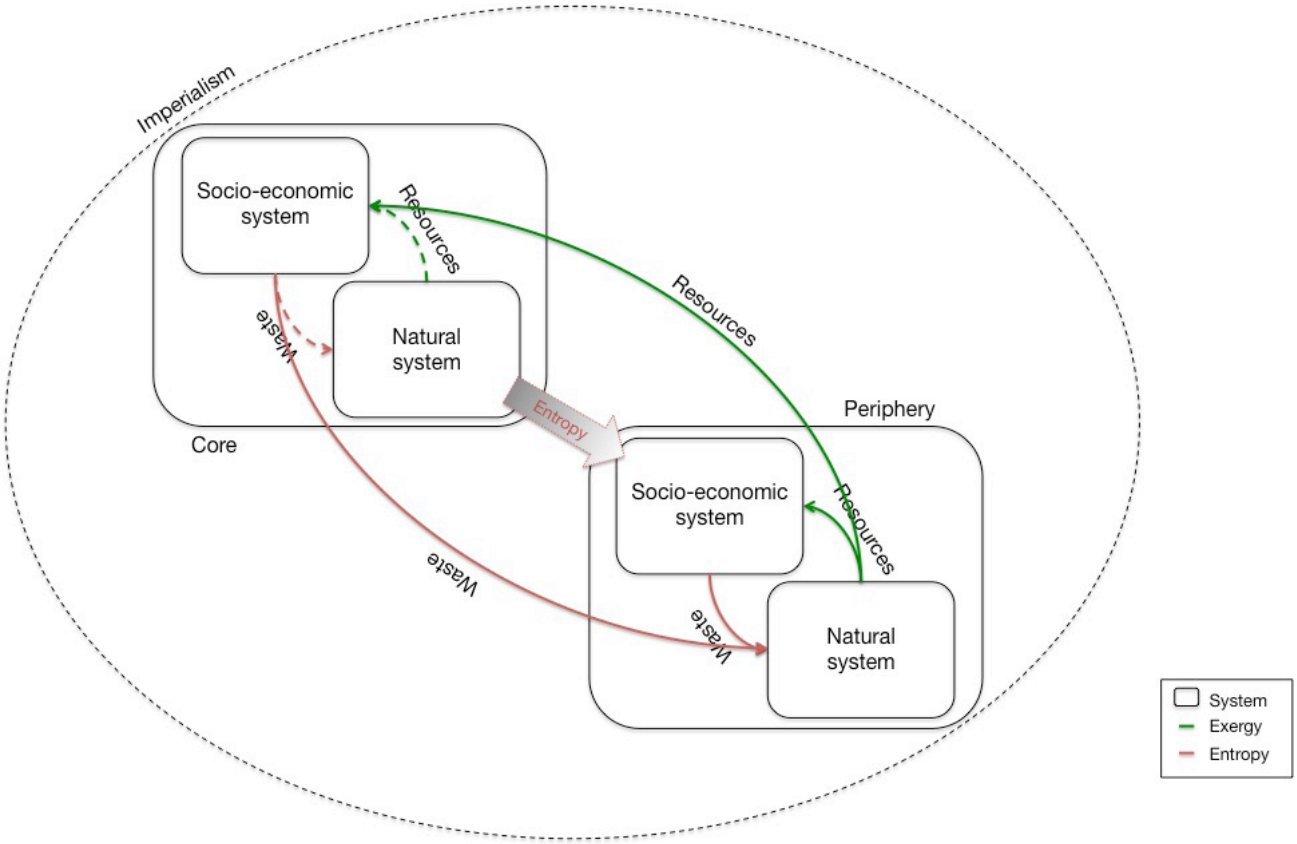


Figure 3.2. Interactions between the socio-economic and natural systems within the world economy[9] (Author's interpretation of Caldwell, 1977 within systems theory)



port of food at this scale is possible, these countries have "extend[ed] imperialist control over the rest of the world and convert[ed] their economies to meet the needs (including the needs for fossil fuels, […] food and foodstuffs) of the metropolitan economies" (Caldwell, 1977, 99).

Hence, there exists a feedback loop fortifying the core's already advantaged position, or a vicious circle of subordination if considered from the standpoint of the periphery. By importing huge quantities of food, the countries of the core manage to focus their economies towards the service sector, which in turn reinforces their financial prosperity and, thus, power. This power permits them to dominate the rest of the world, with no need for costly military control. The periphery's ecosystem is put to the service of the core's socio-economic system, while the detrimental repercussions remain away from the powerful North's territory. In systems theory terms, exergy therefore comes from the periphery's ecosystem to the core's socio-economic system. Entropy, from agricultural production and environmental degradation for example, is exported to the periphery, while the benefits from the energy release are enjoyed at the core. The superstructure—in Marxist terms—that governs this relationship is imperialism, both a product and a driver of the system (Figure 3.2). This imperialist structure is in fact now self-sustaining: having experienced centuries of subjugation, the periphery is now readily exploiting itself to the benefit of the core, in the hope of taking advantage of the window of economic advantage it is being offered. "Anticipating an indefinite prolongation and intensification of dependence, […] the leaders of the rich industrial countries have no option but to seek to maximise the geographical extent of the sphere in which they have a relatively free hand to prospect for and extract […] fossil fuels, and to skim off valuable proteins" (Caldwell, 1977, 102).

3.4. Closing the cycle of entropy

Still, a piece of the puzzle is missing. What Caldwell (1977) did not fully explore[10] , was the return of entropy to the core. The entropy exported to the natural system of the periphery is in no way contained within this subsystem. As explained above, the socio-economic system is highly dependent on the double regulatory process of the ecosystem. If this system is in any way impaired—for example robed of its exergy through saturation by the core's entropy—it will be unable to support the social system. Considering a pre-capitalist society relying on the land, the repercussion of environmental degradation becomes readily apparent: if degradation reaches a point of no return, a point where one of the necessary inputs to agriculture runs out, then production will halt and the population will need to relocate. In my opinion, this is a crucial point. When looking at the trade of food, water is definitely an irreplaceable input: there can be no agricultural activity in the absence of water. If export-oriented agriculture depletes the available water resources and there is no alternative, then this region will be forced to stop producing the exported crop—in a best case scenario—or relocate, with substantial repercussions on the local population's livelihoods—in a worse case scenario.

However detrimental to the periphery, such a development is also damaging to the core's economy. By destroying its partner's nature and thus economy, the core is limiting its set of potential trading partners, ultimately limiting its future room for manoeuvre, a manifestation of entropy within the economic sphere that has already been explored[11] (Biel, 2006; 2012). Nevertheless, I maintain that the mechanisms in play, which result in the depletion of the socio-economic potential of the periphery, are diverse. While Biel (2006; 2012) describes a double dissipative action from the core's capitalist mode of production, this paper supports that the depletion of the South's natural resources is in fact driving the social and economic entropy (Figure 3.3), through a series of feedback loops (Figure 3.4).

Once again, virtual water provides a helpful illustration of this relation. The water used in export-oriented agriculture is diverted in large amounts from other potential activities. This water is then "exported" to the core through crops. If water resources are depleted, then trading activities will stop and, if water poverty reaches the point where the surrounding areas loose access to water, the population might need to relocate[13]. For the core, this translates into the loss of a partner. Naturally, this might not be a serious setback in itself since there might be other regions willing to embark in a trading relationship with the core. It does mean however that the number of possible trading regions is now reduced from *n* to *n-1*. The core is thereby limiting its own activity. This limit becomes increasingly restricting as the water resources of different trading regions in the periphery are exhausted.

In the following chapter, this framework is applied to the case study of the trade of asparagus between the United Kingdom and the Peruvian Ica Valley to examine this model in practice. In line with the traditional application of virtual water, the analysis will begin with an examination of water scarcity in each of these trading poles.

Figure 3.3. Entropy in the imperialistic world economy[12] (Author's interpretation of existing literature)

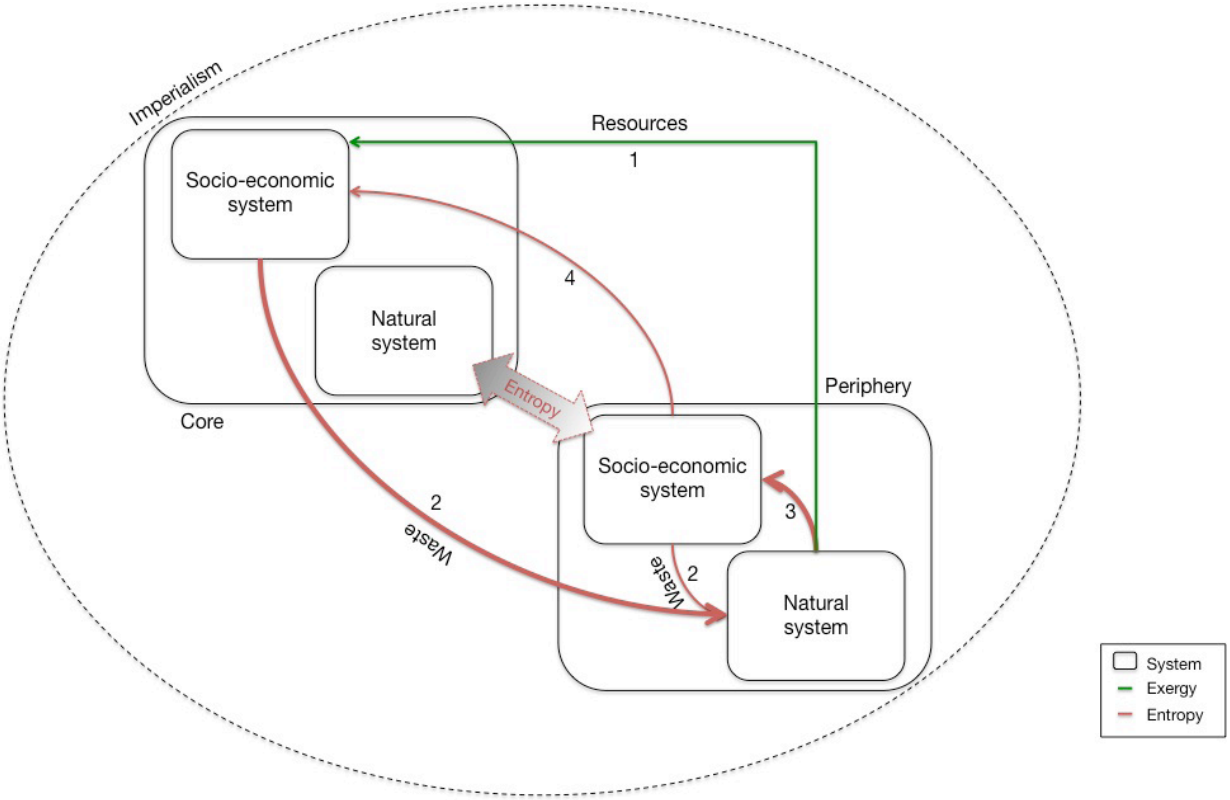
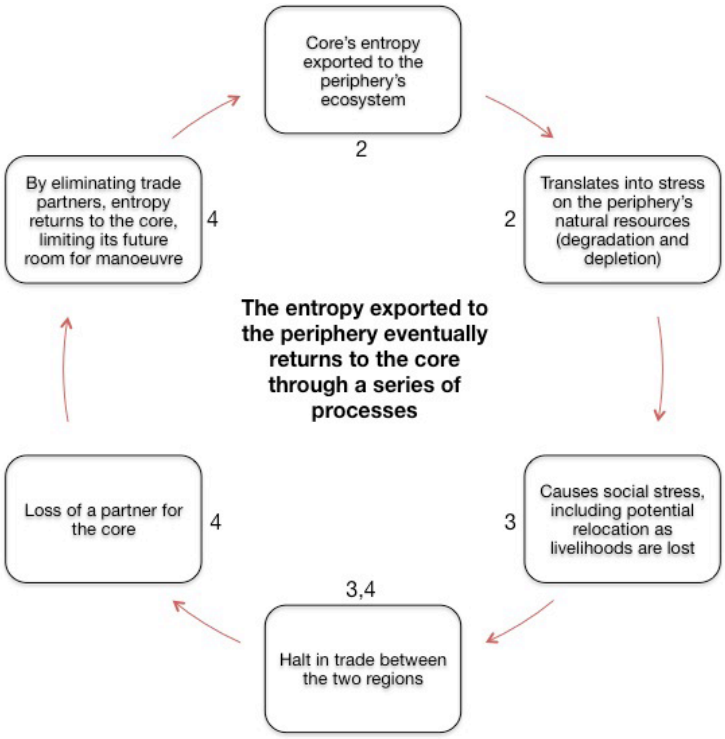


Figure 3.4. The cycle of entropy: Feedback loops explained through different steps (Author's interpretation of existing literature)



NOTES TO CHAPTER 3

1. The expected linearity of the developmental process is perhaps best represented by Rostow's (1953) stages theory, which assumes that economic development can be reached by any society following a pre-determined trajectory through five stages. In particular, Rostow argues that there is a specific 'take-off' stage, eventually leading to the age of mass consumption where all prosper.

2. The best visual representation of this conviction is the Kuznets curve. Simon Kuznets (1955) elaborated a hypothesis that there is an 'inverted-U' relation between economic growth and the level of inequality in a country: the initial growth engenders an increase in inequality, which is later reduced by increasing distribution of the rising levels of wealth.

3. Edward Said (1978) criticised the "Euro-centric bias" of development theories, serving—in his opinion—to justify the South's colonial experience.

4. Modernisation and stages theory were developed during the Cold War, when there was a well-grounded fear of newly decolonised—and underdeveloped—countries adopting communism. In fact, the subtitle of Rostow's (1953) book was "A Non-Communist Manifesto", leaving little doubt on its purpose.

5. Writing in the late 19th century, Marx (1976 [1867]) provided an analysis of the subjugation and alienation of the working classes in the capitalist system. Lenin (1996 [1917]) extended this analysis to a global economy, claiming that the relatively closed economic system Marx was writing about was now obsolete. In this world economy, the duality was no longer merely between the working class and the bourgeoisie, but, more importantly, between the capitalist nations at the core of the system and the poorer, traditional nations at the periphery. There is a linear, seamless progression from Marx to Lenin to dependency theory. Marx is therefore considered the forefather of the dependency school of thought and subsequent theories using the core-periphery divide.

6. This disregard for the environment in both modernisation and dependency theories is interesting, particularly since the notion of limits had already emerged. In the best-selling book *Limits to Growth*, Meadows et al. (1972) used modelling and forecasting to demonstrate that growth could not continue indefinitely, and certainly not when combined with increasing urbanisation and development. The authors identified pollution as one of the limiting factors to economic growth: coupled and aggravated by population growth and industrialisation—two undeniably on-going trends—pollution and natural resource depletion will cause the Earth's carrying capacity to be reached.

7. In a recent study, DeFries et al. (2010) found significant correlation between tropical forest loss between 2000 and 2005 and international urban demand for agricultural produce. International trade in food and foodstuffs, and thus export-oriented agriculture, was found to be one of the drivers in tropical deforestation. There are also substantial data proposing that international trade oftentimes leads to a protection of tropical forests (López and Galinato, 2005). For an in depth discussion of the links between deforestation and trade, see Brown and Pearce (1994).

8. Originally applied in biological science (Von Bertalanffy, 1950), systems theory has been used in different fields as different as psychology (Bateson, 2000) and economics (Georgescu-Roegen, 1993). The fact that systems theory is interdisciplinary at heart explains the absence of a single definition.

9. While the core depends on the regulatory processes provided by the periphery, there remain interactions within the system: the core's environment still absorbs waste and provides resources for the economic system. One could even argue that, as environmental depletion advances within the core, there is an increased incentive to drain additional resources and export increasing amounts of waste to offset environmental degradation at home.

10. Perhaps, as suggested by Biel (2006), due to the fact that Caldwell died before completing his work.

11. Luxemburg (1951) grounded her analysis of the linkages between the capitalist and pre-capitalist spheres on the philosophical idea first developed by Spinoza and developed by Hegel that "every determination is negation", or better *omnis determinatio est negatio* (Melamed, 2012). Luxemburg argues that the capitalist system can only define itself in opposition to a traditional, pre-capitalist social sphere, which it necessarily exploits to fuel itself. Biel (2006; 2012) thus maintains that capitalism dissipates its entropy in both the periphery's natural and social systems. "Entropy as an idea is somehow linked to the exhaustion of the future room to manoeuver, or of the developmental potential, in any system. The latter fuels itself not only at the expense of physical resources (raw materials, human resources), but by depleting its future room to grow" (Biel, 2006: 119).

12. The four steps in this process are further elaborated in Figure 3.4.

13. "Water refugees", that is populations that have had to relocate upon exhausting their regions' water resources, are already a reality in many parts of the world. Agriculture takes a huge percentage of a country's water resources—as high as 90% in parts of Asia and Africa. This is very problematic in a context of water scarcity, as there needs to be a choice between using water for "irrigation, or for domestic and industrial purposes" (Kirby, 2001). There have also been calls to incorporate environmental and water refugees within the existing international refugee laws (Jenkins, 2011).

4. The trade of asparagus between the United Kingdom and Peru: A case study

As explained in *Chapter 2*, the traditional study of virtual water makes certain assumptions on some characteristics of the two trading poles as well as the motivations behind the choice of traded products. The region with less water imports water-intensive crops from the water-rich region. In this manner, the water poor country avoids the costly and unsustainable process of diverting large quantities of water into agriculture (Allan, 1998; 2003; Hoekstra, 2005). In presenting this case study, some qualifications are thus needed. In particular, it is important to:

1. Examine whether the United Kingdom (UK)—the importing country—is water poor.
2. Explore the advantage of trading asparagus both for the UK—in terms of demand—and for Peru—in terms of the effect on its ecosystem.

Dealing with these issues, this paper returns to the concepts of comparative advantage, imperialism and economic demand to examine what really drives trade.

4.1. Presenting the two actors

The United Kingdom

The UK is irrefutably part of the core; Caldwell's (1977) analysis was tailored around the country's experience and development. Once a major European Empire, it still remains one of the ten wealthiest nations in the world (CIA, 2012b). The UK underwent its industrial revolution in the eighteenth century, and the population share in the primary sector has steadily decreased ever since. Nowadays, only two per cent of the population is employed in agriculture, yet providing food and foodstuff for sixty per cent of the country, due to a high mechanisation of the farming system[1] (CIA, 2012b). The government is currently promoting a program to achieve greater food security by reducing its reliance on food imports. However, in 2008, the UK still imported over forty per cent of the calorific intake of its population (Cabinet Office, 2008).

Consumption patterns for all food and foodstuff have been increasing in recent years. According to a 2008 World Wildlife Fund report (Murphy-Bokern, 2008), the British demand for asparagus increased by 126 per cent over the fifteen year period between 1990 and 2005.

Callejón de los Espinos, Peru

Peru is a relatively wealthy Latin American country, with a significant industry; 29.7 per cent of the population is employed in agriculture (nationmaster, n/a). However, there are mass disparities amongst regions within the country. The coastal region is generally the most developed and dynamic, with the exception of the desert near the Ica Valley, the area where Callejón de los Espinos is situated. The Ica Valley is the poorest region in the country, with growth hampered by inadequate infrastructure (CIA, 2012c; Hepworth, et al., 2010).

The population of the Ica Valley and surrounding areas is mostly rural, and the inhabitants live in a delicate balance with nature, as the region experiences severe droughts and is classified as hyper-arid. Because of this, the booming export-oriented asparagus production has had negative impacts on small- and medium-scale farmers (Hepworth, et al., 2010). The cultivation of asparagus is testing the limits of water usage as it is "overexploiting a rapidly dwindling and limited water resource in one of the driest places on earth" (Hepworth, et al., 2010: 5).

4.2 'Water, water, everywhere, nor any drop to drink'[2] : Is the United Kingdom water poor?

The UK is notoriously wet: what better example of the country's perception than the Czech Republic team appearing at the Olympics Opening Ceremony in mid-July wearing Wellington boots and carrying umbrellas (Huffington Post, 2012). Nevertheless, the UK imports two thirds of its water through virtual water trade, which makes the country the sixth importer of virtual water in the world (Hepworth, et al., 2010). In fact, not only is the UK importing water "in the form of food, energy and other goods, that require water for production and transportation", it is importing from countries and regions that are water stressed (Beadon and Page, 2010). In recent years, this practice has been recognised as problematic, also gaining attention in the media (Lawrence, 2008a; 2008b; 2010; Guardian.co.uk, 2008a; 2008b; Vidal, 2010).

Allan (2011) argues that this is because, despite the frequent rainfall, the United Kingdom is in fact water stressed, having surpassed its water environment's car-

rying capacity[3] . Looking at the total water needs for agriculture alone, a mere 38% comes from within the country, the rest being imported in the form of virtual water. In fact, the UK is plagued by regular droughts despite the frequent rainfall, which might explain why it imports 63.6 billion cubic metres yearly (Hepworth, et al., 2010). However, the concept of relative water poverty needs to be introduced at this point. Even accepting Allan's thesis, one must consider the regions the UK is importing its food and foodstuff from. A 2008 Government report on food security noted that sixty-eight per cent of all food imports come from other EU countries, making special reference to Spain as one of the largest exporters for the UK (Cabinet Office, 2008). Yet in the same book, Allan (2011) categorises Spain as a semi-arid country, having clearly less available water than the UK. Considering that the Ica Valley is hyper-arid, Britain certainly does not qualify as a water poor country for the scope of this paper.

4.3. The trade of asparagus between the United Kingdom and the Peruvian Ica Valley

In the past twenty years, the Ica region has experienced a boom in asparagus production, fuelled by an increasing international demand. On the whole, Peru has been allocating an increasing amount of farmland to the production of asparagus, passing from eighteen thousand hectares in 2005 to twenty-eight thousand hectares in 2009 (Benson, 2009). The Ica Valley is at the heart of the Peruvian asparagus production, accounting for nearly ninety-five per cent of total production. In fact, the land allocated to asparagus grew form none in 1990 to over ten thousand hectares in 2008 (Hepworth, et al., 2010). While production is thriving, consumption of asparagus in Peru lingers at an extremely low level: less than one per cent remains within the country; the rest is exported (Benson, 2009). It is thus clear that the asparagus production in Peru—including the asparagus production in Callejón de los Espinos—is entirely export-oriented. The local population has no demand for this good. Internationally however, the demand for asparagus has been rocketing since the early 1990's, and this trend is very clear in the UK as well. The UK is now the third largest net importer of asparagus from this region (Hepworth, et al., 2010).

As mentioned above, the production of asparagus is negatively affecting the water resources of this water-poor region. Hepworth, et al. (2010) present testimonies of farmers, some of who are already in the process of relocating as a direct consequence of their farms having lost access to water. As water for irrigation is becoming scarce, small and medium-scale farmers are either selling their land, relocating or going into debt because of the increasing costs connected to sustaining their access to water—which would include expanding the current wells, digging new ones or getting water from areas further away. Clearly, this favours big agribusinesses—like the asparagus producers—rather than traditional farmers. In fact, small and medium-scale farmers are already selling their land and wells to big agribusinesses in order to survive in an increasingly competitive environment (Hepworth, et al., 2010).

Another important distinction between traditional small and medium-scale farmers and export-oriented agribusinesses is the source of water they use. While traditional farmers mostly use surface water diverted from the Ica river, as it is much cheaper, and only complement it with groundwater in the dry season, big agribusinesses only use groundwater for agriculture as they can easily offset the cost. Water use for irrigation is supposedly regulated by a central agency. The reality, however, is that groundwater is available to those able to incur the cost of the extraction (Hepworth, et al., 2010). Perhaps unsurprisingly then, the export-oriented farming of asparagus is therefore using one hundred per cent of groundwater. In the dry season, the water demand for asparagus is more than double that of traditional crops like cotton—thirty thousand cubic metres per year for the former versus fourteen thousand cubic metres per year for the latter (Hepworth, et al., 2010).

Moreover, water for domestic use has already been affected: the access to water of Callejón de los Espinos has been reduced from "two hours of water at least four times a week [to] about one hour of water three times a week" (Hepworth, et al., 2010: 48).

While the water resources in Callejón de los Espinos can still support exporting asparagus, it is safe to assume that this will not be the case indefinitely. The water necessary to meet the UK's imports of asparagus from this region alone corresponds to nine million cubic metres per year, even thought the Ica Valley is one of the driest regions on the planet. Looking at rainfall alone, the UK receives two thousands times more water than the Ica Valley (Hepworth, et al., 2010). Given the on-going trend of groundwater overdraft, the region will run out of water sooner rather than later. When this happens, the repercussions will be severe, both economically and socially. There are countless recorded cases of exhaustion of water resources in the global South. Moench (2002) presents the cases of Saudi Arabia, India and Yemen as cautionary tales of the dangers of extreme water poverty. He discusses the consequences of such relocation on the poor's livelihoods: they do not only loose their land, but, more importantly, their networks. They are thus unable to cope with hardship, and are often forced to move into the cities to work in the informal economy. There are no indications that the case of the Ica Valley will be any different. What is more, these farmers will loose a part of their identity and culture, which is bound to the Valley, an area that has been populated for thousands of years (Hepworth, et al., 2010).

In systems theory terms, the entropic feedback loops in play in this case study are clear. The United Kingdom—the core—exploits the water resources of the Ica Valley—the periphery—leading to a genuine threat of exhaustion. This, in turn, affects the rural population, which stands to loose both their homes and livelihoods. If this trend continues unchanged, the entropy will be imported back into the UK when the region will stop producing asparagus. This could also momentarily disturb the UK's asparagus imports since Callejón de los Espinos represents a significant exporter for the country.

4.4. Why asparagus?: Applying the theory of comparative advantage within a core-periphery framework

A question arising from this case study is *why would a water poor region in Peru grow asparagus*? Surprisingly, this question is, in all likelihood, answered more satisfactorily using the theory of comparative advantage, rather than its successor virtual water. Asparagus can grow on different types of soil "but deep loam or sandy soils with good surface water and air drainage are best" (Motes, et al., n/a). The implication is that asparagus can grow in the UK since it grows on all soils. However, the proximity to the desert ensures sandy soil in the Ica Valley, ideal for the cultivation of this crop. Moreover, asparagus prohibits the cultivation of any other crop since the crowns stay in the ground for years. It demands manual labour and weeding to ensure the quality of the soil is preserved, while the UK's agriculture is decisively mechanised, as mentioned earlier. Lastly, asparagus only grows during a short window of time—a matter of weeks—in Europe (Tabler and Lawson, 2008). By importing from Peru, the UK ensures a year-round supply. Callejón de los Espinos therefore has a comparative advantage over the United Kingdom in the production of asparagus; but this advantage has nothing to do with water.

Recently, there has been some interest on the UK's import of large quantities of water, while some authors even touch on the fact that the country imports from areas experiencing water shortages (Beadon and Page, 2010; Chapagain and Orr, 2008; Vidal, 2010). Nevertheless, the focus is not put on the countries experiencing water stress. Instead, there are two prevalent positions. Some authors are suggesting that what is troubling is the possibility of a 'perfect storm', where global water, food and energy scarcity will coincide and get exacerbated by climate change, with devastating results (Beddington, 2009; Sample, 2009). The concern is therefore for the future of the UK economy, rather than resource depletion in the South as such. This position is very much in line with the imperialist model outlined in *Chapter 3*: the periphery contributes by providing inputs; its fate after this role can no longer be fulfilled is irrelevant.

On the other hand, some authors are underlying the potential of virtual water in correcting these imbalances. They suggest that an understanding of virtual water trade would stop the trade in asparagus, thus allowing the Ica Valley's ecosystem to restore some of its functions (Hepworth, et al., 2010). However, this paper suggests that the draining of the Peruvian ecosystem is typical of the core's imperialistic tendencies, thus predicted by the model presented in Chapter 3. There is no evidence supporting the thesis that understanding virtual water trade leads to concern over the global water resources, other than the work on the MENA region, and perhaps Israel in particular. This paper therefore sustains that the trade in asparagus is not likely to stop before complete exhaustion of the Ica Valley's water.

The distinction between water scarcity and water poverty is crucial. A region experiencing shortages is not necessarily water poor. As Biel (2009) underlines, water scarcity is often due to mismanagement or maldistribution[4] of water, rather than objective water poverty. In the case of the global South, the increased intensity of export-oriented agriculture has been known to exacerbate existing stress on water by redirecting resources away from the poorest parts of society. Yet the economic benefits of this endeavour are enjoyed by a privileged few rendering some areas water poor. In this way, the government—aided by large agribusinesses within the country—exploits its own people for the benefit of the core. This is the case in the Callejón de los Espinos, where the local population could have inhabited the area for long periods before the disruption caused by the asparagus industry.

NOTES TO CHAPTER 4

1. In his analysis, Caldwell (1977) referenced the mechanisation of agriculture as yet another manifestation of overdevelopment. He stretched the argument to imply that there was a conscious choice over the export of agricultural technology: the UK only transferred said technology to a selected few countries, like the United States and Australia, while subjugating the economy and agricultural production of the rest of the world through imperialist control.
2. Extract from Samuel Taylor Coleridge's (1798) poem *The Rime of the Ancient Mariner.*
3. When thinking about water security, a distinction between blue and green water is needed. While both begin as rain, blue water "flows through the landscape into rivers, lakes, aquifers. [It] can be used damned, stored, stored and metered and used to

irrigate". Green water "infiltrates into [the] soil and is taken up by natural vegetation and crops. Much is transpired by natural vegetation back into the air" (Allan, 2011: 42). While rivers and streams are the visible water resources, Malin Falkenmark (2008) showed that green water was in fact much more important in agriculture. This is particularly relevant in the case of the UK.

4. Uneven distribution of natural resources is a typical example of environmental injustice (Agyeman, 2005). There are numerous examples of sections of society either being unevenly affected by environmental degradation or, like in the case of water, that the poorest part of society has limited access to a resource.

5. Conclusion

Looking at trade between the core and the periphery opens Pandora's box of related issues. In my opinion, the main weakness of the concept of virtual water is the fact that it tries to simplify these issues, detracting from the subject's complexities to reduce it to the amount of water the two trading poles have. By introducing political ecology through a systems theory approach, and in particular using the notion of entropy, the complex relations between the core's economic system and the periphery's environment become apparent. The core is depleting the South's water resources used in agricultural production. This depletion is restricted to the periphery, while the energy release from the crops is enjoyed in the core, which has an invasive and devastating effect on the economy of the periphery, an effect which is all but ephemeral. However, the entropy exported eventually returns to the core after the trading partner in the periphery exhausts its resources—in the case of virtual water, the core is truly 'sucking the periphery dry'. Trade can therefore not be reduced to the sum of its parts; it has emergent properties, the destruction of the environment and subsequent damage to the core's economy being a highly unwanted one.

By exploring the case study of the trade of asparagus between Peru and the United Kingdom, some questions arise: why would these regions trade a product with such small nutritional advantage[1] when the side effects to the economy of both partners are clearly detrimental[2]? The absurdity of this model is confounding. By looking at the historical experience of imperialism however, it becomes apparent that decision-makers in the core have a limited understanding of the consequences of unequal trading partnerships. In this highly globalised world, the prospect of running out of trading partners for any given commodity seems absurd. This however is but a misreading of the concept of entropy.

To be clear, I do not object to the validity of the term as such. On the contrary, further research on virtual water is highly important, since trade is a powerful tool to deal with scarcities, including food and water shortages. However, when applied in the context of development, there are notable discrepancies between the theory and the practice that need to be addressed.

NOTES TO CHAPTER 5

1. While asparagus has a limited calorific equivalence, it can be argued that it is an aspirational good, providing the consumer with a sense of status. It is therefore central to said consumers to be able to procure asparagus all year round.

2. It is not important whether the negative economic effect will materialise in the relative short-term, as is the case of the Ica Valley which might exhaust its groundwater resource sooner rather than later, or in the long-run, as will be the case of the UK after limiting its trading partners.

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