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Social-Ecological-Membrane

Analysis of a

Social-Ecological System's boundary area

by example of a Permaculture farm and its surrounding systems

Verfasserin

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Es war einmal ein Lattenzaun,
mit Zwischenraum, hindurchzuschaun.
Christian Morgenstern

Introduction

Isolation and remoteness are situations, which have been of great interest and attraction for scientists. The Galapagos Islands triggered Darwin's thoughts on evolution (as did the Malay Archipelago for Wallace) and studies on indigenous, isolated societies have been a key topic in Social Anthropology. But in the last decades the face of the planet changed fundamentally. In most parts of the world, demography changed drastically, resources became scare and globalization turned the former *terra incognita* into a *global village*. Although the term *global village* was coined for information technologies[1], it applies to many aspects of modern life and its science: high population density and (mass) migrations (Geography and Anthropology), transportation and infrastructure (Engineering Studies), global trade (Economy), multinational institutions (Politics), etc.[2]

As the Club of Rome already pointed out in 1972, with all these large-scale changes, one thing remained the same: the actual size of planet earth. It did not grow with us, but with all this rise of people, information and knowledge, complexity has risen as well. From an evolutionary perspective this is not surprising, as it is a common trait of evolution. But as Luhmann pointed out, simply stating complexity does not say much. It becomes important, if we look at the difference of system and environment and the attempts of systems to reduce the complexity of their environment (Luhmann 2008:22). These two terms are two important pillars of this thesis. Systems theory is the mental model and frame I will use to approach my questions on how Social-Ecological Systems work.

Organisms show an interesting trait in their organizing attempts. They seem to have identity, reason and purpose, in that sense that they follow their interests and thereby try to maintain their identity. They interpret the environment with regard to their

[1] Marshall McLuhan, *The Gutenberg Galaxy: The Making of Typographic Man*
[2] The role Biology plays in the Global Village shall be spared out for the moment, as it will be discussed in the opening chapter.

interests and change their behavior according to it and through that their self-organization mingles with natural selection.

A whole theoretical branch has developed around *autonomous agents* (cf. Kauffmann 2000). Biologic examples are vast: a microbe might move away from a spot because its surrounding changed from acid to alkaline and another one might "move in" under those same conditions. Billions of migratory birds follow a climate, that is most conducive for their own and the well being of their offspring.

On a larger scale the difference between an ecosystem and its surrounding system can be as seemingly obvious as an island or a patch of meadow surrounded by forest. But it gets difficult here to talk about the whole system as an *autonomous agent*. A forest does not want anything. Individual parts (trees, insects, microorganisms, etc.) have individual interests and out of this *emerges* the system forest. But if the system forest is to be defined, it has to be done by humans. (The forest does not define itself and it is not known that other forests or other ecological areas define forests.)

Ecologists draw an artificial line to define an ecosystem. Reichholf (2008) argues that an ecosystem constitutes the frame for a research concept and is not a functional unit of nature.

But then he also looks further at natural systems governed by people. People confine areas, control them and try to maintain a stable or at least recurring state. (agriculture, conservation areas, etc.). They define the function of what they call an ecosystem.

This is only one reason why it seems it to be impossible, especially today, to look at ecosystems without factoring in humans. If we want to understand, let alone govern natural systems, I consider Social-Ecological Systems (SESs) the most appropriate unit to address. In times of global change and environmental deterioration the understanding of human interactions with the environment is inevitable. Not only for questions of natural resource management but also for basic questions of health, security and well being for humans and other beings.

The relationship people have with their natural environment is probably as diverse as each individual. But nevertheless, changes in human–nature relationships happen on large scale as well.

The Neolithic transitions changed the face of the planet profoundly and irreversibly (for the moment). The natural environment changed drastically and with it human biology and culture, expressed in settlement patterns, food, work, diseases, technology etc.
Human support systems evolved, which are only stable with human intervention. For at least 10.000 years, living and surviving in such systems has been our fate and it will continue so in the future. What might have started out as small settlements at different parts of the world, from the Fertile Crescent to the Americas, grew into this global village we are living in today.

“The first man who, having fenced in a piece of land, said "This is mine," and found people naïve enough to believe him, that man was the true founder of civil society. From how many crimes, wars, and murders, from how many horrors and misfortunes might not any one have saved mankind, by pulling up the stakes, or filling up the ditch, and crying to his fellows: Beware of listening to this impostor; you are undone if you once forget that the fruits of the earth belong to us all, and the earth itself to nobody.” (Rousseau 1754)

Without commenting on the philosophical value of Rousseau’s statement, I find it interesting and very useful for my research as well, taking this first fence stake as pars pro toto and starting line.
The statement “This is mine” is indeed a crucial one and legal and social aspects that follow this statement will be discussed in the course of this paper, but even before that, I think it is necessary to point out the importance of the statement that lies within the latter, which is: “This is.” With fences and borderlines, humans state, “there is something”. Creating this border allows to maintain a certain identity (even if it changes to a certain degree over time). Landowners might go as far as saying not only, “This is mine” but “This is me. This is what defines me.” (cf. Theodossopoulos 2000) This thought might not be as commonly used for landowners as it is for nationalities, clanships, families or other social groups, but it illustrates the connection between mental model and the natural world most drastically (cf. Clayton et Optow 2003).

And although the presented case study will deal mostly with “This is mine” statements, with private landowners, who very strongly identify themselves with their land, the relevance of boundaries for all Social-Ecological Systems is obvious, although different boundary aspects will be relevant for different systems. As mentioned before in the citing of Reichholf, for a scientific view on a(n) (Social-) Ecological System one has to *define* the system first, its boundary or limits. When analyzing complex SESs or managing CPRs (Common-Pool Resources), defining the boundaries has been identified to be crucial for organizing collective action. Since Hardin’s thoughts about the *Tragedy of the Commons* (Hardin 1968) researchers are trying to find ways to avoid this tragedy by creating and supporting sustainable SESs.

“Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself. Defining the boundaries of the CPR and specifying those authorized to use it can be thought of as a first step in organizing for collective action. So [*sic*] long as the boundaries of the resource and/or the specification of individuals who can use the resource remain uncertain, no one knows what is being managed or for whom. Without defining the boundaries of the CPR and closing it to “outsiders”, local appropriators face the risk that any benefits they produce by their efforts will be reaped by others who have not contributed to those efforts.” (Ostrom 1990:91)

I want to pause at exactly this *first step* and have a look around. When applied to questions of resource management, simply defining the boundary might be enough, but boundaries of any ecological system that is defined, controlled and managed by humans, must have more aspects than just that. I want to find out if they can be regarded as vital part of the system, not just a gradient where couplings become weak (cf. Bossel 1994). They need to be maintained and they retroact with the systems control units and the environment. Disturbances in boundaries seriously threaten the integrity and therefore survival of any system.

Helping systems to survive and creating resilient systems that *meet the needs of the present without compromising the ability of future generations to meet their own needs*[3] is the goal of sustainability science.

[3] Definition of sustainability following the Report of the World Commission on Environment and Development. (1987)

By looking at SES boundaries, many features, which are requested from sustainability science, follow naturally its train of thought, making them a helpful guideline for understanding these complex systems of which humans are such an essential part. Things become visible at the border and it might be easier to look for them in a comparatively small area, the borderland, then getting lost in the coppice of the inside. And accepting boundaries as part of the system, as protection as well as separation, as one structure embedded and connected with other structures, might change our attitude towards the differences that lie between “inside” and “outside”. The picket fence, as metaphor for different SES’s boundaries, symbolizes this, because it functions not only because of its stakes, but because of the spacing in between them as well.

Boundary and limits of this paper

This introduction will follow chapter 1 on Social Ecological Systems, building the theoretical foundation. Therein an analysis of systems theory, Sustainability and SES, Permaculture Systems and Boundaries will be given, leading up to a research boundary definition in chapter two. Research question and methods can also be found in this chapter. The research area and its history can be found in chapter 3.
After the establishing of the theoretical material, the results of the field study will be presented in chapter 4 followed by their discussion and implications in chapter 5.

The presented thoughts and results are only the very first attempt to find a way of understanding and describing SESs through their boundary area. The thesis is aiming for transdisciplinarity but cannot deliver a complete synthesis across all levels and scales. (The difficulty of the uniqueness of single SESs will be discussed in Chapter 1 as well.) It is important to point out that the factors and aspects were assembled particularly with regard to the study object, a certain type of SES, namely a private property with some public functions as well. Therefore the theory does not claim to be complete. The findings can rather serve as an adaptable framework that can be adjusted to other study objects with different objectives. Another crucial limitation of the presented results is the lack of time span. The history of the observed area will be considered roughly, but the evaluation represents a snapshot of a rather narrow time window. Considering long-term path dependencies,

developments and changes over time will be an inevitable step towards a more complete and in depth understanding of the occurring processes.

1. Social Ecological Systems

1.1. Systems theory

The word system appears twice in this thesis title. This requires a closer examination of the term. Systems are omnipresent today in any part of life, not only, but especially in the scientific world. A few quotes may illustrate this, “Ecosystems are essential for human well-being…” (Millennium Ecosystem Assessment, 2005) and “…changes in climate and their effects on natural and human systems.” (IPCC Synthesis report 2007), “Environmental governance depends on good, trustworthy information about stocks, flows, and processes within the resource system being governed, as well as about the human-environment interactions affecting those systems” (Dietz, Ostrom, Stern 2003), “With nature and not machines as their inspiration, today’s innovators are showing how to create a different future by learning how to see larger systems of which they are part and to foster collaboration across every imaginable boundary.” (Senge 2008, 2010)

The scientific examination of systems can now look back at a few decades of research. The efforts of finding a common theory in the 40ies of the last century were partially successful (Luhmann 2009) but there is still no general systems theory and there probably never will be one. But drawing from different scientific fields (mathematics, computer science, biology, sociology, etc.) the understanding of systems and system behavior is constantly growing. To not get lost in the ocean of data, definitions and publications, definitions of key terms that will be used and referred to in the course of this paper will be established in the following section.

1.1.1. Systems

In general one speaks of a system if there is something consisting of several elements, which show certain characteristics:

> A system is a set of interrelated objects (elements, parts) that have certain general properties:
> 1. It fulfills a certain function. I.e. it can be defined by a **system purpose** recognizable by an observer.
> 2. It has a characteristic constellation of (essential) **system elements** and an (essential) **system structure, which** determines its function, purpose, and identity.
> 3. It loses its **identity** if its integrity is destroyed. A system is therefore **not divisible**, i.e. the system can no longer be fulfilled if one or several (essential) elements are removed. (Bossel 1994:22)

Because biology is usually dealing with open systems (in contrast to closed systems), the focus here will also be on this type of system. Biological systems keep their structure and order up through a constant exchange in form of energy, matter, or information. The metabolism of an open (biological) system maintains a steady state, thereby (temporarily) decreasing entropy and moving towards increased complexity. (Bertalanffy 1950) In order to do that, open systems need a permeable border.

One can check the above-listed points on the example of the basic biological unit, the cell. An eukaryotic cell for example consists of interrelated elements such as a nucleus, organelles and a membrane. The basic purpose of the cell is its own survival. If the cell is integrated in a higher organization, i.e. a cell of an organ, it might have an additional purpose as well, but this purpose can only be reached, if the basic purpose of survival is fulfilled. The purpose of a cancer cell is obviously different from the purpose of the organism it is part of, in the worst case leading to the destruction of both, the subunit (cancer cell) and the main unit (organism).

This illustrates one difficulty when dealing with systems, the fact that the purpose of subunits might add up to a result that no single unit intended. The different levels of purpose become especially important when we are dealing with highly complex systems (like Social Ecological Systems). Human made systems like organizations for example have great difficulties maintaining their functionality if they cannot establish consistency of purpose across their organizational units. (Bartlett 1990, Simon 2009)

How profoundly the structure of cell elements influences its functioning can be seen if one imagines that the cell's membrane for example would no longer have its permeability. The cell could no longer keep up its metabolism. If the membrane were destroyed all together, the cell would immediately lose its integrity and cease to exist. This characteristic is essential for the upcoming argumentation and will be looked at further in the chapter about boundaries.

The theory of open systems contributes not only to the understanding of individual units, but also to the understanding of evolution. Natural selection will allow any combination that is compatible with its environment and will allow its survival in it. The constant exchange, adaptability and combination of cells can explain how a set of similar structures (nucleus, organelles, etc.) can result in the high diversity we find in life forms on earth.

1.1.2. Stocks and Flows

In order to understand systems and their dynamics, different models have been developed. A very basic model for a system is the Input-Output-Model. This model deals with a founding stock and a flow of material that adds or subtracts from the stock. A popular example is the model of a bathtub. The water in the bathtub is the systems stock. Through a pipe (regulated through a faucet) water can be added to the stock, through another pipe (regulated through the plug) it can be released. The stock can be changed through both, the inflow and the outflow. If the sum of inflow equals the sum of outflow, the stock will be in a dynamic equilibrium.

It is a key point in understanding systems behavior, that stocks, especially large ones, usually allow a system to only change its behavior slowly and gradually. They act as delays or buffers. (Meadow 2008) If the bathtub is very large and holds a lot of water, it might take some time before we realize that the plug has been pulled and

water is running out. This delay may be positive or negative for those that want to regulate the stock. It may cost time, but it also allows trying out different control strategies in order to find a solution.

1.1.3. Feedback

If some sort of equilibrium is maintained over a longer period, it is most likely because of the mechanism of feedback loops. Feedback loops are “the mechanism (rule or information flow or signal) that allows a change in a stock to affect a flow into or out of that same stock. A closed chain of causal connections from a stock, through a set of decisions and actions dependent on the level of the stock, and back again through a flow to change the stock.” (Meadow 2009)
But a system like a bathtub is obviously just the beginning. Jay Forrester, founder of the modeling method *system dynamics* explains: “Systems of information-feedback control are fundamental to all human endeavor, from the slow pace of biological evolution to the launching of the latest space satellite…Everything we do as individuals, as an industry, or as a society is done in the context of an information-feedback system.” (Forrester 1961)

1.1.4. Complex systems

When dealing with ecological, social or combined systems, the bathtub model is not sufficient to describe them, because there we are usually confronted with complex systems. If a large number of elements interact with each other in many different ways it becomes very difficult, if not impossible with today’s means, to understand every process in the system. But it is not only the number of elements that makes a system complex (this characteristic would merely make it complicated). Through their interactions and relations, complex systems are dynamic, spontaneous and are able to change and evolve. They are unpredictable and function at the “edge of chaos” (Waldrop 1992). Holling and Gunderson suggest that the complexity of living systems emerges from a small set of critical processes, which maintain their self-organization. (Gunderson and Holling 2001) Research on such processes has been conducted through computer modeling on different scales. One example would be cellular automata. Usually a cellular automaton consists of cells located on a defined grid. Through the relation to its neighboring cells, the state of each cell is defined: either

“on” or “off”. Through a simple rule like: if exactly two neighboring cells are “on”, than the cell itself is “on” as well and if there are more or less cells “on”, the cell will turn “off” in the next round (generation), the system can create a high number of seemingly complex patterns, that change over time. Cellular Automata show, that simple rules may generate a complex behavior, a thought that might explain genetic influences as well.
The agend-based model (ABM) is based on cellular automata. The idea lying behind ABM basically says: emergent phenomena of complex systems result from the interactions of individual agents who follow their own set of principles and rules. It has been applied to a variety of areas: costumer flows, traffic analysis, stock market, organizational design etc. (Bonabeau 2002)

Another approach that has been mentioned already in the passage about feedback is *system dynamics*. “What system dynamics attempts to do is understand the basic structure of a system, and thus understand the behavior it can produce. Many of these systems and problems, which are analyzed, can be built as models on a computer. System dynamics takes advantage of the fact that a computer model can be of much greater complexity and carry out more simultaneous calculations than can the mental model of the human mind.” (MIT System Dynamics in Education Project). Computer programs using system dynamics, like STELLA®, iThink®, or Vensim® are being used for constructing models of environmental, business, and social systems.

1.1.5. Hierarchy

Hierarchy in connection with complex systems does not mean a vertical authority structure, but a structure that is nested in a larger structure, that is nested in a larger structure, and so on. One example: … > atoms > molecules > macromolecules > cells > organs > organism > …, or individual > family > society > global human system. Ecosystems, economic systems, social systems, they are all arranged in hierarchies with interconnections. These interactions are one reason hierarchies work so well. Relationships within subsystems are stronger than relationships between subsystems, allowing an efficient use of feedbacks. Everything is connected with everything, but not equally strong, usually decreasing with distance.

Herbert Simon, one of the first to point out the significance of hierarchies, argues, that each level of a dynamic hierarchy serves two functions: conservation and stabilization for smaller levels and testing of innovations by experiments within a level (Simon 1974) Complex systems should be studied simultaneously at their different scales, as not to lose sight of the bigger picture, but dissecting the systems can provide interesting insights as well. (Meadow 2008) Cross-scale examinations changed our understanding of ecosystems profoundly (Holling et al. 2001) as it shifted from a small-scale view to larger units, such as Social Ecological Systems.

1.2. Social-Ecological Systems and Sustainability

Within the field of Human Ecology, sustainability sciences make for a considerable part of research activities. With growing public and political interest and global urgency due to social and environmental challenges, initiatives and projects like the *Millennium Ecosystem Assessment* (MA 2005) or the *Consortium for Sustainable Development,* a joint effort of the International Council for Science, the Initiative on Science and Technology for Sustainability and the Third World Academy of Science, emphasize the importance of scientific approaches to the ever increasing complex relations of human and natural systems (ICSU-UNESCO-UNO 2008). Their objective is “the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being” (MA 2005).

These multinational and multidisciplinary studies support the development of new system models that consider social, economic and biophysical factors as well as structural qualities, like resilience, self-organization, uncertainty and adaptability. The evaluation of the Millennium Ecosystem Assessment considers the designation of *systems* rather than *ecosystems* as the primary units of analysis, as one of the successful elements of the MA framework (ICSU-UNESCO-UNO 2008).

These units are often referred to as Social-Ecological Systems (SESs) and deal with management of natural resources and conservation. It may not be surprising that forestry is a popular field of study, as it was the origin of sustainability science (Carlsson et al. 1998, Ostrom and Nagendra 2006). Numerous studies deal with different management aspects, and models i.e. scenario planning (Peterson et al.

2003) and social frameworks for managing ecosystems (Berkes and Folke 1998, Reidsma and Lansink 2007).

But humans not only influence ecosystems, they are influenced by them as well, an interaction that creates the previously mentioned dynamic feedback loops (Cumming et al. 2006).

The broad term of *human well-being*, as used by the Millennium Ecosystem Assessment, demonstrates that social-ecological relations reach beyond the mere physical need for food and shelter to ideational values. The *holistic entity* of landscapes (Haber 2004) has been identified and spans from the wish to control *the wilderness* to romantic landscape paintings and human identification with their natural environment.

The importance of SESs has increased in recent years, as it is not only well-being that is at stake, but survival. Climate change, water shortage, food scarcity due to soil erosion, desertification and salinization, peak oil, etc. have brought back to mind that our own survival is intrinsically connected to the health of our natural systems.

Box 1.0. Diamond's Australian Case Study

Jared Diamond elaborated in much detail causes and correlations of failing and collapsing civilizations. He identifies five factors that can contribute to the downfall of different civilizations: environmental damages, climate change, hostile neighbors, friendly trading partners and the reaction of society to their environmental problems. Some of the factors have been important for certain societies, some have not been. The one factor that played a role in every case he analyzed, was the reaction to environmental problems. (Diamond 2005)

It is worth to look at some aspects of Diamond's Australian case study in more detail. Because it is a recent example, a threatening situation, which is still going on, because of its geographic proximity to this thesis case study in neighboring New Zealand and last but not least, because Australia is the birth place of Permaculture. Chapter 13 in *Collapse* is looking at the current situation of Australia, focusing on three particularly important environmental features, namely nutrient and salt levels of Australian soils, availability of fresh water and distances.

Australian soils are very old and therefore leached of nutrients. Renewal factors like volcanos, glaciers or uplift of crust are very scarce. Economic consequences are inevitable: nutrients need to be added in form of fertilizers and larger areas are needed to produce an equal amount of yield as elsewhere. Agricultural costs (machines, fuel, fertilizers) also rise because of machinery needed to work these larger areas of land. All these efforts often only result in the total degradation of land and new large areas need to be found, which often means clearing of forest cover. From the first European settlers on, a typical land cycle would be clearance, investment, bankruptcy and abandonment.

This vicious cycle resulted partly because of original decisions made by the British colonial power. First settlements were chosen because of proximity to rivers or the sea, not because of agricultural advantages (Adelaide and Melbourne being exceptions). As a result Britain had to supply its colonies with food from the home country for a long period. But the proximity to rivers could not undo the underlying opposite force: distance. This obviously has been posing many difficulties that are still a challenge today. Potential exports markets lie far away and transport costs are high. Principal exports are hence low-bulk, high-value items like steel, minerals, wool, wheat, wine, macadamia nuts, organic wheat and beef. Concerning trade it can be summarized that during the last half of the 20th century, Australia's exports have shifted from agricultural products to minerals (coal, gold, iron, aluminium, etc.) and Asian countries (top three being Japan, South Korea, Taiwan) have succeeded European countries as trade partners. Imports are still dominated by the USA (also second largest export customer) but are followed by Japan as second largest importer.

Along with trade, a change in immigration policy has occurred. After abandoning the former White Australia Policy[4], now one quarter of Australian immigrants come from Asian countries[5].

[4] „The 'White Australia' policy describes Australia's approach to immigration, from federation until the latter part of the 20th century, which favoured applicants from certain countries. [...] [During World War II] Prime Minister John Curtin reinforced the philosophy of the 'White Australia' policy, saying 'this country shall remain forever the home of the descendants of those people who came here in peace in order to establish in the South Seas an outpost of the British race'. " Retrieved from http://www.immi.gov.au/media/fact-sheets/08abolition.htm

[5] „The ABS [Australian Bureau of Statistics] estimated resident population (ERP) at June 2008 was 21.4 million people with 25.0 percent of people born overseas. The proportion of

„Plant immigrants“ – weeds – pose another challenge to Australia. About 3.000 plant species are considered weeds in Australia today causing large economic losses.[6]

But not only the distance to other countries, also the distances within Australia cause a precarious situation.
Australia is the most urbanized country in the world. 58% of its population live in five cities (Sydney, Melbourne, Brisbane, Perth, and Adelaide). Understanding the "distance factor", it is not surprising, that the two largest companies in the country are dealing with distance: Qantas (Transport) and Telstra (Communication).
„Australians don't depend on or really live in the Australian environment: they live instead in those five big cities, which are connected to the outside world rather than to the Australian landscape." (Diamond 2005:387)

Together with their people the British also imported other elements and values to the colony, which were inappropriate for the Australian environment, for example sheep, rabbits, foxes, land values, and British identity.
Sheep: Because wool support from Spain and Saxony was cut off during Napoleonic wars, Australia served as a useful alternative because of the low bulk and high value of wool. But Australian land, due to its poor soils, is not really appropriate for sheep farming. Consequence is once more land degradation. An alternative could be the farming of kangaroos. Kangaroos are native to Australia, adapted to plants and climate, and proponents argue, that their paws are less damaging than the hooves of sheep. But there are various problems: Kangaroos are not herd animals, they have to be hunted down one by one. They are able to jump fences and move large distances if conditions change. Their meat is considered either of less value than mutton or

immigrants born in North–West, Southern and Eastern Europe are in decline, with each region falling 0.8 percent from 1998 to 2008. The proportion of migrants coming from North-East Asia and Southern and Central Asia have increased, with each region up 1.0 percent between 1998 and 2008." Fact Sheet 15. Produced by the National Communications Branch, Department of Immigration and Citizenship.

[6] „Thus weeds lead to an economic loss to Australian agriculture ranging from $3,4442m to $4,420m, with mean loss of $3,927m. Around 80 per cent is a loss to producers because their net incomes are lower. The remaining 20 per cent is a loss to consumers because prices are higher and available quantities of agricultural outputs are lower than they would otherwise have been." (Sinden et al. 2004)

beef (in Australia) or it is rejected all together because it is not culturally accepted to eat Kangaroos (in the US).

Foxes and rabbits: In order to feel at home, the British imported a number of different species to Australia. But while most species did not succeed in the new environment, rabbits and foxes became a large threat to native small mammals: foxes prey on them, and rabbits compete with them (successfully) for food. About half the pasture that would be available to cattle and sheep is consumed by rabbits, causing – again, land degradation and economic losses. Measures against them now range from large fences, bulldozers and dynamite to viruses.

As much as the British liked their rabbits and foxes, they disliked the look of native vegetation like Acacia trees and eucalyptus. Besides this aesthetic reason, farmers cleared large areas of land because of promised tax deduction. A farmer could make a profit just by buying or leasing large areas with native vegetation, clearing it, planting wheat until soils were depleted and then abandoning it.

Because the value of land was set according to prices in England, Australian land is overcapitalised. It sells or leases for more than can be earned through the agricultural use of the land. In order to pay back mortgages, farmers over stock or over plant their land, leading again to overgrazing, erosion and abandonment.

Australians have embraced British land values although they do not represent Australian reality. Besides the low agricultural productivity of Australia, it is, as mentioned before, the most urbanized nation in the world, and yet rural values are hold up disproportionately.

A major national holiday in Australia – and New Zealand, is Anzac Day, celebrated on 25 April every year to honour members of the Australian and New Zealand Army Corps who fought at Gallipoli in Turkey during World War I. („[…] no other geographic location could be more irrelevant to Australia's interest", Diamond 2005:395)

All theses examples can be assigned to one of the three pillars of sustainability, as referred to in the Outcome Document of the UN 2005 World Summit: economic development, social development and environmental protection. (UN World Summit Outcome Document 2005)

And all illustrations emphasize the connection between environment and society.

They show how closely they can be connected but also how these connections can be dysfunctional, cut off or even transferred to other areas, even over large distances. This quality makes SESs very special and distinguishes them from other ecosystems. The human ability to abstract changes the rules SESs follow. This offers possibilities not accessible to any other species but also imposes difficulties not known in "human-less" ecosystems. It is an ongoing challenge to find out which rules can be ignored and changed and which have to be followed in order to guarantee human survival in the natural environment for future generations.

It was already explained in the introduction to this passage, why Diamond's case study fits into this thesis and the accentuation of some key words that will be important for the upcoming discussion, will help to concentrate the focus: proximity, distance, transport, communication, immigration (people, animals and plants), neighbours (trading partners, friends or enemies), and (land) values.
A quote from Diamond leads over to the next section:
„To those of us inclined to pessimism or even just to realistic sober thinking, all those facts give us reason to wonder whether Australians are doomed to a declining standard of living in a steadily deteriorating environment. [...] Fortunately, there are signs of hope. They involve changing attitudes, rethinking by Australia's farmers, private initiatives, and the beginnings of radical governmental initiatives." (Diamond 2005:409)
One of these initiatives and rethinking is the Permaculture movement.

1.3. Permaculture Systems

Looking at SES's boundary areas does not require any understanding or consideration of Permaculture. But because it is the theoretical foundation on which the subject of this case study was built (namely a Permaculture farm in New Zealand) it is essential to look at the main aspects of this foundation. Besides this argument, Permaculture offers a set of guidelines and principles, which are strongly intertwined with the concept of systems theory in general and SESs in particular. Because a Permaculture system is always *designed*, the role of human impact is inevitable. Although the whole theory and praxis of Permaculture deals with ecological principles, there is no Permaculture system in which people are not the core

element.[7] This is also illustrated in Permaculture ethics, which will be discussed in section 1.3.2. Permaculture draws from different schools of thought and mostly, although not exclusively, agricultural practises from around the globe: The Austrian Sepp Holzer developed his way of sustainable land use over years of close observance of natural systems, his work is now called Holzer'sche Permakultur, although he has been practising it long before the term Permaculture was developed. (Holzer 2005) Masanobu Fukuoka, a Japanese biologist and farmer, pioneered in the practice of no till cultivation and natural farming. (Fukuoka 1992) His work and writing influenced Permaculture as well as the works of American (System) ecologist Howard Odum (cf. Holmgren 2002, p.xvi and 17). Odum's work spans from systems theory (e.g. Ecological and General Systems: An Introduction to Systems Ecology. 1994), interaction of human systems and natural systems (e.g. Environment and Society in Florida. 1998) to economic aspects of ecology (e.g. Environmental Accounting: Energy and Environmental Decision Making 1995). Nevertheless, it were two Australian men, David Holmgren and Bill Mollison, who first coined the term Permaculture in the mid 1970s.

1.3.1. Definition

The definition of Permaculture as described by Mollison and Holmgren in their first book, Permaculture One says: "Permaculture is a word we have coined for an integrated, evolving system of perennial or self-perpetuating plant and animal species useful to man. It is in is essence, a complete agricultural ecosystem, modelled on existing but simpler examples." (Mollison and Holmgren 1978) This definition has been expanded and varied over the years, one result being the following definition by Holmgren, "I see Permaculture as the use of systems thinking and design principles that provide the organising framework for implementing the above vision. [Vision: "Consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs. People, their buildings and the way they organise themselves are central to Permaculture. Thus the Permaculture vision of permanent

[7] Zone V in a Permaculture system is considered „wilderness", where no human impact takes place. But just the declaration of a zone V, and its protection implies human influence.

(sustainable) agriculture has evolved to one of permanent (sustainable) culture."] (Holmgren 2002:xix)

1.3.2. Permaculture Concepts

Already in these basic definitions one can see the connection to the previous-mentioned aspects: System thinking, Sustainability, Man–Nature–Relationship. One can find even more in Mollison's magnum opus, *Permaculture: A designer's manual*. "The present great shift in emphasis is on how the parts interact, how they work together with each other, how dissonance or harmony in life systems or society is achieved. Life *is* cooperative rather than competitive, and life forms of very different qualities may interact beneficially with one another and with their physical environment." (Mollison 1988:2)

The ethical basis of Permaculture is summarized in the manual as follows:

1. Care of the earth: Provision for all life systems to continue and multiply
2. Care of people: Provision for people to access those resources necessary to their existence.
3. Setting Limits to Population and consumption: By governing our own needs, we can set resources aside to further the above principles.

As it was stated in Permaculture Two, it is a philosophy of working with rather than against nature; of protracted and thoughtful observation rather than protracted and thoughtless action; of looking at systems and people in all their functions, rather than asking only one yield of them; and of allowing systems to demonstrate their own evolutions." (Mollison 1988:2f.)

The concept of analyzing different factors and their relationship and assembly is also embedded in the Permaculture Design Principles. They are:

- Observe and Interact
- Catch and Store Energy
- Obtain a yield
- Apply self-regulation and accept Feedback
- Use and Value Renewable Resources and Services
- Produce no Waste
- Design from Patterns to Details
- Integrate rather than Segregate

- Use Small and Slow Solutions
- Use and Value Diversity
- Use Edges and Value the Marginal
- Creatively Use and Respond to Change

(Holmgren 2002)

Without going into detail here, these principles represent key concepts of sustainability research and activity as well as systems theory like *energy consumption*, r*esources*, *diversity*, or *self-regulation*, *feedback*, *hierarchy*, etc.

Although Permaculture has only been marginally a topic of scientific research (mostly in its country of origin, Australia cf. Hill 1998), Permaculture systems show many characteristics of SESs that have been subject to scientific research. Reading the research area description of a scientific workshop at the University of Indiana, with highly acknowledged participants like Elinor Ostrom, one is inclined to believe to read yet another definition of a Permaculture System: „The SESs of relevance to this paper are (1) complex systems composed of biophysical and social components and (2) systems where individuals have self-consciously invested resources in some type of physical and institutional infrastructure that affects the way the system functions over time in coping with diverse external disturbances and internal problems. In other words, humans have designed *some parts* of the overall SES. The design effort may have occurred at one time period in the past, or design may have occurred over time as feedback generates information about how the SES is operating and participants in multiple positions try to improve the operation of the system—at least from their perspective.“ (Anderies et al. 2003)

Permaculture theories and practises are particularly interesting for anybody who is interested in linking ecological systems with social systems. Although Permaculture can be described as a *green movement*, social components are omnipresent and the structure giving factor. Also the relevance of traditional, local knowledge has been emphasized in Permaculture literature (Mollison 1988), an aspect increasingly investigated by researchers as well (Gadgil and Berkes 1991, Anderson 1996, Berkes et al. 2000).

One key Permaculture design concept that connects social interests with ecological ones is the concept of *zoning*. Mollison describes it this way: " In this book, I am concentrating on people and their place in nature. Not to do so is to ignore the most destructive influence on all ecologies: the unthinking appetite of people. […] We can think of our zones in other than product terms and management, as a gradation between an ecosystem (the home garden) managed primarily for people, and the wilderness, where all things have their right to exist, and we are only supplicants or visitors. Only excessive energy (human or fuel) enables us to assert dominance over distant resources." (Mollison 1988:57)

If looked at it this way, a Permaculture system comes very close to Bossel's definition of systems and especially system boundaries: at the boundary couplings become weaker by a gradient. (cf. Bossel 1994). Zoning is a very active and conscious part of Permaculture design, not something that happens automatically. "In Zone 1 we are *information developers*; we tend species selected by, and dependent on, mankind. […] In Zone 2 already nature is making our situation more complex, and we start to *learn* from species other than our people-dependent selections. […] We have neither need nor right to interfere or dominate." (Mollison 1988:57) Zoning combines ecological, social and even economic principles. The division into zone 1 and zone 2 has been further developed into 5 zones (cf. Figure 1). They are (depending on prevailing geographic conditions) concentric areas, describing the intensity of use, the closer to the center, the more intensive the use of land.

„Zone I is the origin of the system. The area surrounding the dwelling, representing the most intensive and controlled land use is the centre of activity. In zone I, propagation and nurturing, construction and maintenance, experimentation and observation are characteristic activities. [...]

Zone II is the intensively cultivated permaculture. Structures include terraces, stone walls, hedges, ponds and trellises. [...] Planting is dense with large trees but with a complex herb layer and understorey, especially small fruits. Specimens of a marginal nature requiring special care would be in this zone.

Zone III is hardy permaculture. Products are mainly for animals, both foraged and harvested. It contains only tough understorey and self-perpetuating herb layer or pasture. [...]

Zone IV is extensive tree culture and open pasture with tough hedge plants, often spiny – for protection. Food yields other than meat are occasional, mainly from seeding trees. Timber is a developed product. [...] Animals would be mostly self-feeding. [...]

Zone V strictly speaking, is outside the system and can be considered as uncultivated bushland. Direct use would be hunting and timber." (Mollison et Holmgren 1978)

The Zones correlate with the frequency of visits and the amount of labour needed. Zone I will have frequent visits, zone IV and V only infrequent to none.

In reality the zones are very likely to be distributed not in concentric circles around the main dwelling, but will vary depending on the needs of humans. A small mixed farm design will vary from i.e. a broad scale cattle farm or forestry.

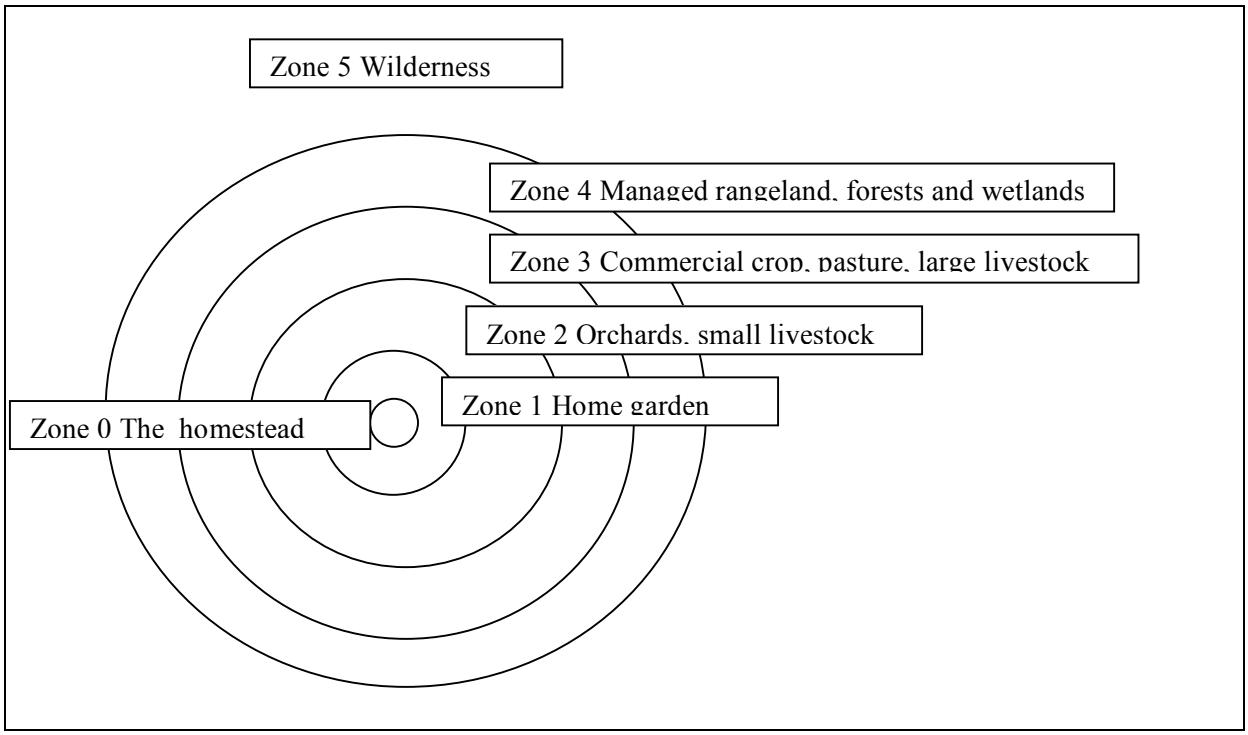

Fig. 1: Zoning for a rural site after David Holmgren 2002

This illustration strongly resembles the economic model of Johann Heinrich von Thünen, proposed in 1826. He drew concentric rings around a city, illustrating the spatial arrangement of different crops resulting from the value of different yields and transportation costs for farmers. Areas near the centre should produce crops with high transportation costs (gardens, dairy production) whereas the area of the outside ring is best used for grazing. (Rubenstein 1999:362f) His considerations therefore show similarities not just in the graphic representation of the model, but also in its content. Because economic aspects will not be discussed in detail further on, a more detailed comparison of the two models will not be discussed here but could be worthwhile to look into for future studies.

Because of its relevance for this research question, I would like to point out one of the already above-mentioned design principles: Use Edges and Value the Marginal.

1.3.2. Edge Effect

Edge effect in ecology is widely known (see section 1.5.2 Ecological boundaries) but in Permaculture, edge effect is extended and applied to both, social and ecological

components: “When a boundary separates two things which differ, there is an opportunity for trade, transactions, or translation across the border. Where the boundary itself is difficult to pass, where it represents a trap or net, or where the substances and objects attempting to pass have no ability to do so, accumulations may occur at the boundary. [...] In design, we can arrange our edges to net, stop, or sieve through animals, plants, money, and influence. However, we face the danger of accumulating so much trash that we smother ourselves in it. Translators keep flow on the move, thereby changing the worlds and relieving stresses. [...]

However, we should look at the translator, which is often of neither medium but *a thing in itself*, the “connection or path between”, created from the media, but with its own unique characteristics. Plants, people, and pipes are translators. Nets, sieves, passes, and perforations are openings for translators to use, and (as traders know) there is no border so tight that a way does not exist for trade. [...]

So edge is also important in Permaculture from the standpoint of implementing and maintaining a section of the designed system. Only by defining the edges around an area can we begin to control it. If we do not control the edge around our garden by planting barrier plants and weed suppressors, elements from outside the garden (animals, weeds) will invade it. In addition, we walk at the edge and we pause there; our energies are devoted to species we have access to rather than to those which may be in the middle of a large expanse of unbounded territory.” (Mollison 1988:4.6)

1.4. Summary

Summarizing the aspects of SESs and the challenges their understanding and management present, some key aspects are:

- Pressing environmental and social problems
- Complex systems as units for research activity
- Systems as units for management and through it (partial) control over pressing environmental problems
- Need for transboundary and interdisciplinary activities (represented by the 3 pillars of sustainability)

SESs are as diverse as the ecosystems and social structures they may contain, which makes them challenging to work with but also offers opportunity. Diversity in landscape and population can be an important factor for resilience and sustainability of systems and diversity in culture may by be closely related to biodiversity (Gadgil et Berkes 1993), but this diversity always adheres to some conflict potential as well. Different systems may fight for energy, resources, power or recognition or they might support each other and draw advantages through material and information exchange. This conflict can occur on all levels from individuals to nations and everything in between. (Diamond (2005) expressed this through the concepts of *hostile neighbors* and *friendly trading partners*.)

In both cases, the characteristics of the systems boundaries will influence their interaction, be it lively or non-existent, and therefore influence the state and organization of the systems. One of the first steps in complex systems analysis is the definition and boundary setting of the system. This applies to spatial boundaries, as well as mental models (Cumming and Collier 2005). The reason for this is often merely the need to define and designate the study area, but boundaries should be of interest for their own nature as well.

But what are these boundaries really? What is their substance and structure, does this structure influence the system and if so, how?

1.5. Boundaries[8]

1.5.1. The demarcation of (living) *things*

The founding fathers of Western philosophy, and science for that matter, were already concerned with the subject of boundaries. “Euclid defined a boundary as “that which is an extremity of anything” (Elements Bk I, Df 13), and Aristotle made this more precise by defining the extremity of a thing x as “the first thing outside of which no part [of x] is to be found, and the first thing inside of which every part [of x] is to be found.” (Metaphysics 1022a)” (Stanford Encyclopedia of Philosophy 2008).

Thoughts like that seem basic and common sense at first, but are quickly exposed to be not quite so simple. Puzzles, like Leonardo da Vinci’s, enunciate the problem: “What is it […] that divides the atmosphere from the water? It is necessary that there should be a common boundary, which is neither air nor water but is without substance, because a body interposed between two bodies prevents their contact, and this does not happen in water with air. […] Therefore a surface is the common boundary of two bodies which are not continuous, and does not form part of either one or the other, for if the surface formed part of it, it would have divisible bulk, whereas, however, it is not divisible and nothingness divides these bodies the one from the other.” (MacCurdy 1938)

The reality of lines or surfaces, thus also of physical boundaries, has been continuously questioned and is still an open philosophical question. Although the philosophical, physical and mathematical debate about this would go beyond the scope of this thesis, the basic questions behind it do touch basic thoughts about biology that will influence upcoming considerations. If all “things” have boundaries, do all *living* things have them as well?

Cells, the basic units of life, are *membrane-bounded* containers. “This container acts as a selective barrier that enables the cell to concentrate nutrients gathered from its environment and retain the products it synthesizes for its own use, while excreting its waste products. Without a plasma membrane, the cell could not maintain its integrity

[8] The term boundary (or edge) is widely used in ecology. Nevertheless a thorough definition will have to be made for the thesis. Choosing English as working language helps this case, as it is not as equivocal as the term *Grenze* in German, which could be misleading. *Grenze* in the sense of limit will not be the main focus of this work. This is important to point out, especially because limits are a common topic in sustainability research.

as a coordinated chemical system." (Alberts et al. 2008:9) And one can dive in even further with a quote from another textbook, "[…] but the plasma membrane is particularly significant because it represents the boundary between the living and the nonliving worlds. The plasma membrane is selectively permeable, which means it allows some materials to pass through but not others. Thus the plasma membrane not only physically limits the cell, it also controls the exchange of material and serves to maintain essential differences between the cell and its environment." (Hopkins 1999:3) A few basic but crucial concepts of boundaries are already addressed here: selectivity, permeability, physical limits, control, concentration, exchange, integrity and differences.
But what is true for a cell is not necessarily true for other systems. Because of the high complexity of SESs, other boundary concepts will be taken into account as well, in hope for an approach towards a SES boundary definition.

Before looking at different system boundaries that can be expected to play a role in SESs, I would like to point out a special theory concerning biological organisms, the theory of autopoiesis.
The concept of autopoiesis basically states that a living system constantly creates itself. The function of its structures is the continuance of the structures themselves and every outside element is interpreted with regard to the system itself. "Wenn deshalb eine Zelle mit einem Molekül X interagiert und es in ihre Prozesse einbezieht, ist die Konsequenz dieser Interaktion nicht durch die Eigenschaften des Moleküls X bestimmt, sondern durch die Art, wie dieses Molekül von der Zelle bei dessen Einbeziehen in ihre autopoietische Dynamik ‹‹gesehen›› beziehungsweise genommen wird. Die Veränderungen, die in der Zelle als Konsequenz dieser Interaktion entstehen, werden von ihrer eigenen Struktur als zelluläre Einheit bestimmt. Wenn dem so ist, dass die autopoietische Organisation die biologische Phänomenologie als Verwirklichung des Lebewesens als autonome Einheiten determiniert, dann ist jedes Phänomen ein *biologisches* Phänomen, welches die Autopoiese mindestens eines Lebewesens einbezieht." (Maturana et Varela 1987:60) This would lead to the conclusion, that SESs are in fact *biological* phenomena, allowing biological concepts to describe them adequately.

Maturana and Varela (1987) also pointed out that a membrane is not only a spatial line of demarcation, but that it also takes active part in the chemical processes of the cell. It is important to keep this in mind when thinking about SESs because the question arises if their boundaries take part in the chemical and social metabolism of the system as well.

The properties of boundaries can be as diverse as the entities they demarcate, but because it is the aim of this thesis to reach a basic concept of SES boundaries, and there is no substantial literature on that matter, the focus must be laid on the boundaries of subsystems that are relevant for human ecological questions. Some observations and theories in these subsystems might serve as building blocks for SES boundaries. According to complex systems theory, the properties of each of these subsystems will most likely not make up the exact properties of SESs. Due to emergence, it can be expected, that they show some of their subsystems properties and/or their own unique properties. Merging properties of the subsystems to a preliminary combined theory of SES boundaries as a whole will be the purpose of section 2.1.
The first subsystem that needs to be looked at is literally the foundation of any SES, the ecological system.

1.5.2. Ecological Boundaries

Ecology's concern with interactions and relationships of organisms, with each other and with their environment, makes ecologists, by the nature of their field, used to think and work in systems, with their core frame of research being the eco*system*. An ecosystem is defined as a community of living organisms and their physical environment (Calver et al. 2009:628).
The study of ecological communities originally excluded humans and focused only on plants, animals and microorganisms. Plant or animal communities do not often operate within sharp boundaries and boundaries have therefore been considered of lesser importance in community ecology: "The safest statement we can make about community boundaries is probably that they do not exist, but that some communities are much more sharply defined than others. The ecologist is usually better employed looking at the ways in which communities grade into each other, than in searching for sharp cartographic boundaries. […] It is not necessary to have discrete boundaries between communities to study community ecology." (Begon et al. 2006:478).
But especially with the emergence of landscape ecology, new influences have been taken into account.

Together with the rise of environmental protection, landscape ecologists added further aspects to their study area, like *spatial dimensions*, *humans as integral parts of ecosystems* and *spatial and temporal heterogeneity* of the environment (Burel et Baudry 2004) A concept that roots in such considerations is that of *landscape units*, defined as "An individual part of the landscape within the visual ENVIRONMENT [capitals in original] having certain uniform characteristics or homogeneity which distinguish that part from other areas; it is used as a classification system." (Gilpin 1996:133) Farina addressed the problem of definition by asking if landscapes are an entity or simply a domain. His thoughts tie in with the theories of Maturana and Varela: "The major problem in defining the landscape consists in the duality by which we can see the landscape as a unit or as a system. If we consider the landscape as a unit, we have to recognize the character of such a unit, specifically the autopoietic character, or in other words, the capacity for self-organizing and self-maintaining through the use of inner forces and processes. If the landscape is a unit, it must have

a defined border and must be distinguished from its surroundings. […] And one needs a large-scale vision to include the unit on a background. Often we select for our convenience a “piece of land” and we define this as a landscape unit but this operation is without sense and is destined to fail. If we consider the landscape as a system, it exists only if the composing parts interact with each other. For instance, a man is a unit, a separate autopoietic entity, but contemporarily is a part of the society. […] A landscape is at the same time a unit and a system, depending on the role and the local conditions.” (Farina 2010:21f)

Another concept of basic landscape units are landscape patches (“discrete, bounded area of any spatial scale that differs from its surrounding in its biotic and abiotic structure and composition.” Peters et al. 2009). They can be separated from one another with a gradual change of species and different types of transition zones. These transition zones or *ecotones* effect on the movement of animals and materials, rates of nutrient cycling, and levels of biodiversity. Their characteristics on the other hand are influenced by patch properties like size, type, spatial configuration, and connectivity. (Peters et al. 2009) Landscape connectivity, especially in highly fragmented landscapes is of great interest for system ecology, because biodiversity is highly dependent on access to habitats, which can be severely disturbed in such landscapes. (Bodin 2009) The definition of ecotones in the Oxford Dictionary of Ecology leads to a first hint towards ecological boundaries: “**ecotone** [original emphasis] A narrow and fairly sharply defined transition zone between two or more different communities. Such edge communities are typically species-rich. Ecotones arise naturally, e.g. at land-water interfaces, but elsewhere may often reflect human intervention (e.g. the agricultural clearance of formerly forested areas).” (Allaby 1998:136) Subsequent phenomena like the edge effect are common ecological knowledge but although there has been quite some scientific interest in ecologic boundary areas and edges for some time (Wiens et al. 1985, Naiman et al. 1988, Peters et al. 2006), a conceptual framework and classification of ecological boundaries has only been developed in recent years in order to understand how boundaries influence the functioning of ecological systems (Cadenasso et al. 2003).

How did the boundary originate, and how is it maintained?	• Integrity (perforated versus unbroken)
• Investigative or tangible	• Geometric shape and tortuosity
• Causal or consequential	• Number of attributes (single or multiple)
• Contemporary or relict	• Offsets or congruencies of multiple attributes
• Endogenous or exogenous origin	**What are the functions of the boundary?**
• Endogenous or exogenous controls (maintenance or suppression)	• Transformation
	• Transmission
What is the spatial structure of the boundary?	• Absorption
• Grain size	• Amplification
• Extent	• Reflection
• Thickness and dimensionality	• Neutral
• Geometry of adjacency	**How does the boundary change over time?**
• Interactive or noninteractive	• Changes in any structural or functional properties
• Abruptness, steepness	• Mobility (stationary, directional, oscillating, or random)
• Patch contrast	• Age and history

Table 1. Attributes of ecological boundaries. Source: Strayer et al. 2003

One reason, why it is difficult to classify and deal with boundaries, is the fact that they are often a combination of ambiguous factors, e.g. shaped by exogenous and endogenous factors at the same time and the distinction between these characteristics is often done with respect to the study system. (Strayer et al. 2003). Ecologists like Deconchat et al. (2007) coupled ecological boundary effects with socio-technical phenomena (management practices) and found a link between ecological structures and their social boundaries. The findings were used to illustrate how social constraints shape a landscape and ecological processes.

This shows that although ecological boundaries have been described in view of the characteristics ecologists care about, it has been pointed out that it has become necessary to include human activities and alterations when setting ecosystem boundaries (Lookingbill et al. 2009).

Human Influence

For a few decades now, ecologists have been aware of the fact that it is not recommendable to leave humans out of ecological inspections but "to define ecology as the study of the structure and function of nature, it being understood that mankind is a part of nature." (Odum 1971)

Human-influenced landscapes are created not per chance but in response to the landscape and in order to extract necessary resources, plant and animal biomasses. By often choosing their living sites on natural boundaries, humans were able to benefit from different resources, e.g. coastal settlements, villages at the base of a slope etc. (Forman et Godron 1986:497) Whereas natural border areas are usually rather fuzzy and transitional, human influence most often leads to quite abrupt boundaries (Forman et Godron 1986:17) with linear elements like fences, roads or railways, creating a specific *human landscape mosaic*.

The distribution of these mosaics changed drastically over time, first through the Neolithic (or agricultural) revolution then with industrialization and most recently with globalization. Local communities used to be largely self-sufficient, producing goods and services for themselves, with an urban center and a surrounding variety of support systems (Birx 2006:2285), resulting in high ecological diversity. In the *global village* goods and services are now produced rather regionally or even globally and are being transported over large distances, leading to a loss of environmental mosaic and thereby reducing ecological diversity and resilience[9]. (Farina 2010) The global boom of food production and distribution through intensive agriculture with monocultures, heavy machinery and chemicals did not come without environmental costs.

But although human influence is often a cause for ecosystem disturbance, instability and destruction, concerning their resilience, SESs also have an advantage over human-less ecosystems. Their boundaries do not necessarily have a physical representation (Fernández-Giménez 2002), but they often do. This boundary can

[9] Mollison addresses the problem of mosaic loss as well: „It is our skill in organising spatial or functional distribution that may create beneficial interdependece in incompatible components. When we know enough to be able to select mutually beneficial assemblies of plant and animal species (**guilds**) then we have two powerful interactive strategies (edge harmonics and species compatibility) for design applications. Mosaic design (the opposite of monoculture) means the creation of many small areas of difference. A few mistakes will occur, but good average benefit will result. This was the tribal strategy." (Mollison 1988:4.7)

vary from a massive wall around the system (e.g. a monastery or a medieval fortress), an electric fence around pasture land or a national park to a picket fence or just a line on a map, but in every case it is drawn and can be defended more or less vigorously against the outside, at least theoretically. Control over that border is fundamental and often an issue of dispute. It has been shown that in conservation or natural resource management, control over the boundary strongly influences the effectiveness of activities within the system. (Ostrom et Nagendra 2006).

Considering the ongoing global environmental change, almost no land area will be *unclaimed* or under some sort of management or control, - counting in natural reserves (Goudie 2002:25). Notwithstanding that one could argue humans help to solve problems that the ecosystem would not even have without them and there would be no need of protection. But human influence is a fact and with population growth still rising, the claiming of land will continue to be of great interest and often a matter of survival.

This aspect of protection and defense leads to another concept that needs to be examined, namely the concept of territory.

Territory

A territory, a more or less exclusive area, is defended against intruders by a recognizable pattern of behavior. In biology the concept of territories was first described in connection to birds. Subsequent studies showed, that a territory may be one spatial unit where individuals or populations feed, nest and breed but that these functions can also be divided into separate territories (a feeding territory, a nesting territory etc.) (Begon et al. 2006). The benefits of a territory are manifold: exclusive use of resources, reduced predation, predator escape facilitated by familiarity with the area, population control etc. (Ricklefs 1990)

Today the concept of territories is well known inter alia for insects, crustacea, fish, reptiles, mammals, etc. But because of the close relatedness to our species, it might be worthwhile to have a closer look at non-human primate territories. The Cambridge Encyclopedia of Human Evolution notes on home range[10] and territory: Primate home ranges can vary in size and differ in the degree to which they are defended against other individuals. Most primate species live in stable groups, where females usually stay in their natal group and males seek breeding opportunities in

[10] Home range is another space related concept. In contrast to a territory, a home range is not defended. (Alcock 2006)

neighboring groups with adjacent home range (e.g. *Macaca*, *Papio* and *Presbytis*). Some species have overlapping home ranges, within which groups avoid each other; other species defend their territories with displays, vocalizations and interactions against conspecifics or sometimes individuals from other species. The cost of defense (time and energy) thereby depends on the predictability and stability of the resource (Harvey et Read 1992:155f).

Because territorial organization is highly resource dependent and linked to social organization, this coupling of social structure (small group or family) and spatial organization (territory) probably had adaptive value for primitive hominids, as other primates often use home range rather than territorial strategies (Taylor 1988). Our closest relatives, chimpanzees, show territorial behavior, although analogies do not necessarily imply homology and the reasons why humans are territorial are not necessarily the same out of which they might have developed.

Goodall (1986) summarizes chimpanzee territoriality with the following aspects of classic territoriality: “Conspecifics from neighboring social groups […] are aggressively expelled”; “Boundaries are visited frequently and monitored”; “Parties traveling to peripheral areas show tense, nervous behavior and are much less confident than when in their core area”; “Auditory displays, loud pant-hoots, and drumming may be exchanged between parties of adult males of neighboring communities, followed by ritualized aggressive display, and members of both sides may retreat without conflict”; “Boundaries may be respected over a number of years”. Chimpanzees in captivity show territorial behavior like patrolling their boundaries even without the presence of neighboring groups. Territorial boundaries seem to serve a purpose even in artificial circumstances. (De Waal 2009:189)

The chimpanzees of Gombe also showed behavior that does not comply with classic territoriality: “it is the relative size and composition of the two neighboring parties that determine the outcome of an encounter, rather than the geographic location. […] The fact that in both species [Goodall refers to a previous example with spotted hyenas] individuals of the community (or clan) travel around in parties of *variable* size and composition means that there will be opportunities for intimidating neighbours seldom vouchsafed to other species.” Other untypical territorial behaviors are the “considerable overlap between neighboring communities” and the “violence of their hostility toward neighbors”.

Territorial behavior in other primates, like Bonobos for example, can be quite different to the ones found in chimpanzee communities. Bonobos organize themselves in overlapping home ranges with frequent and sometimes friendly contact between groups at the border. (de Waal 2009)

Even if such findings are interesting from an evolutionary point of view, they are not the sole point of departure for an approach towards understanding the relationship humans have with their territory and boundaries. But they suggest that territoriality has biosocial roots, with variations and species-specific patterns closely related to social organization. (Birx 2006:2180) Social organization and their boundary concepts are therefore the next step in our approach.

1.5.3. Social Boundaries

Social studies frequently deal with border phenomena (Freudberg 1970, Lamont et Molnar 2002, Sorenson et al. 2007). They are drawn across different contexts and scales like social, psychological, cultural or structural.

Social boundaries, just like biological membranes, can be considered as essential parts of cultures. People try to establish boundaries to other individuals or groups constantly. Generally speaking social human boundaries can be defined as more or less artificial division lines, that allow a social separation, ensuring symbolic, spatial and social segregation or that prevent the crossing or exchange of certain truths. (Girtler 2006)

A thorough summary of boundaries in social studies was done by Lamont et Molnar (2002) in the Annual Review of Sociology, which offers an overview of this vast body of research:

Boundaries can be classified into symbolic boundaries and social boundaries. *Symbolic boundaries* are conceptual distinctions made by social actors to categorize objects, people, practices, and even time and space. They are human tools to agree upon definitions of reality and generate feelings of similarity and group membership. They are an essential medium through which people acquire status and monopolize resources.

Social boundaries on the other hand are objectified forms of social differences manifested in unequal access to and unequal distribution of resources (material and nonmaterial) and social opportunities. “But symbolic and social boundaries should be

viewed as equally real: The former exist at the intersubjective level whereas the latter manifest themselves as groupings of individuals." (Lamont et Molnar 2002)
The differentiation of social groups happens through the comparison of in-groups and out-groups (Tajfel & Turner 1985: 16–17). Group identities are often a theme in literature on class, race or gender inequalities. On even more abstract levels, the concept of boundaries is being used to understand the creation and organization of professions, science and knowledge (e.g. scientists drawing rhetorical boundaries between science and non-science in order to establish epistemic authority. (Gieryn 1999). (Lamont et Molnar 2002)

Because the term boundary is used so extensively in social science literature, the focus will now be laid to theories and phenomena related to physical space starting with territory, because it is a now already familiar concept.
As demonstrated in section 1.5.2, a territory is the area defended against certain out-groups by an occupying in-group. In human territories, attitudes, emotions, and believes of in- and out-groups are closely connected to "their" area and these believes influence human territorial behavior, reaching beyond the sheer need for natural resources. Human territorial functioning has been defined in different ways. Depending on cultural, physical and psychological factors, areas are defended actively with a more or less aggressive behavior or indirectly through signs. Communications include warnings as well as expectations about adequate behavior within the territory and definitions on who is allowed inside at what times.
The research activity around territoriality is vast as well and oscillates between different extremes. To alleviate orientation, four continua of organizing dimensions have been suggested by Taylor (1988):

- Territoriality as a cognitive and affective process versus a behavioral process
- Territorial behaviors accumulate power to one individual or group at the expense of another individual or group versus territorial behaviors promote orderly social interactions between individuals or groups
- Territorial behaviors are highly place dependent versus socially and culturally determined
- Territories are limited in scope versus territories can range over different scale levels

Furthermore territoriality has been inspected frequently in connection to states and nations (Mellor 1991, Buchanan 2003, Elden 2010). These aspects will briefly be illustrated in section 1.5.4.

Next to territorial functioning, other related concepts are e.g. personal space (Sommer 1969), privacy (Edney et Buda 1976) or place attachment.
The latter has been described in countless research, with different terminology like the selfsame place attachment or place identity, sense of place, etc. (Jorgensen et Stedman 2001, Hidalgo et Hernandez 2001, Prohansky 1978) They all refer more or less to the phenomenon of a personal or group attachment to a spatial setting. This attachment can vary over a large spatial range from house or neighborhood, up to cities, regions and nations. As shown above, the need for resources (food, shelter etc.) is a strong factor for territorial behavior and it also effects the attachment to a certain place (Wellman 1977).
In coupled SESs social boundaries can evolve out of an ecological precondition but ecological conditions are also shaped by social boundaries. (Bonnemaison 2005, Gadgil 2000, Theodossopoulos 2000)
Although modern lifestyles and transportation may have cut social bonds from a specific place, some research emphasizes the physical component of place attachment (Riger et Lavrakas 1981, Hidalgo et Hernandez 2001). Whether physical elements, psychological ones or social ones are prioritized, usually depends on the point of view of the researcher, respectively his or her field. A combination and mutual support of different theories is the aim of human ecological approaches to phenomena like place attachment. (cf. Weichhart 1994)
Because the reason for attachment might reach beyond the ecological necessity and people choose communities or neighborhoods because of their believes or values as well (Hunter 1975), religion also plays a major role in the organization of space. Ethnic religions are usually closely tied to physical structures like mountains, rivers or rock formations. Human made places of worship and sacred spaces can be found everywhere and on all scales ranging from house shrines to religious buildings and from relatively small parcels for burial of the dead to religious settlements. Especially cultural geography offers some very interesting insights into human-place-

relationships, but for reasons of efficiency and concentration, only a few aspects shall be mentioned at this point.[11]

The founding father of the French school of geography, Paul Vidal de la Blache talks about "*geographic beings* that derive from a combination of physical laws, bio-geological laws and human realities." (Bonnemaison 2005:22)

And Bonnemaison writes, "Cultural space is a geosymbolic space laden with emotions and meaning: in its strongest expression, it becomes a sanctuary-like territory, that is to say a space of communion with an ensemble of signs and values […] An ethnic group may not be able to survive without a territory, in other words, without roots that allow it to give a foundation to its geosymbols […] " (Bonnemaison 2005:47)

Besides these cultural implications, ecological ones might be linked to religious aspects as well. Religious believes and thereby deliberate restraints on resources by a group through sacred areas (e.g. groves or ponds) are a known mechanism of traditional resource usage and might give useful inspiration for modern resource management because when social mechanisms change from small-scale horticulture to agrarian societies, state sponsored regulations become more significant than regulation through respect for the sacred. (Gadgil et al. 2000)

The occurrence of states is intrinsically connected to the establishing of boundaries. And although religion has been a dominant factor in the actual drawing of state boundaries in a few cases (when Britain allocated the Muslim portions of India to Pakistan, while the Hindu parts became the independent state of India or the boundary between Northern Ireland (Protestants) and Ireland (Catholics)), political boundaries are usually determined by different factors and their observations are also done under different concepts.

[11] If necessary, further references will be made, if examples in the case study require it.

1.5.4. Legal Boundaries

State Boundaries

Only a few boundary characteristics that state borders illustrate particularly well will be discussed here in detail since the state is not the main level of investigation in the case study. But because any system is part of (at least) one state border, their examination seems inevitable.

One commonality of social and political respectively state boundaries is their relevance for identity and their symbolic value (cf. Bloom 1990, Donnan et Wilson 1999). They are defined units of territory, a trait we have found in other boundary concepts as well. “A state is an area organized into a political unit and ruled by an established government that has control over its internal and foreign affairs. A state occupies a defined territory on Earth’s surface and contains a permanent population.” (Rubenstein 1999:267)

But there are clearly some differences as well. “State boundaries obviously entail a mapping out in geographic space and recognition in international law. They mark the limits of sovereignty and of state control over citizens and subjects, limits which may be upheld by force or by the threat of force.” (Donnan et Wilson 1999:26)

With this quote a few new concepts of boundaries are introduced that often come along with political boundaries: *Law*, *Sovereignty*, *Limits*, *Force*, etc.

States have been described as “bordered power container” (Giddens cited in Elden 2010). The term *container* was already mentioned in the discussion of cells, but the concept of *power* is newly added here. Buchanan and Moore (2003:2) explain the difference between ethical traditions of space organization and political boundaries by the “coercive” nature of political boundaries.

The force by which nation-state borders are kept intact is demonstrated and enforced continuously and expressed in border control. Because of the complex system of laws and regulations, state border control far exceeds the basic border patrolling, shown in animal territorial behavior (cf. p.32ff).

Box 2.0 Border Control

Border control can assume different forms and set varying priorities. The homepage of the U.S. Homeland security for example informs that it “prevents and investigates illegal movements across our borders, including the smuggling of people, drugs, cash, and weapons.” (U.S. homeland security website) The European Commission Home Affairs website explains that “now that the Schengen area extends along nearly 8,000 km of external land borders and nearly 43,000 km of external sea borders1 as well as hundreds of border crossing points, it is time to look ahead and develop the next generation of border management tools. […] The first communication offered Member States a roadmap for gradually developing a European Border Surveillance System (EUROSUR), with the main purpose of preventing unauthorized crossings at the EU’s external borders, reducing the number of illegal immigrants losing their life at sea and increasing the internal security of the EU as a whole by helping to prevent cross-border crime.” (European Commission Home Affairs Website)

Because of its relevance and omnipresence in New Zealand, another political aspect of national border control has to be mentioned here.

For some states (predominantly islands, like New Zealand) biosecurity is a dominant issue. The website of *Biosecurity New Zealand* reads:

“The Government has entrusted the Ministry of Agriculture and Forestry (MAF) (offsite link to www.maf.govt.nz) with one of the most important and complex public service mandates – to lead New Zealand's biosecurity system toward the future state identified in the Biosecurity Strategy for New Zealand (2003) whereby:

"New Zealanders, our natural resources, our plants and animals are all kept safe and secure from damaging pests and diseases". Biosecurity Council (August 2003),

Tiakina Aotearoa Protect New Zealand – The Biosecurity Strategy for New Zealand. Biosecurity Council, Wellington, p8. MAF Biosecurity New Zealand is the division of MAF charged with leadership of the New Zealand biosecurity system. It encompasses facilitating international trade, protecting the health of New Zealanders and ensuring the welfare of our environment, flora and fauna, marine life and Maori resources. […]

As an island nation, New Zealand is largely free of many of the pests and diseases found in other countries.

Keeping those unwanted pests and diseases out – and controlling those that have already crossed our borders - protects our environment and those living here. It also helps New Zealand exporters to market high quality, uncontaminated goods around the world.

These risks can be grouped as animal threats, plant threats, unwanted salt and freshwater organisms and threats to human health."[12]

Besides the strong elements of force and control, boundary classification in political geography offers helpful orientation when dealing with boundaries in general: "Boundaries are of two types: physical and cultural. Physical boundaries coincide with significant features of the natural landscape (mountains, deserts, water), whereas cultural boundaries follow the distribution of cultural characteristics. [language, religion, geometry (meaning straight lines drawn on maps)]" (Rubenstein 1999:280).

Furthermore state boundaries can be differentiated by their shape and classified into

- **Compact States** where the distance from the center to any boundary is approximately the same, in an ideal theoretical case, resembling a circle.
- **Prorupted States** with a compact area and a large projecting extension. Proruptions can either provide a state with access to a resource, often water or separate two states, which would otherwise share a boundary.
- **Elongated States** with a long narrow shape.
- **Fragmented States** include several discontinuous pieces of land, separated by water or an intervening state.
- **Perforated States** surround another state completely.

(Rubenstein 1999:276-278)

This classification illustrates the importance of relativity of the border, to its (power) center, to neighboring states and to the natural environment (resources, barriers). Like any boundary, political boundaries are lines of direct contact, offering great potential for conflict as well as cooperation.

[12] A few randomly listed unwanted organisms are: **Mammals**: Mustela furo, Trichosurus vulpecula, Oryctolagus cuniculus, Mustela erminea **Land invertebrates**: Periplaneta americana, Vespula vulgaris, Bemisia tabaci **Microorganisms**: Avian Influenza, Melissococcus pluton, Foot and mouth virus, Lentivirus, Tomato mottle virus
Land plants: Ipomoea indica, Berberis darwinii, Equisetum (all species), Hedychium gardnerianum. Source: http://www.biosecurity.govt.nz/pests/registers

Boundaries between states may cause conflicts for various reasons. One can be the existence of many nationalities within the same state that were used to autonomy before they were taken over by one state. Examples would be Cyprus, with Greek and Turkish nationalities or the former Soviet Union (Russia is a multinational state with 39 nationalities).
Another reason could be the circumstance that one nationality is distributed in more than one state (e.g. Kurds living in Turkey, Iran, Northern Iraq, Armenia, Azerbaijan, and Syria). The demand by ethnicities for more self-determination can lead to changes in the internal organization of states from unitary to federal states. (Rubenstein 1999)
Conflicts in Africa are often the result of a mismatch of state boundaries set by the colonial powers with areas that were occupied by various ethnic groups with no distinct boundaries long before the era of colonization. Small-scale human societies often organize their territory through diverse, socially organized rights to movement and located ritual activities (Birx 2006:2180) rather than bounded national territories. Bonnemaison concluded for stateless societies like the Melanesian society that by overcoming constraints through trade and alliances, territory is not a system "organized by a state and marked by frontiers, but an interdependent link within a system of relations." (Bonnemaison 2005:9)

A different aspect of ecological issues intertwined with political boundaries is shown by the example of the *European Green Belt*, an international nature conservation project, aiming to preserve natural and cultural heritage along the former iron curtain. "For decades the 12,500 km Iron Curtain split the continent into two – from the icy Arctic Sea to the Russian border to the sunny shores of the Black Sea in south-eastern Europe. Today it is a thing of the past and this strip has new significance. In the shadow of the heavily guarded borders nature was given a 40-year breathing space. Intensive land use was impossible between watchtowers and the barbed wire. Many border areas were left undisturbed and unused, remote and forgotten. Refuges for rare species formed – natural oases in the midst of a densely populated continent, a "green belt" across Europe. Today it is the largest and most ambitious nature conservation project in Europe. There are both geographical and historical reasons for this. National borders often follow coastlines, mountain crests or major rivers. These are always signposts for nature as well and have a high or select species

population. The neglect of the seam running between two highly militarized blocs helped to preserve many species that would otherwise have disappeared. […] The Green Belt today is a peaceful strip of land. It passes through magnificent European natural and cultural landscapes. But its outstanding importance is not just a matter of nature conservation. For coming generations it will be an ecological memorial to the division of Europe. Today it joins rather than separates people in a converging Europe." (Frobel 2009:16-19)

Whereas this example shows some kind of correlation between a border and an ecological area, the opposite is far more common. Certain invasive[13] plants and animals are very unlikely to follow human set boundaries. States that are surrounded by large water bodies, deserts or mountains (= physical boundaries), offer a better protection against any invaders, but with global mobility and trade, these advantages become relative. Of 118 *unwanted land plants* listed on the New Zealand Biosecurity website, only 5 are not in New Zealand, 2 are under investigation, 8 are controlled and 103 are established. (Biosecurity New Zealand*)* One possible outcome of introduced species, not native to an area, was demonstrated in the Australian case study of Jared Diamond (Box 1.0).
From the perspective of wildlife protection, the congruence of legal and biotic boundaries is essential in order to effectively protect species in protected areas. If biotic boundaries lie within legal boundaries, management is easier than when biotic boundaries, like the home range of certain species, exceeds legal boundaries. In this case the collaboration with adjoined systems is necessary in order to fully achieve animal protection. (Newmark 1985) Efforts in this direction are numerous (Nationalpark Neusiedler See – Seewinkel, European Green Belt, Red Sea Cross Border Research Center, etc.) and of great interest to cross-border environmental management.

The issue of state boundaries shall not be discussed any further now for two reasons: 1) In most (western) states globalization leads to an omnipresent transnational flow of people, goods, money, information, ideas and cultural traits, making it impossible to grasp them with a (simplified) boundary-focused approach (cf. Amin 2004). The connections and networks across regions, states and continents

[13] This term already suggest a kind of agressive trespassing of some sort of boundary.

simply make the nature of state boundaries too vague to pin down, at least for this thesis. 2) States must be considered public space, with different aspects to private space and therefore private property, the *legal unit* of the case study.

Property boundaries

There is an ongoing debate in resource management about whether private property is superior to common property and until recently, private property was leading the race as the only possible strategy against the tragedy of the commons. (Ellickson et al 1995, Smith 1981, Demsetz 1967, Heller 1999) But this opinion is questioned more and more (Ostrom et Hess 2007).

The fact that the case study is a private property is sheer coincidental and does not reflect any personal opinion whether or not this system is more appropriate for natural resource management. I agree with Ostrom and Hess that no institution will guarantee best outcomes under all conditions.

Like the mentioned essential characteristics of states, "a property right is an enforceable authority to undertake particular actions in specific domains. The rights of access, withdrawal, management, exclusion, and alienation can be separately assigned to different individuals as well as being viewed as a cumulative scale moving from the minimal right of access through possessing full ownership rights. […] Property rights define actions that individuals can take in relation to other individuals regarding some `thing´." (Ostrom et Hess 2007)

This definition illustrates an interesting feature of real property, where a piece of land can become a commercial object as well as an emotional identity.[14] Owners are tied to land as farmers, ranchers and businessmen, but private persons are tied to their land for other reasons as well, like recreation and family history or kinship. (cf. Abramson 2000:8, Theodossopoulos 2000)

Indigenous people often consider land as belonging to ancestors and future generations (David and Bierley 1985 cited in Wilkinson 2002, Abramson 2000) thereby applying very different scales compared to legal ones. The issue of indigenous land rights has been an essential part of New Zealand history (e.g. Treaty of Waitangi and Treaty of Waitangi Act 1975) and has also become integral part of its

[14] This topic touches a fundamental philosophical debate about nature as well, illustrated by the different approaches of Locke and Heidegger, the instrumental description and the anthropological description of nature. (cf. Durman 2000)

environmental policy (e.g. Resource Management Act 1991). (cf. Aboriginal law and Australian legislation in Strang 2000)

But the question of property rights does not only affect indigenous populations but anybody who lives or works on and owns land. (Hansen et Libecap 2003, Williams 2002)

Property rights are an *instrument of society* (Demsetz 1967), not only linking people and things but also people and people (Alcorn et Toledo 2000) and are therefore strongly connected to communal or public interests as well, with various examples. First of all, individual ownership is often combined with communal property rights systems (e.g. farmers with individual plots sharing a communal irrigation system (Coward 1980 cited in Ostrom et Hess 2007). Another example from a different sector would be parking: the equilibrium between common and private property in the control of rights to use curbs on public streets ("curb rights") (Epstein 2002).

The United States Natural Resource Conservation Service (NRCS) framework of land stewardship called one of their initiatives *Geography of Hope*, addressing directly the connection of private landowners to public interests. Like the Soil Conservation Act of 1935, passed during the era of the Dust Bowl to control soil erosion, a *Geography of Hope* calls to extend efforts in natural resource management to private land:

"Nearly 70 percent of the United States, exclusive of Alaska, is held in private ownership by millions of individuals. Fifty percent of the United States, 907 million acres, is cropland, pastureland, and rangeland owned and managed by farmers and ranchers and their families. The responsibility for stewardship of this land lies in the hands of about 4.7 million individuals. This means that the care of 50 percent of the United States is in the hands of less than 2 percent of our citizens." (USDA 1997:7)

The framework focuses on non-market environmental goods like wildlife habitat, water quality and biodiversity. ("Nearly 88 percent of the water that falls on the United States as rain or snow each year falls on private land before it reaches our lakes and streams and groundwater aquifers." USDA 1997:8)

"…our farmers and ranchers produce a safe, affordable supply of food and feed grains, meat and dairy products, fruits and vegetables, and fiber crops. But our Nation's farms and ranches produce far more than these traditional commodities. Well-managed agricultural land also produces healthy soil, clean air and water, wildlife habitat, and pleasing landscapes, all of which are increasingly valued by rural

and urban citizens alike. This growing public interest in private land couples well with the strong and growing desire among landowners to meet their individual and community responsibilities to protect the natural resources they hold in trust with society." (USDA 1997:77f)

Furthermore a few "boundary issues" are emphasized as well:

"While some of agriculture's environmental impact can be assessed within an individual field or farm ownership, there is some that cannot. Few farms are large enough to encompass an entire landscape or watershed, and even those farms that are exceptionally large are ecologically linked to neighboring land, including nonagricultural land. Everybody is somebody's neighbor." (USDA 1997:19) and "Each owner's action are important, not just because they affect that particular piece of land, but also because they affect neighboring land and the health of the larger ecosystem and watersheds in which they occur." (USDA 1997:21)

Although these citations could just as well serve as an example of national identity (cf. section 1.5.4. state boundaries) and the populist wording set aside, they illustrate a very direct and graphic connection of privately owned land and public interests. This combination of interests does not come without problems for both sides in terms of responsibility, costs, rights and power, on all scales.

Those different scales are addressed by another initiative, called "national priorities for protecting rare and threatened native biodiversity on private land" by the NZ Ministry of the Environment. In their brochure "Protecting our Places" the government considers: "Nevertheless, there remains a need to provide a better framework for decision making about biodiversity on private land, particularly for regional and district councils who work directly with landowners in local areas." (Ministry of the Environment 2007)

The New Zealand project *FarmsOnLine* was created out of the need of the NZ government to successfully execute their BioSecurity (see Box 2.0) efforts. The FarmsOnLine project will develop and implement a shared data resource of rural and urban fringe property location, ownership, management, and stock and crop information. (FarmsOnLine. Privacy Impact Assessment 2010)

In these examples public interference on private land is still quite limited. More drastic examples are the questions of private land within natural reserves and condemnation (cf. Nierer 1994, Theodossopoulos 2000)

Because any private property is nested in a variety of governance units, interferences are omnipresent on many scales and further examples will be given when applied to the case study.

Another legal boundary issue that is important for the establishment of the research boundary definition, is the legal maxim *Cuius est solum, eius est usque ad coelum et ad inferos*[15], which addresses the question of property rights extended to air space and subsurface areas. Jurists and courts in different countries interpret this question differently, but all seem to be agreed that an owner's property right is not infinite. (cf. Goeke 1999) A, on first sight maybe amusing but nevertheless significant example, is taken from U.S. law, the case of United States v. Causby from 1946:

"Respondents owned a dwelling and a chicken farm near a municipal airport. The safe path of glide to one of the runways of the airport passed directly over respondents' property at 83 feet, which was 67 feet above the house, 63 feet above the barn and 18 feet above the highest tree. It was used 4% of the time in taking off and 7% of the time in landing. The Government leased the use of the airport for a term of one month commencing June 1, 1942, with a provision for renewals until June 30, 1967, or six months after the end of the national emergency, whichever was earlier. Various military aircraft of the United States used the airport. They frequently came so close to respondents' property that they barely missed the tops of trees, the noise was startling, and the glare from their landing lights lighted the place up brightly at night. This destroyed the use of the property as a chicken farm and caused loss of sleep, nervousness, and fright on the part of respondents. They sued in the Court of Claims to recover for an alleged taking of their property and for damages to their poultry business. The Court of Claims found that the Government had taken an easement over respondents' property, and that the value of the property destroyed and the easement taken was $2,000; but it made no finding as to the precise nature or duration of the easement." (United States v. Causby, 328 U.S. 256 (1946))

Besides its relevance for air traffic, the maxim of *cuius est solum* touches topics like power lines, mineral resources (mining), disposal of chemical and industrial waste or ground water (for a detailed elaboration on subsurface rights see Sprankling 2008), all of which are of significant interest for environmental concerns.

[15] *Who owns the land, owns it up to the heaven and down to the lower world*. Proclaimed by William Blackstone's Commentaries on the Laws of England in 1766.

Other legal concepts, relevant for property boundaries, are obviously trespassing and also negligence. The juridical value of all theses issues is not relevant for the moment, but they show how closely and directly laws and legislation on boundaries are connected to social and ecological aspects: a quote from another famous case, Fletcher v Rylands, says, ”The person whose grass or corn is eaten down by the escaping cattle of his neighbour, or whose mine is flooded by the water from his neighbour's reservoir, or whose cellar is invaded by the filth of his neighbour's privy, or whose habitation is made unhealthy by the fumes and noisome vapours of his neighbour's alkali works, is damnified without any fault of his own; and it seems but reasonable and just that the neighbour who has brought something on his own property (which was not naturally there), harmless to others so long as it is confined to his own property, but which he knows will be mischievous if it gets on his neighbour's, should be obliged to make good the damage which ensues if he does not succeed in confining it to his own property.." (Fletcher v Rylands ([1866] LR 1 Ex 265)

1.5.5. Economic boundaries

The relevance of economics for environmental concerns is undoubted and any sustainability theory concerning real-world-problems is incomplete if economics are left out. Therefore it is emphasized here that economic boundaries should be part of a future more complete concept of SES boundaries, but must be left out here because of lack of time. The economic interests and different exchanges and trades of the SESs in the case study will be addressed, but because financial flows have not been monitored and evaluated, no theoretical background will be given at this point.
On a very basic and general level, one of cost and benefits, land boundaries can be seen as an economic construct:
“Where population density is extremely low, land is abundant, and land generates a rich diversity of plant and animal products without much husbandry, the expected costs of establishing and defending boundaries to a parcel of land of any size may be greater than the expected benefits of enclosure. […] Once land becomes scarce, conflict over who has the rights to invest in improvements and reap the results of their efforts can lead individuals to want to enclose land through fencing or institutional means to protect their investments. There are tradeoffs in costs to be considered, however. The more land included within one enclosure, the lower the

cost of defending all the boundaries, but the higher the costs of regulating the use of the enclosed parcel. […] it should now be clear that the cost of fencing land by physical and/or institutional means is nontrivial… ” (Ostrom et Hess 2007)
A view like this on boundaries reminds of one already mentioned in connection to primate territories: The cost of defense (time and energy) thereby depends on the predictability and stability of the resource (Harvey et Read 1992), thereby closing the circle to the beginning of this examination of boundary concepts.

1.5.6. Summary

When overlooking the different boundary concepts, one gets the impression that there are quite a few similarities but no boundary concept is exactly the same and only rarely do they fully coincide with each other. Before deciding on a research definition of SES boundaries I will summarize very briefly the different approaches, already in view of the case study. All characteristics are taken from the descriptions in section *1.5. Boundaries* unless cited otherwise.

→ Ecological boundaries

demarcate differences in biotic and abiotic structure. They are artificial division lines drawn by ecologists. Almost always are they linked to social organization. They can be described with structural and functional characteristics and are usually regarded as rather fuzzy transition zones between different systems.

→ Edges in Permaculture

are important elements of Permaculture design. They increase opportunity for trade and exchange. Different “translators” connect the inside with the outside. They are necessary for the control of the system by regulating (net, stop, or sieve through) animals, plants, money, influence, etc. Accumulation can be helpful or dangerous for systems. Translators (people, plants, pipes, etc.) keep the flow on the move.

→ Social and symbolic boundaries

are artificial division lines in social organization. They have symbolic value and meaning, creating feelings of similarity and difference often recognized in signs, laws rules or rituals. They can be place dependent or culturally determined. They are

areas of exchange (ideas, cultural traits) as well as conflict. Social organization of space can range from overlapping home ranges to violently defended territories.

→ **Legal boundaries / Private Real Property**

Units of real property are enclosed by a legal boundary. Property rights are social constructs, regulating ownership and different rights and responsibilities, such as access, withdrawal, and exclusion in regard to a geographical space, recognized in laws. Legal boundaries are commercial objects as well as emotional identities. Power and control are essential for their existence. They are often areas of conflict and cooperation.

→ **Biological Membranes:**

are selective, permeable and dynamic structures enabling the cell to concentrate nutrients and excreting waste products. A membrane is not only a spatial line of separation, but also takes active part in the chemical processes of the cell maintaining the cells integrity.

Many of these boundaries concepts are combined with each other frequently, forming complex new constructs influencing each other. Social boundaries shape ecologic boundaries and vice versa, legal boundaries follow cultural boundaries or ecological ones and vice versa. Mismatches lead to various problems and conflicts, a trait all concepts share. But they also all share the trait of exchange. With these differences and similarities in mind, can they be bound together to describe the *area of contact* of SESs?

1.6. Research Question

Complex systems with human and natural components are difficult to understand and almost always impossible to fully control. Because of this high complexity, focusing on a single level or singling out the relationship of only a few key components is a common approach. Handling complexity without oversimplification is a challenge.
One possible way of reducing complexity but still looking at the system in a broad range is focusing on the boundary of the system. There is no theory combining

different aspects of SES boundaries and therefore the aim of this thesis is to develop a model for an extensive description of a SES's boundary area.

On the basis of different boundary concepts (from natural and social sciences) a combined definition will be offered in the concept of a Social-Ecological-Membrane (SEM). This concept and the presented characteristics will be illustrated by the example of a Permaculture farm (a private property) and its surrounding systems.

The question does not aim for a description of a physical reality but for a describing synthesis of physical and conceptual elements in SESs. This knowledge shall add to the understanding of SES characteristics and the effects they have on each other.

2. Research description

After given this broad and therefore unavoidably incomplete outline of different boundary concepts, I will try to tie up the loose ends to a new research definition of SES boundaries. But first it seems necessary to address the question of scale.

Scale

All of the previous boundary concepts emphasized the importance of scale. In landscape ecologic, to just name one example, different scales lead to different representations. “Depending on the objective of the research, and the perspective of the researcher, a single landscape will be represented differently, and the spatial heterogeneity of this representation will vary with the diversity of elements present. The differentiation of representations depends on the scale of perception.” (Burel et Baudry 2004:5)

Because the perspective of this research is a social-ecological one and the objective is to describe the boundaries of a SES in a transdisciplinary way, still suitable for a master’s thesis, a “property boundary scale” seems to be an appropriate choice.

By choosing an already defined (and in this case even designed) area, a farm that fills out all of the property, the problem of scale becomes a little bit easier to grasp. Its relatively clear distinction is easier to describe than cultural boundaries, which are very fuzzy and often cannot be traced in a geographical space.

Nevertheless the cross scale nature of SESs cannot be ignored and the view will have to be extended to other scales as well. It has to be emphasized here that the defined research area is nested in other areas that are influencing it and are influenced by it as well.

But in order to not get lost in too many connections to scale levels above and beyond the property line, other scale levels (personal opinions, Permaculture zones, local community, regional district, country, etc.) will not be directly examined. If effects on the studied scale cannot be explained sufficiently, references to other scales will be made and even if they can be explained, the possible influence of other scale levels is not negated.

If this approach will be applicable to questions of managing other scales or system types (CPRs for example), is a subject for future testing and research.

Terminology

First of all a common term for the different boundary concepts needs to be established. So far used vocabulary included: (symbolic, legal, social) boundary, border, transition zone, ecotone, membrane, etc.
SESs do not have one distinct SES boundary. Their boundary *area* is made up by different boundaries, physical and conceptual ones. Together they built an area that can be defined as an interface between different SESs.
To express this, I decided to create a new term, so as not to get confused with either one of the separate terms and to emphasize that the concept is expected to be more than the sum of its parts. **Social-Ecological-Membrane (SEM)** is the term that will be used from now on when referring to the boundary area of the case study.
The reasons for establishing this term are various: The very first boundary concept discussed and closest to my "scientific home base", was the cell membrane and I consider the term membrane an appropriate and justifiable one for combining different boundary concepts. Cell membranes represent common traits of all presented boundary concepts like physical limits, permeability, selectivity, control, concentration, exchange, integrity and differences.
I want to adapt one quote already cited in the beginning (cell membrane definition of Hopkins 1999) and apply it to the definition of SEMs: The SEM does not only physically limit the SES, it also controls the exchange of material and serves to maintain essential differences between the SES and its environment (other SESs).
Just like a cell membrane can only exist together with other cell components, especially the nucleus as control center, SEMs can only exist through social control units (individuals or groups), they are the main structure-defining factor (thereby distinguishing them from "ordinary" ecological systems).

The dynamic structure of cell membranes is a more suitable picture than rigid constructs like borders (often inducing images of walls and fences) but at the same time it is sharper than fuzzy conceptions of cultural or ecological boundaries.
In systems theory, boundaries are mainly seen as the demarcation of a certain study area or field. They are considered important because they define what is still inside the area of interest and what is outside. The nature of the boundary itself, as a unique element is not a topic.

But a membrane is at the same time part of the system it defines. Its complexity is so immanent and obvious that it does not tempt to simplify the approach.
Furthermore it is three-dimensional, completely enclosing the cell, a unique trait enabling a truly holistic approach in a three-dimensional world because even if an artificial human-made boundary is very sharp (line of trees next to pasture) it is never two-dimensional. (cf. Cadenasso 2003)

For al these reasons I consider membranes a perfect metaphor for complex system boundaries with countless opportunities. When dealing with a complex system like the presented SES and on top of that using a new approach, the image of a membrane makes it possible to keep the definition flexible and yet defined. Future data layers can be integrated into the membrane or added to the outside as a new layer like a cell wall is added to a membrane for example.[16]

2.1. Research boundary definition

SEM definition

- A Social Ecological Membrane (SEM) is a theoretical construct describing the boundary area around a Social-Ecological entity on a private property
- It contains combined, coupled factors (ecological, social, (economic)[17], legal,…)
- It is integral part of the SES taking part in its processes
- It is part of its inside as well as its outside
- It is an area of contact where the exchange of material and information takes place

The SEM is constructed out of the different subsystems affecting SESs, based on private real property. The SEM surrounds a legal and emotional identity with, but not limited to social, ecological, (economic)[17] and legal aspects combined in a dynamic way, not in separate layers. An artificial separation has to be made in order to describe different qualities but afterwards they have to be put in relation to each other.

[16] One could possibly add an "economic shell" or a "virtual shell" to the SEM.

[17] The area of economics has to be put in brackets at this point, because, although their relevance is assumed, it will not be tested.

The property boundary provides the basic foundation onto which social-ecological factors can be added. This choice is pragmatic and artificial and does not suggest that a legal property line is the cause or precondition for other SEM aspects.
Property boundaries are social constructs but are visible (to a varying degree), making them easier to identify and thereby offering a reference point for other boundaries. Mental constructs and values are literally brought “down to earth” at the property boundary.
When describing the SEM of the study area, the two dimensional legal boundary on the cadastral map has to be extended by a multidimensional data field.
A first set of data describing physical characteristics of the SEM are almost all self-explanatory and will include size, shape, orientation, permeability, natural structures, and artificial structures along the property boundary and channels (roads, gates, pipes, cables, etc.) across the property boundary.

Spatial and Physical Characteristics
• Size (length, extent)
• Shape
• Orientation
• Permeability
• Structures / Channels

Table 2: Spatial characteristics

Symbolic characteristics (social boundary aspects) cannot be *defined* as easily but because they are the main influencing factor on the spatial characteristics, they at least need to be *described* as well. A second data set will therefore include qualitative “soft” data from interviews, relating to topics like opinions and aesthetics of the participating social groups. Visibility of opinions, believes and neutral information is a factor combining physical and social characteristics and is therefore included here as well. This list is only very rudimental and tools to quantify these characteristics should be developed and applied for future comparisons.

Social and Symbolic Characteristics
• Size of Social Units
• Opinions / Aesthetics
• Visibility

Table 3: Social and Symbolic Characteristics

Besides identity creation, there is one characteristic present in all boundary concepts: exchange. Therefore this trait deserves its own data set, and it is in fact necessary to describe the relationship between different SESs because they shape the SEM. The questions here are: what is being exchanged, who and what has access to the SES, and how is the exchange regulated (rules, laws, etc.). The flow across the SEM will not be measured in the way a material flow analysis is done (although this would be possible in the future) but only in terms of defining what passes the SEM and how is this controlled. Especially for comparison to other types of SESs it is relevant to know how access, withdrawal, and exclusion are managed through rules, rituals and laws. (cf. Ostrom et Hess 2007)

Exchange Characteristics
• Exchanged materials and/or information
• Access
• Control: Rules, Rituals and Laws

Table 4: Exchange Characteristics

In the discussion of results, the functions of the different SEM factors need to be examined and evaluated: which factors are neutral, which function as barriers, and which as gateways. Are they considered positive or negative, do they result in stress or in cooperation and support (level of disturbance) and how does this influence the stability of the involved SESs. But significant statements will only be able after a longer observation period.

Because this definition and provisional lists of factors to be analyzed is only a first attempt to describe SEMs, future possibilities and changes to this theory will be discussed in the outlook section at the end of the thesis.

2.2. Methods

The first part of the thesis contained the theoretical approach to the broad area of research: SESs and the boundaries of their subsystems. Current literature on different boundary theories was presented and by deductive reasoning a combined theory was proposed.
In the empirical part of the thesis, main aspects of this theory were tested on the basis of a case study, a Permaculture farm in New Zealand (referred to as RVF) and its surrounding systems. Methods include studies of maps, field observations, questionnaires, problem-centered interviews and document analysis.

In order to address the different aspects of a SES, quantitative methods were used as well as qualitative ones. Quantitative methods were used for any physical structure of the boundary area. Maps and area photographs illustrate the location of the boundary. Guiding line was the legal property line but a rough ecological presentation (dominating vegetation, climatic effects, distinctive features like rivers) will be made to see whether there are severe differences or similarities on either side of the property line and whether or not the differences influence the systems. The description of the spatial structure was based on the attributes compiled in the research boundary definition (section 2.1.):

Size

Length data was measured using the metric system and available maps.

Shape and Extend

Shape and extend of the boundaries were evaluated only through geometric characteristics of the lines on the cadastral map.

Orientation

Orientation was determined through maps and on site observation (position of the sun).

Permeability

To test the presented general SEM theory the most basic questions of permeability were asked: is the boundary permeable, inpermeable or semipermeable *at all*. As a theoretical step this might be acceptable but it is highly insufficient for most practical

questions. For any real world problem dealing with SESs the question has to be extended by the additive: permeable *for what*?
And this question is as complex as the elements involved. A general categorization into physical characteristics like different sizes (e.g. small elements like anorganic and organic particles, microorganisms, seeds, vapour, small insects, etc., medium elements like mice, rabbits, possums, cats or poultry and large elements like sheep, goats, cows or dogs as well as humans) is too unspecific and not functional. Some species are likely to overcome their size group through their behaviour and e.g. climb or jump a fence they could not pass through directly (in other cases the skill to swim through water bodies at the boundary could be an issue as well).
Variety within species can pose another challenge for broad categorization. Sexual dimorphism can influence body size as well as behaviour and therefore a wooden fence can be inpermeable for cows but permeable for bulls for example. Herd behaviour can also differ from individual behaviour making quantity of elements yet another issue to consider.
Another problem is the fact that animals and plants usually change their size and/or behaviour throughout their life cycle. This affects not only the capability of the elements to pass the physical boundary but the physical boundary itself. A *living fence* made out of trees changes over time through growth, as does a wooden fence through rotting. Further aspects including the time dimension into the SEM concept can be found in the discussion of results.
Because the large group of all flying or digging animals, as well as elements distributed by wind or rain (organic and inorganic particles, seeds etc.) can be summoned in a category of air and ground space (cf. paragraph *property boundaries* in 1.5.4. Legal Boundaries), they are being discussed separately in section *Notes on Ground and Airspace*.

For all these reasons an approach selecting a few animals present in the area and relevant for this specific system, seemed reasonable and promising and was therefore chosen in addition to the simplified but highly inaccurate general approach. To reach a reduction in complexity but still remaining enough significance, the following conditions were set:
Different size groups were represented by single adult individuals of species, common in the area: Phalangeridae (a male possum), Anatidae (a male duck),

Bovidae (a female cow), a male human, and a vehicle (passenger car). The boundary was considered permeable for these elements if the elements could pass through it in general, under normal conditions (= being physically capable) on their own at one point in the boundary.

Contrast

Contrast was determined by comparison of the vegetation on both sides of the boundaries, only taking into account the predominant landscape structures of the area: pasture / meadow and bush area (not differentiating between single species). The considered area was made up of the property boundary line and 3 meters width to both sides. If bush areas met pasture or meadow, the contrast was determined "high", if the vegetation did not change, the contrast was determined "low". If the contrast changed between "high" and "low" along the boundary it was determined "medium".

Structures

Structures were recorded differentiating between typical landscape structures of the area (pasture, bush area, water bodies) and artificial (man-made) structures like roads, buildings, fences, ditches etc. Listing of elements was supported by photo-documentation with a digital camera during the observation period.

Social characteristics

For the social aspects, participant observation was the inevitable choice as research strategy. Since I was living and working on the farm and have done so previously as well, it was not possible to take a passive-recording position only. To learn about events laying in the past or otherwise outside of my observation range, interviews and analyses of documents were being used. Interviewed groups included people living on RVF, neighbours, and visitors. Being an active member of the group of people living on RVF posed the problem of ethical dilemmas. To address those issues I have always been transparent about the nature and reason for my inquiries, explaining my research interest and usage of information that was given to me. I relied on the ongoing confirmed informed consent to my research questions. If possible and not compromising the comprehensibility of data, individuals were not referred to by name.

The description of symbolic characteristics was based on the attributes compiled in the research boundary definition (section 2.1.):

Size of Social Units

To evaluate and compare the size of the social units of the properties, the following parameter were considered: the number of people living permanently on the property and the number of people working (professionally) permanently on the property. Further the stability of that number was differentiated between stable (if the number did not change during the observation period) and flexible (if the number changed (up or down) during the time of observation).

Opinions / Aesthetics

The presented results were taken from interviews conducted during the research period in February and March 2010. Central questions were used as guide line for problem-centred interviews following Witzel (2000). To reduce and concentrate the extent of the results, only relevant parts were transcribed. Recordings of the complete interviews are existing and available from the author. To create manageable data blocks, I grouped all information gathered through interviews relating to (ecological) lifestyle, Permaculture and Sustainability and aesthetics together until no new information would have altered the overall description of the category.

During the preparation period and guided through observations made during previous visits (August 2008 and February 2009) some main problem fields were identified and keywords determined to group and compare statements from interview participants.

Keywords Ecology: Permaculture, ecology, sustainability, weed, pest, insecticide, plant and/or animal names, land.

Keywords Social issues: problem, argument, fight, verbs expressing likes and dislikes (e.g. like, love, hate, etc.), expressions of aesthetics (beautiful, ugly, tidy, messy, etc.)

Visibility

To evaluate visibility of symbolic boundaries, signs along the boundaries were recorded with a digital camera.

3. Research Area: A Permaculture farm in New Zealand

3.1. System description

The research area is located on the North Island of New Zealand in the territorial authority of Rodney District[18], near Matakana village and Warkworth.
The property boundary encloses 20,5409 ha, which were, at the time of research, owned by Trish Allen and Joe Polaischer.[19] The property is usually and herein after referred to as “Rainbow Valley Farm” (RVF).

Fig.2: Property Boundary. Yellow line indicates roughly the property. Actual boundaries lie within. (purple lines) Source: Trish Allen altered by author

Around 15 hectares are covered by native bush, the other 5 hectares are mainly pasture and bush areas. Besides serving as a private home, the area was developed by its owners as an example of Permaculture and sustainable living. In 2010 the farm was awarded an Auckland Regional Council (ARC) Sustainable Environment Award. In the application documents the aim and objectives were described as follows:
“Aims:
To live sustainably

[18] At the time of finishing the thesis, the area fell into the governance of the Auckland Council, replacing Rodney District Council.
[19] Joe Polaischer passed away in February 2008 but his wife, Trish Allen was running the farm until the property was sold in November 2010.

To inspire and support others to live sustainably

To enact the Ethics of Permaculture within a rural environment:

- Care for the Earth
- Care for People
- Share resources and limit consumption

To produce healthy organic food and move toward increased self-reliance

Objectives:

The farm will move toward an evermore sustainable way of living.

Those on the farm embrace sustainable ways of thinking, acting and relating to their environment restoring and protecting it.

The management of the farm safe-guards the life-supporting systems of soil, water, air and eco-systems for future generations.

The farm works toward 'zero waste' in all decision making and activities.

The farm and its systems are moving towards ever increasing energy efficiency and renewable sources.

The farm preserves and promotes bio-diversity.

Farming management is holistic and uses only organic systems.

Growing soil is a key activity.

The farm sequesters carbon in its soils and the bio-mass of its plants.

Cyclic thinking is applied to all physical, social, cultural and economic challenges.

The farm fosters strong community ties.

Community Participation:

Rainbow Valley Farm was initially designed and developed by Joe Polaischer and Trish Allen as their home. It quickly became known as a place to see 'sustainability in action' with the first workshops being offered on the farm just three years after they moved onto the land.

The farm provides education for hundreds of people each year. Most of these educational programs are self-funded providing a sustainable economic base that does not rely on funding from outside organizations. The farm's educational activities aim to empower individuals and groups to achieve similar sustainable results wherever they live. Groups who have visited and continue to visit the farm include, schools, polytechs, farming groups, iwi, community groups and individuals with an interest in organic food production and/or Permaculture. Those living on the farm are

also involved in facilitating the development of these skills in local schools and at workshops around the area.

Sustainability is central to every decision made on the farm. Examples from every day life include: making their own bread to avoid plastic bags, using a solar dryer for drying fruit, using a cart and wheelbarrow around the rather steep farm instead of a tractor, car-pooling at every opportunity. Last year the number of vehicles on the farm was reduced. Those on the farm work creatively to reduce the need for petroleum based forms of transport. Joe was passionate about hand tools and his collection of appropriate technology continues to be used on the farm. " (Source: Trish Allen)

An information leaflet available on the farm gives further ecological details about aspects like climate or soil:

Climate:

Summer: rainfall can vary from very little to almost every day. Normally dry February to April.

Winter: mild frost possible from July to September. Can be very wet May – August.

Rainfall average 1800 mm annually.

Soil: Northland clay with little topsoil except on valley floor. Fertility is low with a lack of trace elements.

3.2. History

As mentioned in the theoretical part, history is an important factor for any thorough understanding of a system and its development. But because the research time frame was rather narrow (2.2.2010 to 31.3.2010) historic aspects are not the main focus here, but an overview of the area's history shall be given here anyhow, to introduce the setting, further gaining understanding of some of its main features. The information leaflet, written in 2001 mentions the farm history briefly: Burnt off and cleared approx. 90 years ago. Sheep and Cattle farmed. Kikuyu grass and gorse introduced. Stock removed in 1988. Bush secondary growth mixed with pine and macrocarpa. Further information on the history was drawn mainly from an introductorily interview with Trish Allen.

In 1988 the previous owner divided his property of 400 acres into 5 lots and sold one lot of 20,54 ha (now parcel I 49.520m^2 and parcel II 155.889m^2 as indicated on the map) to Joe Polaischer and Trish Allen. They originally only wanted to purchase ten acres (approx. 40.468 m^2), but at the time the local district plan allowed only to subdivide parcels of 50 acres.

"In 1988 we arrived at the run-down farmland we had purchased in Matakana, north of Auckland, New Zealand, in a house truck, carrying with us a dream to become self-sufficient and tread lightly on the Earth. We had been influenced by our travels in the Third World and the stark evidence we found of the unfair distribution of wealth. We had also discovered Permaculture and read the books by Bill Mollison and David Holmgren. Permaculture made sense to us and we were keen to put it into action.
We named the farm "Rainbow Valley Farm" because we saw so many rainbows arching over our new home.
The land, considered to be "rubbish land" by local farmers, was eroded, weed and pest infested, and the heavy clay sub-soils were a bog in winter and as hard as concrete in summer. The waterways were choked with an introduced aquatic grass. The first few years were hard going, and at times we wondered if we were crazy!" (Joe Polaischer, RVF Website)
"Well, when we came here, we came in a house truck. And we lived in the house truck for about a year without power or phone. So we just observed the site. Within

its legal boundaries we just observed, did our Permaculture analysis, our sector analysis, where does the sun come up, where does the sun go down, in winter, in summer. And this was the best site for the house. It's reasonably flat, it's a little bit elevated, it's facing North, we had the opportunity to cut into the hillside a little bit to make an earth sheltered house. So that it was no chill effect from the cold winds from the South. So this was the perfect spot, open to the East, open to the West. It was really, after a little bit of time we spent here, looking around, this was the best spot." (Trish Allen 10.2.2010)

Because the issue of *weeds* is very present to the owners of the surrounding properties and it was brought up regularly in interviews, a few words on the history of RVF's vegetation: "Twenty years ago there was a lot of weeds in there, lot of Gorse. Because it had been grazed by cattle. So it was a lot of Gorse and Ragwort and weeds and lots of Possums. So that part, where it's all nice and looks like beautiful native bush now, we just left it and that's just natural succession. […]"
(Trish Allen 10.2.2010)

A Permaculture teacher put it another way by stating: This land wants to be a forest. And Alfred Crosby mentioned this trait of some of New Zealand's native vegetation in Ecological Imperialism: „Any station owner will maintain that the indigenous flora is ineradicable and will leap to take back any pasture from which livestock are withdrawn." (Crosby 1986:268)

"Some years ago the local council designated areas that were native bush. They've called them significant natural areas because there is so little native bush left in this County. So any areas of native bush were designated significant natural area, which means that you can't cut down any trees in there. So, it didn't matter to us, 'cause we didn't intend to anyway. But some farmers were very angry because that meant they couldn't use their own land. So that whole area across the stream is now significant natural area." (Trish Allen 10.2.2010)

Although the legal boundary did not change over the years, the physical boundary changed drastically, especially the southern one. The first picture shows the southern border with RVF being on the left side of the fence, the second picture is an aerial photograph with the southern border going from the left lower corner of the picture to the middle of the upper edge. In 2008 the neighboring pasture was bordering a line of trees along the fence line on RVF.

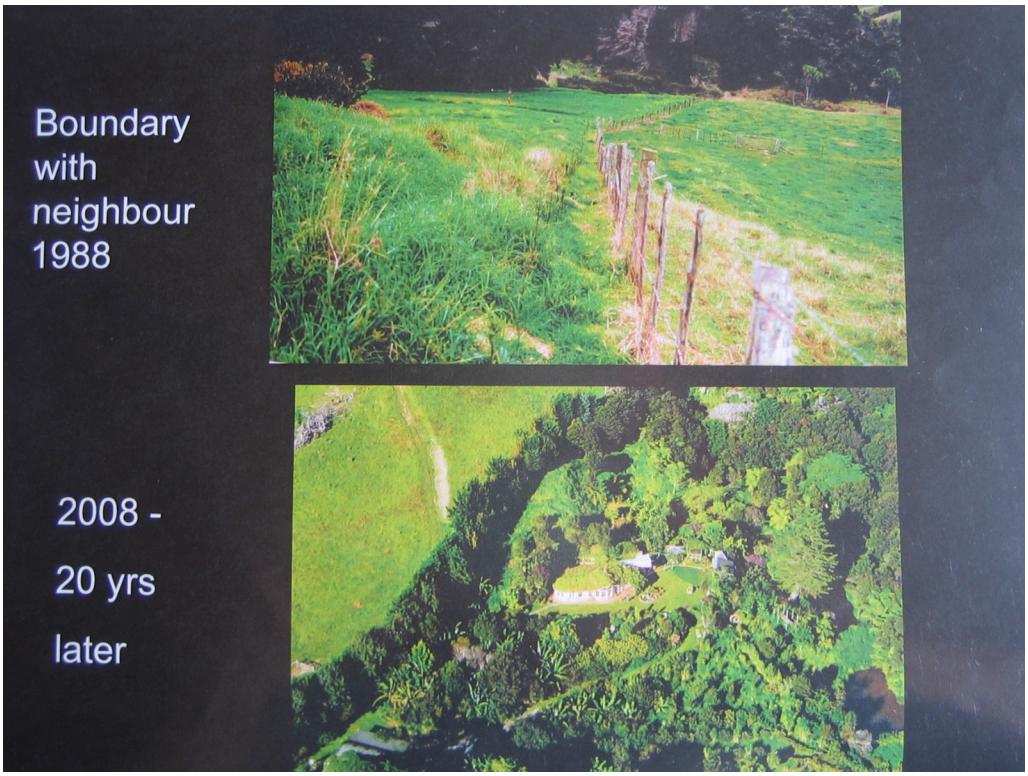

Fig.3: Photographs as shown in a display book about “20 years of RVF”. Upper photo showing RVF on the left side of the fence, bottom photo showing an aerial view of RVF on the right side of the fence now covered by a tree line. Source: Trish Allen

3.3. General property boundary description

Using the cadastral map as a blueprint, the boundary has been divided into 4 sections and given the random specification A, B, C, D, for easier reference throughout the description, going clockwise starting north. The boundary separating the two lots has not been considered because the focus of interest lies on the inter-action between different SESs and not intra-action within the SES. The different properties were numbered and labelled clockwise along the boundary.

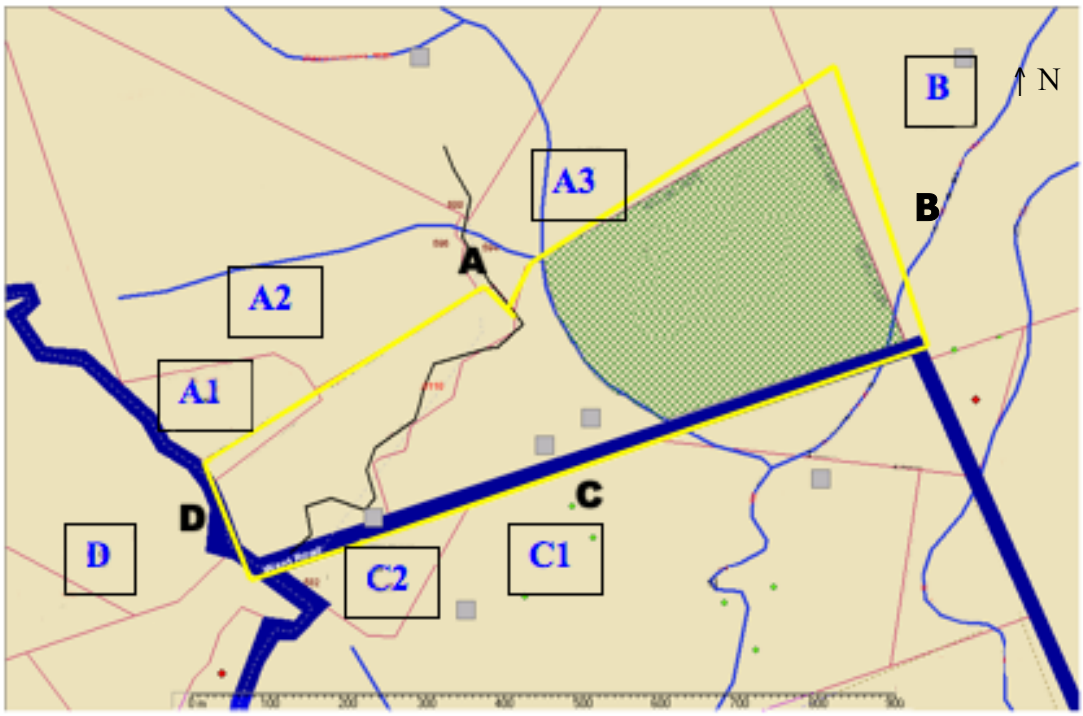

Fig.4: Labeling of property boundary. Yellow line indicating roughly the property. Actual boundaries lie within (purple lines) Blue Lables indicate the different properties along the boundary. Source: author

Surrounding Systems

On a regional scale, RVF and its surrounding systems are bound to similar ecological conditions (climate, soil), dominated by bush areas and pasture. Because RVF is located on a slope, microclimata and local soil conditions can vary along this slope.
But besides climatic and soil conditions, the most influential factor on the properties is their social usage, with a much greater variety then the ecological conditions might suggest. There is no other Permaculture property in the adjacent neighbourhood,

surrounding properties are privately owned and used for business (dairy farming and beef production along side boundary C) or for sole private usage (properties along boundaries A, C and D). Except for the properties used for business, which are mainly pasture and bush, all properties contain dwellings and serve for private activities like gardening with some food production, keeping of small animals (mainly dogs and poultry), art production (pottery), art collection (sculptures) and recreation. RVF's property and its neighbourhood were described in an Environment court paper as follows, addressing the crucial factor of shared access: "The farm itself is accessed via a gravelled lane from Matakana Road serving the subject property and four other properties […]. The access way is adjacent to the Rainbow Valley Farm property for most of its length and then accesses three other properties beyond the gate to Rainbow Farm […].

The entry point to the site is on a corner of Matakana Road as it crests a hill. The site falls from this ridge through steep faces towards the valley basin of Rainbow Farm and three separately owned properties […]. Due both to the topography and vegetation, there are limited views and outlook in this area, with overhead aerial photographs necessary to understand the overall configuration of the various properties. None of the buildings on any of the properties can be sighted from any building on another property and a combination of site factors including vegetation and topography give a high degree of privacy to each of the landowners." (Decision paper Environment Court, Source: Trish Allen)

Fig.5 Aerial photographs of RVF and surrounding properties. (Source: Trish Allen)

4. Results

4.1. Spatial and physical characteristic

The first set of data describe some physical characteristics of the SEM including size, shape, orientation, permeability, contrast, natural structures, and artificial structures along the property boundary and channels (roads, gates, pipes, cables, etc.) across the property boundary. Not all physical elements could be recorded, nor was the whole area examined due to lack of time and accessibility. The presented data are a personal selection by the author and can at this stage (before further case studies) only serve as building blocks for the description of the SEM. They are by no means exclusive or complete.

Nevertheless the characteristics were described using objective, repeatable criteria to guarantee scientific standards and allowing future comparison and/or revision. (see 2.2. *Methods* for further details) Furthermore the characteristics were not chosen completely randomly but followed the presented boundary concepts in the foregoing theory part in order to reach a first combining description of social and ecological elements enclosing a SES (cf. table 4).

Size

Boundary	Length
A1	167 m
A2	240 m
A3	520 m
B	320 m
C1	587 m
C2	173 m
D	100 m

Table 5: Size

Length data was measured using the metric system and available maps rounded up or down to full meters.

Boundary A1 is 167 meters long, boundary A2 240 meters and boundary A3 520 meters. Boundary B measures 320 meters, boundary C1 587 and C2 173 meters. Boundary D is the shortest with 100 meters.

Extent

Because this data layer must be restricted to the property boundary, the horizontal and vertical extend is restricted to the line on the cadastral map and is therefore only one-dimensional. The relevance of air and ground space was mentioned in the theory part (cf. paragraph *property boundaries* in 1.5.4. Legal Boundaries) and will be discussed in the separate section *Notes on ground and Airspace*.

Shape

The shape was also defined by the geometric characteristics (dots, lines and curves) of the property boundary on the cadastral map.
Together, boundaries A, B, C and D build a polygon composed of straight lines.

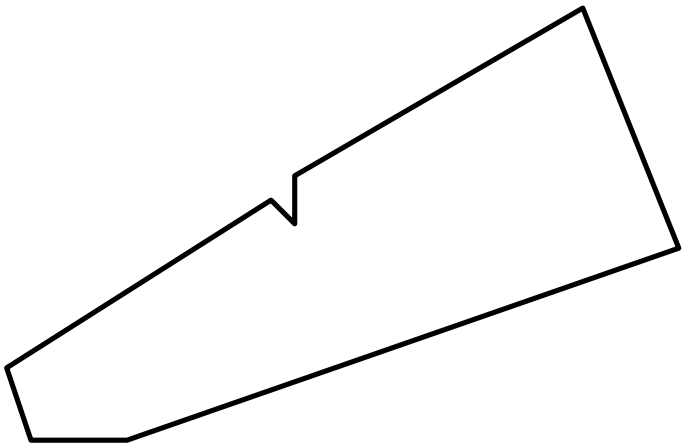

Fig. 6: Shape of RVF's property boundary. Not in scale. Source: Author

Orientation

Boundary	Orientation
A	NW - NE
B	N - S
C	SW - SE
D	N - S

Table 6: Orientation

Data was taken from available maps and on site observation. Boundary A stretches from North West to North East, boundary B from North to South, boundary C from South West to South East, and boundary D from North to South.

Permeability

Boundary	In General	Element	Permeable
A1	semipermeable		
		Possum	X
		Duck	X
		Cow	-
		Human	-
		Passenger car	-
A2	semipermeable		
		Possum	X
		Duck	X
		Cow	-
		Human	X
		Passenger car	X-
A3	semipermeable		
		Possum	X
		Duck	X
		Cow	-
		Human	X
		Passenger car	X-
B	semipermeable		
		Possum	X
		Duck	X
		Cow	X
		Human	X
		Passenger car	-
C1	semipermeable		
		Possum	X
		Duck	X
		Cow	-
		Human	X
		Passenger car	X-
C2	semipermeable		
		Possum	X
		Duck	X
		Cow	-
		Human	X
		Passenger car	-
D	semipermeable		
		Possum	X
		Duck	X
		Cow	-
		Human	X
		Passenger car	X-

Table 7: Permeability. “X” indicating “permeable”, “-“ indicating impermeable. “X” and “–“ together indicate that the permeability was dependant on gates.

The general result was that the whole boundary (A,B,C,D) was semipermeable. No section was inpermeable or permeable for all elements, everywhere and at all times. For the selected elements the boundary was mostly permeable with the exception of fenced areas that were impermeable for cows. Other elements were able to pass through fenced areas by climbing under or over it. Disruptions like gates or cattle grids are further described in section *Structures and Channels*.

Fig. 6 Cows on property C1 unable to pass boundary C through electric fencing. Source: author

Fig.7 Ducks from RVF “visiting” the neighbouring property C1 by climbing through the fence. Source: author

Contrast

Boundary	Contrast
A	low
B	low
C	medium
D	low

Table 8: Contrast along boundaries

Except for a disruption through the driveway the whole length of boundary A was covered by bush area. Boundary B was completely covered by bush area. Along boundary C bush area and pasture were alternating and contrast therefore considered medium. Like boundary A, boundary D was covered in bush area except the disruption through the driveway.

Structures and Channels

Boundary	Natural Structures	Artificial Structures
A1	Bush area, pasture	Fence
A2	Bush area, pasture	Fence
A3	Bush area, pasture, stream	Gate, Cattle grid, Driveway, Power line, Telephone line
B	Bush area	-
C1	Bush area, pasture, stream, tree shelter belt	Fence, Gate, Pathway
C2	Bush area, Tree shelter belt	Fence, Pathway
D	Bush area	Main Road, Fence, Cattle Grid, Gate, Driveway, Wood Hut, Power line, Telephone line

Table 9: Structures and channels

Fig.8 Boundary A (RVF on left side) of property A2. Not seen on the photo is the fence running through the vegetation on the left side. Source: author

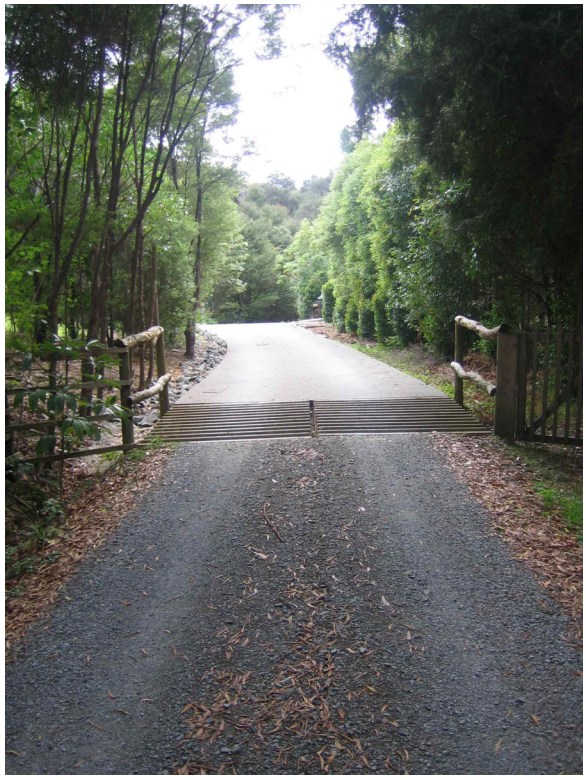

Fig. 9 Driveway, fence, gate and cattle grid crossing boundary A with property A2 on the left side of the driveway and Property A3 on the right. RVF ending at the gate and cattle grid. A. Source: author

Fig. 10 Walking path on RVF towards boundary B, ending in thick bush. Source: author

Fig. 11 Part of boundary C, RVF on the right, Property C2 on the left. Source: author

Fig. 12 Part of boundary C, showing fence line, path and shelterbelt of RVF on the right and property C1 on the left. Source: author

Fig. 13 Stream crossing boundary C. RVF on the left, property C1 on the right. Wire in the right corner is part of the fencing running along boundary C. Source: author

Fig. 14 Access driveway from Matakana Valley Road onto RVF's property, showing parts of cattle grid, wooden fence and a small wooden hut that was once used as a farm shop and is now only used for storage. Source: author

4.2. Symbolic characteristics

The second data set includes qualitative "soft" data from interviews relating to areas like contrast, opinions and aesthetics of the participating social groups. The visibility of the contrast is a factor combining physical and social characteristics and is therefore included here as well. This list is only rudimental and tools to quantify these characteristics should be developed and applied for future comparisons.

Social and Symbolic Characteristics
• Size of Social Units
• Opinions / Aesthetics
• Visibility

Table 3: Social and Symbolic Characteristics

Size of Social Units

Neighbour along boundary	Number of people living	Number of people working	Stability
A1	1-2	0	Flexible
A2	0	0	Stable
A3	2	0	Stable
B	0	0	Stable
C1	0	1	Stable
C2	4	0	Stable
D	no data	no data	no data
RVF	3-30	3	Flexible

Table 10: Size of Social Units on RVF and the neighbouring properties

The neighbouring properties were numbered clockwise along the boundary.

The social unit on property A1 consisted of 1-2 people because one person was working outside the area and therefore not staying at home for the whole time.

On property A2 nobody was living or working during the observation period.

Nobody was living or working along boundary B.

Most of boundary C (property C1) was used as pasture with only the owner working on it.

A family of 4 people was living on property C2.

As three neighbours confirmed, the owner of property D just moved recently back onto the property, but because there was no possibility of direct contact with the owner, exact data could not be collected.
The number of people living on RVF fluctuated highly, especially if the time before the observation period is considered as well, but even in that period, numbers varied from 3 to 25. Originally it was only the two owners that were living on the farm. Over the years they had workers and volunteers living on the farm for a few weeks up to several months, ranging from 1 to 4 people at a time.
During seminars and courses, this number could be raised to around 30 people living and working on the farm for the duration of the course. A list of visitors from the year 1991-2009 estimates an approx. number of 8.759 visitors on the farm, differentiating Farm Tours (guided tours on the farm to show visitors the practices of Permaculture), Workshops/Education courses and other activities (school groups, polytechs, farming groups, etc.).

Opinions / Aesthetics

The presented results were taken from the problem-centred interviews conducted during the research period. Key words (see methods 2.2) are underlined. They emphasize and combine related problem fields.

Property A1

The owners of property A1 considered themselves “green” even before they moved to the area. Where they lived before, they were protesting against nuclear power and whale hunting. (Memo to interview A1 10.2.2010)
They were familiar with Permaculture principles and practised them to some extend, but they would not refer to themselves as part of a Permaculture movement.
A1: I mean, I know about Permaculture, I know how you organize your, your surrounding so that the most important things are closest to you and then you have all the different zones […] (Interview A1 10.2.2010)

The owner was growing Cyclamen on his property, a passion brought with him, when he was still living in Europe. Growing cyclamen on his property and applying Permaculture rules became a challenge to him.

A1: I was very keen and I had lots of cyclamen but because they are slightly stressed in this climate they get things like thrips and spider mites and things like that. So I've had to use some insecticides and stuff, so I tried not to use those things for a while.

But because I couldn't grow them unless I did, I do use some. So like, I can't say I am a Permaculture person while I do things like that.

R (*son of owner A1*): But Joe, Joe definitely put pressure on you to not use sprays.

A1: There was moral pressure. But I mean I felt guilty, so I didn't use any insecticides and I lost all the plants that I had. And then I stopped for about four or five years but then I started growing them again and now I use them but I try again not to be indiscriminate, I only use miticides and things when there is a bad infestation.

I (*interviewer*): Would Joe have offered you an alternative?

A1: We had several discussions. And his attitude was that you shouldn't have monoculture. But cyclamen are monoculture plants. They grow in, they grow in, what's the word, in, like most natural plants, they grow in colonies. […] But it never became, it was never, it was never, an argument. Well, not an unfriendly argument. Just a discussion really.

I: Yeah, which is good.

A1: Yeah, no, listen, I am a big supporter of Permaculture, I like, I think it has a solution for a lot of places in the world, where growing stuff is difficult, where there is lack of water, like Australia, where it originated. I think it is a good system.

(Interview A1 10.2.2010)

Besides wanting cyclamen to grow, the wish and need (because it is required by law) to control and eradicate pests was a transboundary issue because of different believes on how to deal with the problem.

A1: One of the things that we've been doing is, we've been trying to control the ginger. Do you know what ginger is?

I: Yeah. Yeah

A1: We've been trying to control the ginger. There was a huge amount of it.

I: Really?

A1: Up and down this, this, ahm, this road. And its been going down into the bush and up the other side. And we got a grant to get Escort to spray it. And so I've been involved for the last 12 years or so spraying the ginger to try and control it. […]

I: But I don't think that's a problem at the farm. Is it? Or at least I haven't heard about it.

A1: Well. It is, it has been a problem. And Joe didn't want the ginger to be sprayed. But he has not been able to control it either because it's been so rampant. I mean, what he did was, he got Wwoofers to dig it up, the roots up. And to, trying turn it into liquid compost. […] It's a, you know, like, this is an ecological problem that we have and Permaculture people have it too. You know, like, there is a limit to the amount of hours that people can spend. You know, like, one of the things that used to upset Joe was, because he was in the valley, all the weeds ended up being waterborne going down into the valley. And the ginger, the birds spread the seeds all over the place. You know, so like, there's always this problem of weeds going every which way. And it's a problem that all Permaculture people have. If you've got 50 acres, I don't know how you. He tried to, you know, control it. But it was difficult.

(Interview A1 10.2.2010)

Macrocarpa trees grow along boundary A1 and have become a neighbour issue at some point as well:

A1: So they wanted to make that into a bush block, which, if they'd done it properly would have entailed cutting down all the Eucalypt trees, the Macrocarpas and I was quite keen that these Macrocarpas, just here below us didn't get cut down, because, what happens is, most of our strong winds come from the east, they come across this way and even though the Macrocarpa are a bit lower down, what happens I think is the wind hits the Macrocarpas and goes over our house it sort of acts like a kind of a windbreak. And Joe wanted to cut, discussed cutting them down with me a couple of times because he said if they get really old, they fall over and when Macrocarpas fall over they take a lot of soil, when their roots, with them and then its eroded.

I: Mhm.

A1: So I wasn't so keen that they got cut down and in the end it never became an issue.

(Interview A1 10.2.2010)

Property A2

At the time of conducting interviews, nobody was living on this property therefore no data was collected on this property.

Property A3

Two people were interviewed at the same time, hereafter referred to as A3/1 and A3/2.

I (*interviewer*): Do you do any farming?

A3/1: No.

I: Growing food?

A3/1: Not really. (*laughing*) A little bit.

A3/2: We have a few trees, fruit trees.

A3/1: Yeah. But we don't, ahm

A3/2: Eggs. We've got chickens.

A3/1: Oh yeah, chickens.

A3/2: And stuff like that. but

A3/1: But not a lot. We should do more.

A3/2: You can see the land, it's not productive land, it's rubbish land. I mean not in our lifetime, but it's beautiful bush up there, but ours is regenerate. But that's ok. If I had a cow or something, I wouldn't kill it, so.

A3/1: *laughing*

A3/2: It would walk free. So I wouldn't make a very good farmer.

A3/1: *laughing*

(Interview A3 18.3.2010)

Later in the interview the topic of being a farmer came up again as they were confronted with farm activities on the main interface between the properties, the driveway.

A3/1: [...] The only thing I got upset once or twice, I went up the driveway while they were killing the cow. Joe used to get the butcher and I, you know, would be hitting it out and unfortunately they'd already done the deed but there is like a carcass hanging there in the middle of the driveway

I: Ahhh.

A3/1: *laughing*

I: On the driveway?

C2/1: Yes, they used to do it up on the top of the driveway. The truck came down

A3/2: Home kill.

(Interview A3 18.3.2010)

Although they were not farming on their property, through their gardening and poultry keeping, the question of Permaculture applications arose and like in the previous interview, led to the topic of weeds.

I: Do you use any Permaculture principles?

A3/2: Yes. Both [*A3/1*] and I have done a course in Auckland. And I have done a course up here with Joe. I mean, I can, when I bought this property, I never even heard of Permaculture, I didn't even know what Permaculture was. Until I met Joe. He was my teacher. Taught me heaps. But I mean, we practice Permaculture by mulching,

A3/1: We don't spray.

A3/2: Don't spray. And don't fight nature. We try to live with nature. I don't worry about weeds. Or. And Joe taught me all that. When you work with so many people that are in constant battle with weeds. It is like a nightmare to them. [...]

A3/2: But to me, and Joe taught me that, what is a weed? What's a weed? There are some beautiful looking weeds. What's a weed? I don't bother.

A3/1: We were learning at the Permaculture course about the stinging nettle. They are apparently quite good for you.

(Interview A3 18.3.2010)

I: Do you have any ecological problems due to the farm? Like animals or plants invading?

A3/1: From the farm? No.

A3/2: No, Not at all.

I: Did you have any animals from RVF coming to your property?

A3/2: Occasionally. Occasionally a cow came across. But that's ok.

A3/1: Not for years though.

A3/2: I love their Swissy [name of one of the two cows on RVF] coming here. But Joe used to panic. We put in the cattle crossing.

A3/1: That's why that cattle crossing was put in there.

A3/2: That's why we bought this place. When we first came down the driveway, we've been to Switzerland. [A3/1] loved it. We saw those cows with the bells on their neck.

A3/1: and the little milking shed. It just reminded me of Switzerland, cause I love Switzerland.

(Interview A3 18.3.2010)

The overall attitude of the owners of A3 and their view on social relations to other properties are illustrated by the following statements, as well as their view on aesthetical issues:

A3/2: I mean this valley is beautiful. If they wanna have their property like that, or they wanna built whatever they like, we don't care the slightest what they do. We don't care what Rainbow Valley people do, we don't care what he does.

A3/1: I don't even really even care what they do with the driveway.

A3/2: No.

A3/1: To be honest.

A3/2: Just let us do our thing, you know. And if you do have a problem, have a sit down and talk about it

A3/1: We used to do that, you see.

A3/2: with a bottle of wine: I am not happy with this. What do you think? Do you think you could turn it down, or not do this or not do that.

A3/1: Before the [*xxx*][20] moved in, ay, and the [*xxx*] moved in, we were able to do that. It was lovely. We all could walk around each others properties, ahm, you know. People would come and look at our property and we'd go and look at their property. And nobody minded. But then when the Aucklanders, well I can't say that, we are Aucklanders too, but (*laughing*) when rich people came in, you know that all seemed to change.

A3/2: That may just be a sign of the area. Because the whole area is changing. There is a lot of wealth in Matakana now, a lot of wealth.

A3/1: And of course they are very wealthy, well they are meant to be very wealthy. And they just want a retreat. They want a retreat. They don't want people wandering in and out their property. Which is fair enough I suppose. I mean everybody needs their privacy, don't they?

A3/2: But they never seem to relax, they just seem to be always doing something. Digging, or mowing. Mowing lawns all the time. But, I mean that's great, if that's what they want. That's fine. But I always thought, after all the trouble, they just expected us to be like them. They don't like untidiness. They don't like things just left. I used to have them on when I was talking, you know, do you wanna borrow my laser level? You know, cause they were cutting their hedges.

A3/1: *Laughing*

[20] The names of the respective neighbours were deleted by the author.

A3/2: *Laughing*

(Interview A3 18.3.2010)

Although they expressed that they do not care too much what other people do on their properties, they wouldn't have liked RVF's property to be sold to people who would change it's look drastically.

A3/2: If it ever went to people who would just clear all that .
A3/1: Would be a shame
A3/2: And put in flower gardens and do this like them over there. Pffff. That'd be horrible.
A3/1: It would be a shame.
A3/2: I mean good luck to them, but not, no, I love walking over there.
A3/1: It's lovely to see the cows on the driveway.

(Interview A3 18.3.2010)

Property B

Nobody was living on property B, therefore no data was collected on social issues from this side of boundary B

Property C1

The interview with the owner of property C1, a commercial cattle farmer (mainly milk with some meat production) resulted in the longest data collection. Because the owner's family has been living and working as farmers or drovers in the area for generations, his view and experiences, especially on ecological aspects relating to his business were very extensive.

C1: That was my first block of land that I ever bought. So,
I (*interviewer*): Does that have like a special meaning to you?
C1: Well it does for that reason. But, ahm, yeah. I suppose it does really. And, I, yeah, I've spent my best years of my youth (*laughing*) working on it really. Yeah, so, I don't intend to give it up for anything really.

(Interview C1 22.2.2010)

This block of land (C1) was his start for becoming an independent (from his family) farmer and is still being used mainly as pasture. But there is also a large bush area that serves a different purpose.

I: Are you allowed to use the bush or is that protected?

C1: Yeah, the bush is mine, yeah. It's not protected. I can do whatever I want, yeah.

I: Do you use it for timber?

C1: No. No. But it has got timber trees up in there. So, but, yeah, no. It's just for beauty's sake really.

(Interview C1 22.2.2010)

The problem of weeds is a big issue for him because they affect his business more than just in an aesthetic way.

C1: Well the ginger is a problem that's coming in too, yeah. I think somebody said to me that there is ginger up in here but apparently I said to him I think it's on the neighbour's place, up the top up there (*pointing out property A3 on a map)*. Yeah, but it could well be up in there too because I haven't been up in the bush there for ages.

I: And what other weeds are there?

C1: Oh, there is ragwort. Ragwort comes in from this property here (*pointing out a neighbouring property not bordering to RVF in the west)* on and when it blows from the west it just blows straight into my front paddock, here, the seeds. And that way it gets to me but, there doesn't seem to be a lot I can do about it. And the other time they grow in Rainbow Valley Farm, in here and I go over the fence and pull them out and put them in a bag and get rid of them and then this guy up here *(referring to property C2)* he has ragwort growing there, but I kind of tell him about it and have educated him about it and he seems to kind of get onto it, cause he likes looking out over my property here, so he kind of does realize that the ragwort is an issue to me, so he is trying to be a good neighbour.

I: Because he enjoys the view?

C1: Yes. Yeah, yeah. Well he doesn't want to see it all in ragwort down there. Yeah, yeah. It's a noxious weed, so, like, it's invasive and it just take everything over. Especially in a grazing situation. So and then I have it get up, down in there in the dock land and then I have to go up into the dock land to clear the ragwort up there because it all gets washed down the creek and then it just goes right through and invades into my place.

I: And is the only way of controlling it, is by digging it out?

C1: No. Spraying it.

I: Could you spray it?

C1: Yeah, I spray it. Yeah, so. Spray it and dig it and chop the heads off and put them in a bag and bury them, yeah, so. (*Still talking about plants. No crimes were committed)*

I: Other weeds?

C1: Yeah, well, there is sedge growing, was, here growing on Rainbow Valley Farm's bit of land there but I sprayed it with a helicopter two years ago.

I: Mhm.

C1: Joe would turn in his grave but he knew, but (*laughing)* he couldn't do anything about it because it's an invasive weed and he couldn't get to it anyway, so.

I: Yeah.

C1: Yeah, so he wouldn't have sprayed it anyway, so, yeah. So, that's a really invasive weed the sedge. I've kind of got it all up in here.

I: Mhm.

C1: Yeah, I've been spraying it and battling it the whole time too, yeah.

I: And are the weeds a problem because, are they poisonous for cattle?

C1: No, they just don't eat them. They are just so invasive they are covering everything and you end up without any grass you just end up with weeds, yeah. And then you got no feed to feed the cattle, you know what I mean?

I: Yeah, yeah.

C1: Yeah.

I: Ok. So. They come either by wind, or by the creek, you said?

C1: Yeah. Wind, creek, birds. Birds is a big problem. Anywhere trees are, ragwort, like, the birds drop the seeds in their dung and, yeah, then the ragwort comes up and so, yeah. Trees are a real problem, especially dead ones, like dead Macrocarpa trees or something like that. Yeah.

I: So, then, actually that's quite, I mean, there are a lot of trees.

C1: No, no, not those trees. Like, dens trees are alright because under dense trees the light doesn't get in and so then they can't grow.

I: Ok.

C1: Yeah. It's only if you've got, say, a tree there or these trees down here (*indicating trees on property C1*), you find under the hawthorn trees around here, birds go into a single tree and they sit there and roost and then a year later you've got all those little ragwort plants all come up.

I: Mhm.

C1: It's so frustrating.

I: Mhm.

C1: Yeah.

I: So why do you, because I really don't know anything about cattle, *laughing*

C1: Well, ragwort is poisonous to cattle. They won't eat it unless they are just starving.

(Interview C1 22.2.2010)

A question relating to the protection of his boundary led to the description of yet another plant problem:.

I: Do you need to keep people off your property? Are people using it as a shortcut, or

C1: I've had, mhm, yeah, I have actually. People wanna go in often with horses.

I: Ok

C1: And I kind of kept them out with horses because when I bought this in 1984 it was covered in Kikuyu grass, do you know what that is?

I: Yeah.

C1: Yeah, well I've sprayed it out over the last twenty odd years and, ahm, twenty-six years and hardly have got anything there now. People that are all on lifestyle blocks they buy cruddy blocks of land that have got Kikuyu all over them. Their horses eat Kikuya, people bring them in and they stand down by the creek or staying somewhere and the horse, what does it do? It does a dung and straight away the Kikuyu will come up.

I: Mhm..

C1: So, yeah. I've basically banned horses from in there. Yeah. Mean, ay? But, ahm, when you've walked around with a knapsack on your back for twenty-four years.

[…]

C1: All the other neighbours don't have issues with Kikuyu because they are not farmer.

(Interview C1 22.2.2010)

When I called C1 to arrange for the interview meeting, I briefly explained on the phone what I was doing and what the thesis was going to be about. When later asked during the interview about his relationship to RVF, the answer provided information on the social and economic opinions of C1.

C1: Since you rang up, I did a bit of thinking about all this and ahm, you said at the start that you wanted to know about the social implications, yeah, so, I think what it boils down to, is the relationship between myself and Rainbow Valley Farm, what I've learned in the last few years, is basically we have a different socionomic look on life, probably and the value of the land to us.

I: Mhm. Mhm.

(Interview C1 22.2.2010)

Coincidently the theories of socionomics[21], mentioned by C1, also deal with complex human self-organizing systems. This analogy to the underlying theories of this thesis is interesting, but plays no significance for the further discussion with regards to content. Socionomics are presented here only as an example of a personal point of view:

C1: Back in nineteen, whenever it was, in nineteen ninety or whenever, when Joe and them arrived in here, they came in and they wanted to get away from the world, how it was going. Well, the first time I met Joe he was waving a stick at me while I was spraying with a tractor, saying: I came here to get away from sprays. Ok. And I always remember that day. And yeah, he basically from then on kind of shut me down and made my life really miserable, that I had to walk around spraying everything by hand and I just couldn't cope with all the weeds and stuff.

I: Mhm

[…]

C1: What I am trying to point out is that socionomicly Joe and them came in, doing their thing, which is a complete bull market type of, ahm, organic type thing is a bull market type expression of human psychology.

I: Yeah?

C1: And as the bear market crashes out, goes way down, you gonna find people aren't going to be so much into organics and Permaculture and stuff because they are going to be worried about survival and that's what's happening over there now and from what I see in Britain and Europe, isn't it?

[21] Socionomic theory postulates that „contextual differences between economics and finance produce different behavior, so that in finance the law of supply and demand is irrelevant, and EMH [efficient market hypothesis] inappropriate. In finance, uncertainty about valuations by other homogeneous agents induces unconscious, non-rational herding, which follows endogenously regulated fluctuations in social mood, which in turn determine financial fluctuations." (Prechter et Parker 2007)

What I am trying to explain to you in a round about way, that I see the issues in the future are going to be, the organics and that will be less of a problem - to me. It's been a real problem in this 1982 to, from there to there time, because everybody had heaps of money and everything was booming. And so it became a kind of bull market trend. This guy that wrote this book, Robert Prechter, he said that organics is basically gonna be dead as this market crashes down.

[…]

C1: What has happened because of the Auckland influence is, this happened way back in 1982 too, was the Auckland influence influenced the value of the land because of all the people wanting to come up here to live in the country and look at the nice views of rural and quiet and whatever. So, from about 1987 onwards the land value just went through the roof and I couldn't comprehend it, I couldn't understand what was driving it. For a long time I thought it was just absolutely ridiculous. You went from, you know, you only paid a couple of hundred thousand for a block of land and then 20 years later or whatever, it's worth millions. Yeah, and it just seemed ridiculous to me. And you couldn't buy any more land. You couldn't do anything because the land values have been pushed up way in excess of what the value, the intrinsic value of what you could draw an income off the land was worth. Do you get what I mean?

I: Yeah.

C1: Yeah. And so I think that's probably what pushed me into finding other, while this has happened. Yeah.

[…]

C1: I bought it as a farmer, whereas they are buying it for the lifestyle, for the quiet, the peace, the lack of sprays or whatever.

[…]

C1: Joe had his ideas and I had mine. He wasn't gonna bail to me and I weren't gonna to bail to him, so. We had to learn, well I did bail to him anyway really, in the end because, yeah, I couldn't, he was forcing me to go to his ways really. People were scared to go in there with helicopters or whatever because he caused so much bobsy die[22], yeah.

I: Mhm.

[22] New Zealand dialect for „great trouble"

C1: Yeah. So the weeds just got worse and worse and worse, yeah. My health suffered, I suppose because it basically wore out hip joints and whatever, yeah,
I: Because you had to do it
C1: I had to do it all with, on my back, walking around all manually. Like I've got stuffed wrists from grubbing thistles and gorse and whatever. Yeah, I had a big bursa come up couple of years ago. Just burst up and the doctor had to pull the fluid out, yeah, yeah. But it could get bad anyway, but if I'd been able to spray and do everything I wanted to, my health would have probably been better for me, yeah. But then he would have said it was worse for him, so. *laughing*
[…]
C1: I think, ahm, we did have a sort of mutual respect for each other. Bizarre as it may sound.
I: Was there anything that you learned from him or that he
C1: Oh learned plenty from him! I learned heaps. I learned heaps of things from him about, how, he had a total different view of life to what I did, just the complete opposite. I suppose I'd have loved to live like him but that wasn't going to be, was it? Like, I had a family to bring up and I had mortgages to service and I wanted to own my own business and, I suppose, get it into a better shape than what it is so that possibly my son or whatever can take it over some day in the future, you know.

(Interview C1 22.2.2010)

When asked what he considered the biggest problem on his property, the topic of weeds came up again.

C1: The most severe problem would be the weed problems, yeah. And I suppose it would be nice to have a fence through this bush around here next to Trish. That would be very nice.
I: To keep the cattle in.
C1: Yeah to keep the cattle in so I didn't have any worries there. Because at the moment I've just got a single hot wire. Yeah.

(Interview C1 22.2.2010)

Aesthetic issues, like expressed in other interviews, were not so much an issue to him as practical questions relating to his cattle.

C1: I have no problem aesthetically how this looks. But then, I don't see it.
I: Mhm.

C1: Really. Yeah, cause it's all blocked out by Joe's trees along the boundary, ay.
I: Are the trees a problem for you, on the boundary?
C1: They will be.
I: They will be?
C1: Yes, and they have been. […] The trees are actually growing on the legal road and, but he went and planted Macrocarpa trees or Lusitanicas, some of them were Macrocarpas, up just there and they are still there. I think there's one or two just a bit in from the boundary and there was one right down by the creek and Macrocarpas cause cows to abort.
I: Ah.
C1: Yeah. So, I kind of told them at one point to, there was one growing right on the boundary fence so I tried to tell them to move that and Trish said: Yeah, Joe will do that. So he removed that one. And then these ones along here, I kind of told her periodically to trim them so my cows can't eat the Lusitanica cause it causes abortions and she has been accommodating the whole time. But further down the track, it's still gonna be a problem, cause, ahm, Trish is on her own, and the trees get bigger and bigger and the branches get bigger and bigger and they come down or the trees fall over or whatever.

(Interview C1 22.2.2010)

Because of the opinions expressed before (especially socionomics) the interest in Permaculture, as a way of land care, was not really existing because of a general disbelieve that it could be applied economically successful.

I: Do you know anything about Permaculture?
C1: No. Not really. No. I know that if you don't put fertilizer on, it doesn't grow grass. Yeah. Cause, it is quite amazing. If we don't put fertilizers on, you just see your production drop. Yeah, in the long term, so, yeah. You basically gotta keep doing it. Mmm. If anything I don't do enough fertilizer. *Laughing*
[…]
C1: I don't think Permaculture systems would support mortgages. And families. And I think that's a valid thing that you even could write about. Because I haven't seen a Kiwi system that is fine, like organics, or that, with a young guy taking it on, with a mortgages and rearing a young family and being able to do it. Permaculture is a system from what I see, of an old guy, who's paid off his mortgage, who just wants to take life easier and live the good life type of thing.

I: Mhm. Mhm.

C1: Yeah. And live in harmony with nature or whatever.

I: Yeah.

C1: Or he is a Richard Branson and he doesn't have to worry about money. Do you get what I mean?

(Interview C1 22.2.2010)

Economic aspects were also emphasized when asked about the relevance of the farm for the region. Because of the misconception that I was asking about his farm, he showed me bills of local companies he had paid for fertilizers or machinery, to illustrate his contribution to the local economy.

I: Do you think that RVF is important for the region for some reason?

C1: Ahm. I think that, ahm, in it's own way, for all the lifestyle, the people that have been living the good life up to here, this point, they all embody that, yeah. And so, yeah. But I don't know. I can't say that they are actually creating an expenditure of 40.000 in two months. Are they? That's being generated back into the community. Do you get what I mean?

I: Yeah, yeah. Well, the only thing that I, cause of all I have heard of, the conflict with other neighbours. The social support of the community is very big for the farm.

C1: Yes. For the Rainbow Valley Farm. Yeah. That's why I say, the social aspect is big for the people that have moved in, that are wanting the lifestyle and the attributes that Joe and Trish have pushed. They have pushed that it's the good life and, I don't know. If you are thirty, you would have been around, there used to be a program on TV. Was it called "The good life", or something? It was a British one.

I: Maybe we didn't get it in Austria.

C1: Oh, ok. And it used to be about the people on a little section and they were growing their own food and having their own pigs and yeah. It's a real thing that town people aspire to. But when they go and do it themselves the reality is often quite different. Yeah. Often they think, what the heck are we doing this for? You know. Yeah. But, ahm, yeah, financially I don't think Rainbow Valley Farm is, ahm, creating that much for the community. It's creating, what's the word, I suppose it's ridden the coattails of the bull market. That's how I would describe it. But as time goes buy, people won't be able, if things paying out people won't be able to do all those things. Life will be about survival. Yeah, so. Maybe they all will go and live the good life on

five and ten acre blocks and we will all be peasant farmers, I don't know. But I wouldn't like to think so.

I: Why? If we could all live from our land and just, you know,

C1: But you can't. Like, you are here on this trip in New Zealand. You have moved, you have come over here on this trip, haven't you?

I: Yeah, yeah.

C1: Yeah. You've come here, you have aspired to come here to New Zealand. I aspired last year to go to Sydney for a holiday. If we want a good life and to see things and do everything, unfortunately we've gotta have money and you can't generate money on a ten acre block, ahm. Living the good life. You just can't. I don't care what Trish and them say. There is just no way that financially they can go in there and pay the rents and everything and aspire to having a good life going to Austria or wherever and survive, can they?

(Interview C1 22.2.2010)

Property C2

Two people were interviewed at the same time, hereafter referred to as C2/1 and C2/2. The overall interest of the owners of property C2 in a "green way" of living was strengthened after they moved from Auckland to the area by the fact that they assumed an already existing house that was set up by the previous owners under ecological aspects.

C2/1: We have always had an interest in, you know, growing vegetables and all that sort of thing anyway and eating well and living a nice cruisey[23] life really, but the fact that [*xxx*][24] and [*xxx*] were here and the way that the house was, it had the composting toilet and it had those sort of things. So it was like a certain type of person was going to buy it.

I: Mhm

C2/1: Which was really nice, it was sort of, it was a step in that direction, wasn't it? Instantly.

[…]

[23] New Zealand expression for stress-free, relaxed.

[24] Names of previous owners were deleted by the author.

C2/1: It was really, really lovely, coming and finding, this area, when we bought the house and we found a community. It wasn't just a house, we found a community. We've got some really lovely neighbours.

[…]

C2/1: I went and did one of his night school courses that he [*Joe*] was doing on Permaculture and that sort of eased me into that.

(Interview C2 12.2.2010)

There had been ongoing problems and (legal) disputes with other, not direct, neighbours, who also have shared access of the driveway on RVF in order to get to their property.

C2/1: When there started to be a bit of friction when that bottom property sold, there started to be a bit of friction. That certainly unsettled everything and made people uncomfortable.

[…]

C2/2: But really it is not a clash of their Permaculture thing,

C2/1: Well, who knows what there is a clash about.

C2/2: No, it's all just a personality thing, ay. I am sure.

C2/1: I don't know. I can't fathom it out what the problem is. Yeah, I don't know, I don't know.

I: But you still, I mean you have just been down there this afternoon.

C2/1: Oh yeah. We do. I mean, I, ahm. It also changed when poor Joe got sick, ahm, because you know, at the end, you didn't want to intrude, cause, you know, they needed their time.

[…]

I: Was there any conflict with the farm?

C2/1: Not that I know. With us? No.

I: You didn't have any animals come in eating your vegetables?

C2/1: Oh, yeah, we did.

C2/2: We had plenty of that.

C2/1: We've had that. We had the ram, called her Rammy. He came up.

C2/2: He got you, ay?

C2/1: He got me, knocked me over.

I: Really?

C2/1: Yeah. *Laughing*. (*name removed*) was just a little baby and we'd been down to play centre and came home and the ram was in the garden here munching away.
C2/1: And he was a big ram.
C2/1: He was really big and I, being a city girl, didn't really understand rams, so I was just there going, you know: shoo, shoo, shoo. And he just put his head down and poofed me, rammed me, knocked me over and then I got it just about down again down to the bottom, to the fence line and he decided to charge me again.
I: *Laughing*
C2/1: So I ran back up here and he was chasing after me, (*name removed*) was standing in the window watching and we rang Joe up and Joe came up and got him. It was funny. Never trusted a ram again.
C2/2: Well, you know, that's why they call him a ram. *laughing*
C2/1: Yeah, that's why they call it a ram.
C2/2: Yeah, he had a few problems with that, the ram. There was another, that, and they all wanted him to kill it, ay?
C2/1: Mhm. I didn't want him to kill it.
C2/2: Yeah. I'd like to think that I maybe, hopefully, have talked him out of, because he was gonna bend to the pressure. Those things are always gonna cause conflict in and me dropping in a rural setting, that's life, ay. You gotta
C2/1: It's all part of it.
I: I guess it just depends on how you react, you know.
C2/1: Yeah.
I: You can make a big, big thing about it, and
C2/2: Yeah, yeah.
C2/1: Well I guess if it was your prize garden or something, but *laughing*
C2/2: We've had cows coming, off the road because we always get them because of the corner here, they all get down to there. We had them all coming through here, ay? *laughing*
C2/1: Even our own cows
C2/2: Yeah, our cows have jumped the fence and so
C2/1: Yeah, that's just the way it is.
C2/2: You gotta really, just try your best to keep them in *laughing*
I: And with plants? Did you have any problems with plants, I don't know, weeds, or?
C2/1: No

C2/2: Oh, we've always got weeds.
C2/1: We've got all the weeds in creation, but
C2/2: The ginger thing.
I: The ginger, yeah.
C2/1: That was the big thing. Well, that was the only thing so far that got so bad that they had to poison, wasn't it?
C2/2: Well, I don't know if Joe actually poisoned it, did he, I don't think he did, ay? He was digging them out.
C2/1: No, I think at the end they had to
C2/2: And I gotta say that was a battle lost, ay? When you walk up through the bush now
I: Yeah.
C2/2: It was a lot of money spent
[…]
We often wondered that it probably came from this property.
I: From your property?
C2/1: Years ago.
C2/2: Years ago. Because apparently it was all lined up the road but it was beautiful, you know. You drive up and
C2/1: just the scent and the flowers are beautiful
C2/2: It is a beautiful smelling thing
I: Mhm.
C2/2: And, ahm, there's so many things here, like, now there are noxious weeds, we sort of figure that maybe, it might came from here. You know, these people have planted all these different things.
C2/1: That's a think, we think, we don't really know, because the council offices had a fire and a lot of the old records were burnt so, but we think that this site here was one of the original farm homesteads for the area.
C2/2: Well it was. But there was another one just here that burned down.
C2/1: Mhm.
C2/2: It was rebuilt here. But whoever lived here years ago had put all those sort of plants in, they probably would have put the ginger and other things. Lovely, I mean I love all those. It is just like a bonus every time *laughing*. You gotta look at it thinking oh, it's a noxious weed

I: *Laughing*
C2/2: We wouldn't be able to buy it now
I: Yeah.
C2/2: But I mean. We've got no problems. We are trying to live
C2/1: as simply as possible
C2/2: And applying what Joe
C2/1: believed
C2/2: the principals
C2/1: You know, I think, like you say, the strongest thing, I think we've got from Joe is the community thing. He was really community minded. He wanted people to work together and laugh together and live in peace. That's what he wanted.
[…]
C2/2: Really what it boils down to, that's the whole reason of doing Permaculture, so you can live well
C2/1: Sustainably
C2/2: Sustainably with a reasonably clean conscience.

(Interview C2 12.2.2010)

There was never a competition for any resource between property C2 and RVF. Trees on the boundary had been an issue that never turned into a problem because of Joe's understanding and complying with the wishes of C2.

C2/1: We had some big trees here and we asked if we could chop them down because they were shading us. And he did it, didn't he? I mean you (*addressing C2/2*) helped him. There has never been any problem. No.

(Interview C2 12.2.2010)

We talked a bit about the opinion other people had of the farm. C2/1 thought that only people, who hadn't visited the farm had understanding of the farm's activities and I commented that many people thought it was a kind of "Hippie place".

C2/1: I know. Joe was always very conscious of that, wasn't he? He was saying he'd liked the place to have been a lot more overgrown and things but he always tried to keep it relatively tidy so that people didn't feel that it was, you know, like a Hippie commune or whatever.

(Interview C2 12.2.2010)

Property D

At the time of conducting interviews, nobody was living on this property therefore no data was collected on this property.

Rainbow Valley Farm

This data resulted from interviews held with the owner, Trish Allen and with Jocelyn Winters who was living and working on the farm for a longer period as a manager.

I (Interviewer): Can you tell me a little bit about each neighbour and a bit about the history of the farm and how you established the border?

Relationship to A1

T (Trish Allen): Ok. Well, when we came here in 1988, we had, one of our current neighbours was here, [*A1*] and he'd arrived with his wife and his two children just a few months before we had. So, we became friends almost immediately because we were both newcomers to the area,

I: Ok.

T: So we didn't know many people but they had similar interests. They liked gardening, they liked growing things, they liked organic food. So we immediately established a bond and we also, because we were both foreigners to the area.

(Interview Trish Allen 10.2.2010)

Relationship to A3

They bought this land with the idea of building a house there and coming up to live there from Auckland, West-Auckland. So we saw mostly A3/2 in the early days. He'd come up and start working there and planting things and building and then eventually after about seven years he built the house and they moved up. So they are also very lovely people and we have a lot to do with them.

(Interview Trish Allen 10.2.2010)

Relationship to C1

In the beginning there was a little bit of conflict with him because he was a conventional farmer and he sprayed 2,4-D, which is a chemical herbicide, by helicopter on his land. So, we were horrified, absolutely horrified, because when a helicopter, with the rotors, spray gets all whipped up and of course it comes down on our side of the fence as well. So we were pretty upset about that and we met him a

couple of times but he and Joe just didn't get on ever. So, that's always been a little bit of a strange relationship.

I: Mhm.

T: However, after Joe died, I met him one day, not long, it was only about two weeks later. He was coming down to do some work on his land and I went to the fence and talked with him and he was really, really kind. And so since then, we've had a good friendly relationship and he said to me, that he learned a lot from Joe. He said that he actually misses him. So, that was quite an admission. He said to me, 'Oh well, we never got on but we are both strong men, we are both stubborn.' But it was just such, it was so lovely to make that contact and think, God, for 20 years they didn't get on and they'd probably had so much in common."

I: Mhm. Mhm.

T: So I was really very, very pleased about that. So, I have spoken to him quite a number of times and he's been here and I've been to his house a couple of times to see him about things. So, we are cooperating really well now.

(Interview Trish Allen 10.2.2010)

On invaders like weeds and pests

T: Twenty years ago there was a lot of weeds in there, lot of Gorse. Because it had been grazed by cattle. So it was a lot of Gorse and Ragwort and weeds and lots of Possums. So that part, where it's all nice and looks like beautiful native bush now, we just left it and that's just natural succession. When, the Gorse is a fantastic mother crop for native bush, because when you clear an area, mother nature wants to close it, she wants to cover bare soil, so the Gorse is the first plant to come through and it's a really good plant, because it fixes nitrogen from the air into the soil and it improves the soil and this soil badly needed to be improved. So, the Gorse came up and of course the Gorse is a great safe place for birds to nest, so the native birds nested in there 'cause they were away from predators, 'cause it is very prickly, and the droppings from the birds contain seeds from trees around here, native trees and then the native trees start to grow up through the Gorse and as soon as it's shaded out, it can't stand shade, it dies. And so then Manuka comes through and the Kanuka, the ferns, the Pangaferns and within ten years you have native bush. So that's what happened there. We didn't plant any trees over there. It was just natural succession.

(Interview Trish Allen 10.2.2010)

T: Well, Possum migrate in here all the time, because this land, it borders onto a thousand hectares of native bush over here.

I: Mhm.

T: And Possums are territorial. So if you eliminate a possum from an area, another one will migrate in. So we are constantly putting out the possum traps. Rabbits also need to be controlled otherwise they eat our gardens. But there is not so many just at the moment. Once in a while the Auckland regional council comes in and does a big possum and rabbit eradication program in the bush over here.

I: Mhm.

T: And of course they use poisons and things, which is not so good but it does stop the migration in here.

[…]

T: Yeah. There are pigs up here in the bush, which is a little bit of a controversial subject because some hunters up here, who live up in Governor Wilson Road released some pigs in this bush so that they could have their own little hunting ground. And those pigs bred up and now they are making a big mess up there in the bush, cause they root up the ground. So. And then the hunters come down and say, oh there's pigs up there. We'll go and shoot them for you. So, I am a little bit unhappy about this. *Laughing*

I: So it's on your property? Or?

T: Some. The pigs migrate.

I: Yeah.

T: they migrate because there is no fences up there.

[…]

T: The main weeds, like, things like gorse, is not really a problem for us. That's a good plant. It heals the earth, it takes nitrogen out of the air and fixes it into the soil, improves the soil. So we, that's not for us a problem. But there are some problem pest plants, like the Kahili ginger.

I: Mhm.

T: Because it has, it comes from somewhere, Hawaii or somewhere. It is not an edible ginger, but it has this massive big root mat and if it starts growing in the native bush it doesn't allow any seeds to germinate from the native trees and plants. So…

I: Mhm.

T: It becomes a little and it can grow in shade as well.

I: Yeah.

T: Kahili ginger. So there is spots of it popping up all over the place. The birds spread the seeds, so. We just had a ginger eradication day in December. We dug up a lot of the roots. The local land care used to have a program where they came around and sprayed it throughout the whole catchment but that program is over now. So, it's up to the landowners to do it themselves.

I: Mhm.

T: We, ahm, we didn't have them spraying ours but we cut it down and they painted the roots with this, ahm, this herbicide, so we didn't want it sprayed but up in our bush we allowed it to be painted on.

I: Mhm.

T: But…

I: So it's more ahm, it's just local, on the plant

T: Very local, because we didn't want to be the only ones in the whole catchment who wouldn't take part in this community project. But now, that that's over, we need to control it ourselves and it is a big job going and digging up those roots, huge job. Did a whole lot before Christmas, but I've just noticed some more, so.

[…]

T: There is other weeds as well but they are not really a problem, like ragwort. That's toxic.

[…]

T: It's very, very unpopular with farmers. But sheep eat it. So it's not toxic to sheep

I: Mhm.

T: So that's the good thing about having the sheep here. When we first came here we had a lot of ragwort but now there is very little. Occasionally I see some. And if I see one, I pull it out. But it isn't really a problem here. Ragwort. That's an invader. There's some other weeds that come in more recently, like, ahm, wandering willie. And that's supposed to be a noxious weed but our cows love it.

I: Mhm.

T: That's the first thing they will eat if they can get at it. So I don't see that as such a problem. There's always some things that come in that you don't want but those are the main ones.

The one that worries me the most is that ginger.

[…]

T: We love to see the native birds here. We have, we have these beautiful Kereru, the wood pigeons. They are such beautiful birds. They can be a bit naughty, cause they love olives. And they'll sit in the olives trees and they'll

I: Ahhh.

T: eat a whole hand full of olives and they'll hardly be able to fly off

I: *Laughing*

T: They love exotic food. They don't just stick to the native food. *Laugh* But they are such beautiful birds. We, we, ah don't mind, we think that's ok

[…]

T: Water. Yeah. I think, ahm. Of course we get run off from the road and road surfaces do have stuff on them from tires and from exhausts and there is probably some nasties in the water that comes off the road. Ahm. Which comes down, of course gets washed down into the stream and comes through our property. I don't think it is too much of a problem because last summer during our Permaculture course we, we did this water care, this water care testing of the stream

I: Yeah?

T: And someone came in from the ARC and we collected, with nets, we collected water insects, tiny, tiny, tiny minute water insects at the bottom of the stream down the bottom.

I: Mhm

T: And then put them into these, ah, little plastic boxes with magnifying glasses and we identified these tiny creatures and we compared them to a chart and we were able to see what they were and there were some very rare little insects, that we found that only survive in clean water.

I: Mhm.

T: Very clean water and we found some of those

I: Ah, ok

T: So we, I was very happy about that. So the quality of the water, going through our, the bottom of this land is fairly clean,

[…]

T: Well, hmm. In the past, the, this road, before it was sealed it had lots of limestone on it. Like the council used to, when it was just a gravel road, they used to use

I: The Matakana Valley road?

T: Yeah, yeah. They used to use limestone and of course lime stone has a very, ahm, high pH and when it heavy rained, when there was heavy rain, some of that lime stone got washed off into the water ways and limestone it kills off, with such a high pH, it killed off any insects in the water, any life in the water.
I: Yeah, yeah.
T: But that doesn't seem to be a problem now because it's been sealed and then we did the testing last year.

(Interview Trish Allen 12.2.2010)

On aesthetics and differences with (not direct) neighbours

I: Yeah. But it's interesting. Because I was briefly talking to X. [*former farm manager of RVF*] about it and he said that actually the difficulties you had with [*xxx*] are quite typical for the moment because city people start moving here and they just sort of see it as their weekend hide out and they just can't really relate to the rural lifestyle and they would think, you know, it's, I don't know this looks messy or untidy because they don't really understand the thing
T: Yeah. That's true.
I: But that didn't seem to be the case before
T: Oh, no. Not at all.
I: That's what they were looking for.
T: That's what they wanted. That's right. Well, all of those people, all of the previous ones, They wanted to grow things in the garden, grow vegetables, have fruit trees. They wanted to enjoy the bounty of the land whereas [*xxx*], they want to have their place like a park. So they don't grow any food or have a veggie garden. I don't think so anyway. But it looks beautiful. It' all mowed and trimmed and they have sculptures. Which is nothing wrong with that it's just different.

(Interview Trish Allen 10.2.2010)

T: He [Joe] was often called upon by the council if they needed an opinion, a kind of a green opinion on something. They would ring him up or the local newspaper would and he often voiced those sort of things, so but I don't know in the end if it helped.

(Interview Trish Allen 12.2.2010)

J: I think the biggest thing is the contrast, it's the case of contrast, the difference between this property and certainly [C1]'s property. I remember talking to some people that arrived in the last PDC [Permaculture Design Course] and also during

farm tours, especially with this drought looking at the contrast between the properties. And that's most evident at the boundary. And I think that's, I mean, if you have two conventional farms and you have a boundary, you will see no difference between the two. And you know, so many people talk about this is being so different. And I think this boundary really emphasizes the contrast, yeah.

(Interview Jocelyn Winters 29.3.2010)

Signs / Visibility

An effective way of expressing opinions, attitudes and believes of individuals or groups is through signs. They allow people entering the system to literally see the social background and rules of the system.

Information for people entering RVF is transmitted through various signs along the driveway. They are mostly handmade out of wood and display believes, principles, rules and wishes of the owners.

At the entrance gate a sign displays the name of the property one is about to enter.

Fig.15 Entrance Gate Sign. Source: author

A few meters down the driveway a welcome sign in English and Maori hangs over two signs informing about hazards and asking drivers to drive slowly because of farm animals:

Fig. 16 Welcome and Information Signs
Source: author

Fig. 17 Welcome Sign Detail
Source: author

Fig. 18 Hazardous Area Sign
Source: author

Fig. 19 Farm Animals Drive Slowly Sign. Source: author

Fig. 20 Request for respectful behaviour
Source: author

Fig. 21 Minimize Driveway Damage
Source: author

Fig. 22 Another Sign asking to slow down
Source: author

Fig. 23 Warning Sign Electric Fence
Source: author

Signs not only transmit ideas but help with spatial orientation as well by pointing out directions:

Fig. 24 Sign indicating direction to the Farm
Source: author

Fig. 25 Signs indicating direction to different properties. Source: author

Fig. 26 Sign indicating parking area
Source: author

Fig. 27 Information on Farm Tours
Source: author

Fig. 28 Parking sign and Farm Tour information. Source: author

Entrance points are marked by signs as well as exit points.

Fig. 29 Cattle stop and sign informing people about the boundary of the property.
Source: author

Fig. 30 Detail of “do not go beyond this point”. Source: author

The gate at the bottom of the driveway was usually open. Only when absolute privacy was required it was closed. To emphasize the “message” of the closed gate a sign was put on the gate.

Fig. 31 No visitors sign. Source: author

One fence on the property was used to display Permaculture ethics and principles.

Fig. 32 Permaculture fence. Source: author

Fig. 33 Permaculture Principles
Source: author

Fig. 34 Detail, Permaculture ethics
Source: author

Fig.35 Fence Detail Energy

Source: Author

Fig.36 Fence Detail Change

Source: Author

Fig.37 Fence Detail Diversity

Source: author

Fig.38 Fence Detail Pattern

Source: author

Fig.39 Fence Detail Resources

Source: author

Fig.40 Fence Detail Waste

Source: author

Fig.41 Fence Detail Observe

Source: author

Fig.42 Fence Detail Edges

Source: author

Fig.43 Fence Detail Integrate

Source: author

Fig.44 Fence Detail Slow Solutions

Source: author

Fig.45 Fence Detail Yield

Source: author

Fig.46 Fence Detail Feedback

Source: author

Fig.47 Fence Detail Fair Share

Source: author

Fig.48 Fence Detail People Care

Source: author

Fig.49 Fence Detail Earth Care

Source: author

4.3. Exchange Characteristics

Exchange Characteristics
• Exchanged materials and/or information
• Access
• Control: Rules, Rituals and Laws

Table 4: Exchange Characteristics

The tables were established through information extraction from interviews and observations. The list of exchanged materials was assorted roughly following the framework of MEFA (materials and energy flow accounting) but extended to suit the theory of SEM. Because there was no quantitative or qualitative accounting being done, the direction of flow is also not reproduced in this list. If the material was passing the SEM of RVF during the observation period or an exchange event was mentioned during an interview, the respective SES (A1, A2, etc.) was marked with an "x" in table 13.

Material	A1	A2	A3	B	C1	C2	D
Space[a]			x				
Time[b]	x		x			x	
Labour[c]	x		x			x	
Information[d] (support, stress, neutral)	x	x	x		x	x	
Biomass[e]	x	x	x	x	x	x	x
Water[f]	x		x	x	x	x	x
Electricity[g]							
Minerals[h]	x	x	x	x	x	x	x
Waste[i]							x
Manufactured Artefacts[j]	x		x			x	
Money[k]			x				

Table 11. Materials exchanged between RVF and surrounding SESs

[a] Examples for Space: Storage room, accommodation or camping space for people participating a PDC course on RVF.

[b] Time was usually combined to exchanged labour but also in the form of leisure activities like goodwill visits or neighbour dinners.

[c] Examples for Labour: helping with building construction, housework, animal care, etc.

[d] Information subsumes every type of communication (oral/acoustic, written, visual). The classification of support, stress and neutral should point out that the quality of information can vary significantly and have opposite effects on the system. But because of their complexity the recorded events were not qualitatively separated.

[e] Main examples of biomass are crops, timber, livestock, fish or seeds.

[f] Water was entering either through surface run off or through the creek. Rainfall was not included.

[g] The exact position of power lines through property boundaries could not be recorded, but was included in the list for the sake of completeness. The main power and telephone lines were entering through boundary D but not directly coming off the SES D.

[h] Main examples of minerals are dust, chemical spray and fossil fuel

[i] Waste was differentiated into solids, grey or black water and smoke. No waste was exchanged between RVF and its surrounding systems. Smoke had been a frequent problem but coming from a property not directly surrounding the farm.

[j] Examples for manufactured artefacts are pottery, books or glass bottles.

[k] Money exchange was not documented directly but mentioned in interviews as payment for rented space for example.

Access

Access was differentiated into physical possibility of access and right of access.

Information on the physical possibility of access for any relevant objects or organism can be drawn from the results of permeability and structures and channels in section 3.1.

Therefore only the access onto RVF for humans shall be presented in this paragraph.

The main access to the property is the driveway leading from the main road into the valley. The construction of the driveway was really the beginning of the settlement of the area. Trish Allen explained how the driveway way was established: The man, we bought this land off, he purchased this whole valley when he retired. He was a company director, but he was also an engineer and this 400 acres had been for sale for a long time and no one purchased it because they didn't know how to get access down into this valley because it is so steep and so difficult to get in to. But being an engineer, he designed a way into this valley. He spent quite a lot of time here and he engineered this driveway, so that it could get access into the valley without creating erosion and instability. So he designed this driveway and he got it approved by the local council and then he built it. So it just came down into the valley and it was very rough when we came. It is much better now than it was originally. And we planted a lot of trees up the left and right hand side of the driveway to help stabilize it. And it's been really good. It's never slipped away. If you did any major earthworks on that driveway, you could lose it. It could go. It could create erosion. So, it was very carefully designed, sensitively, so it would be stable by a very, very experienced engineer. And then, that's why no one bought it for so many years but because he could see a way in, that's how it all happened.

(Interview Trish Allen 10.2.2010)

Ecological and geographic aspects were not only relevant during the creation of the driveway, they still influence its condition. An evaluation of a civil & structural consulting engineer states: "The surrounding vegetation is beneficial in that it provides stability and helps prevent erosion in the roadside drains. The shading effect of the trees is also beneficial in maintaining sufficient moisture in the pavement surface during the summer months. This helps in preventing ravelling of the unsealed pavement surface." (copy of statement available from author)

The driveway is also a very distinctive feature of RVF and its surrounding SESs, because it is a shared access road located for the most part on RVF. Properties A2, A3 and another one past A2 and A3, share a right of way, as it is the only possible way to access their properties. This situation caused a great deal of conflict ranging from frequent disputes over its condition and maintenance to protracted, costly court cases. The investment for maintenance and repair in the form of labour or money is a shared cost for all affected parties, but the different frequency of its usage made the apportioning of costs a reason for disagreements.

Fig. 50 Entrance of Driveway
Source: author

Fig. 51 Left Turn of Driveway
Source: author

Fig. 52 Right Turn of Driveway
Source: author

Control

The main elements of control along the SEM are definitely fences and gates.

The main gate at the top of the driveway was never closed and therefore the general access to RVF was not controlled at this point. The signs at the top of the driveway do not regulate the access in any way as well. They only inform about expected behaviour within the property (driving slowly, respect for human, animals and plants; see section *visibility* and Fig. 15-21)

To control cattle, a cattle stop was installed just before the junction to the main road.

At the bottom of the driveway, where the shared access ends and people are entering the pathway that leads to the main buildings, another gate can be found. This gate was closed at times when absolute privacy was required, for example during the time of Joe Polaischer's illness. When the gate was closed a sign reading "no visitors" and the farm's phone number (Fig.31) emphasized the wish for privacy. Even when the gate was open and access was theoretically possible another sign at the side of the driveway and directed at visitors coming unannounced to the farm, asks them to make an appointment for a farm tour (Fig. 27). These signs were only put up, when the flow of visitors was interfering too much with the daily work on the farm. "Some people used to just came by. And this became a real nuisance. Because it just disrupted the work that you needed to do all the time. So, we did try to discourage that. We put up signs and things saying, visitors by appointment only." (Interview Trish Allen 10.2.2010)

Another mean of access control was the granted resource consent of the council. This legal paper defines the usage of a property as well as how many people may enter it.

Conditions of the Resource Consent regarding access to the property state:

"(ii) The educational programme offered by the consent older shall be limited to 350 visits to the property per season. For the purposes of this consent, attendance at a course of more than one day will constitute one visit.

(iii) There shall be no educational programme at the property between June and October inclusive.

(iv) The consent holder may also make the property available for a fee, donation or koha[25] for other educational activities (including visits from schools and pre-schools,

[25] A koha is a Maori tradition of giving a gift or contribution, often by visitors to a host marae. A marae is a sacred or communal place for social or religious purposes.

polytecs, universities and other training organisations who may visit the property as part of their course on the property); community and charitable organisations; and other farming groups.
(v) There shall be a limit of 800 visitors to the property per 12 month period and no more than 200 visitors per month may access the property via the existing shared right of way for those activities described in condition (iv) in respect of which a fee is charged or waived or a donation/koha is requested or given." (Resource Consent of Rodney District Council)

The control tools can be divided into legal ones (resource consent) under the influence of a higher hierarchical order (the district council) and rules and regulations of the owners themselves, like "drive slowly", "respect living beings", or "visits only by appointment".
Another form of control was practised more indirectly through the Maori ritual of the *powhiri*. The ritual does not really regulate access but is an important protocol in Maori culture, adapted by the owners of RVF for the multicultural setting of the Permaculture courses held on the farm. During a *pōwhiri* the hosts or people of the land (*tangata whenua*) greet the group of visitors (*manuhiri*).
Students of Permaculture Design Courses go through the experience of the *powhiri* at the beginning of the course, although this is not practised as strictly as it would be done on a marae. The group is not allowed to go up to the main building before the ritual took place on the lawn in front of the house. Students gather for registration at the workshop space and then are called up onto the home marae by the call of a conch shell, a ritual not only common in Maori tradition but throughout the Pacific region. Then a *karanga* takes place, a form of female oratory, the first call of welcome in the pōwhiri. The common powhiri chant *Toia mai te waka* then calls the visitors onto the *marae*: *Tōia mai, te waka! Ki te urunga, te waka! Ki te moenga,te waka! Ki te takoto rungai, Takoto ai, Te waka! /* Drag it here, the canoe! To the entry, the canoe! To the berth, the canoe! Up to the resting place, set it down. The canoe!
After listening to more songs and welcome speeches, the powhiri ends with the singing of the waiata *te aroha* and finally the *hongi*, the traditional Maori way of greeting another person by pressing foreheads and noses together, takes place and everybody has not only gained access to the property but has become *tangata whenua* for the duration of the course.

4.4. Legal Property

"Property in New Zealand is supported by a strong and reliable cadastral system. The tenure regime can be relied on to guarantee and protect property rights. New legislation, new pressures within the property market and new social and environmental conditions have disturbed the status quo. There is now a need to renegotiate the allocation and content of rights in land. Conflicts exist between private property and public rights, between orthodox English legal rights and indigenous customary rights, and between land productivity and land conservation. " (Strack 2004)

Several legal bodies and laws have influence the "legal property" RVF:

One is the Property Law Act 2007 regulating issues around:

- Mortgages
- Leases of land
- Covenants, easements, profits, and access lots
- Special powers of court (entry onto neighbouring land, wrongly placed structures, landlocked land, trees and unauthorised improvements on neighbouring land)

Another one is the main piece of legislation for environmental management in New Zealand, the Resource Management Act 1991 (RMA). Its purpose as cited from the legal document is: „... to promote the sustainable management of natural and physical resources.

In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment. (Resource Management Act 1991 No 69 (as at 01 July 2011), Public Act)"

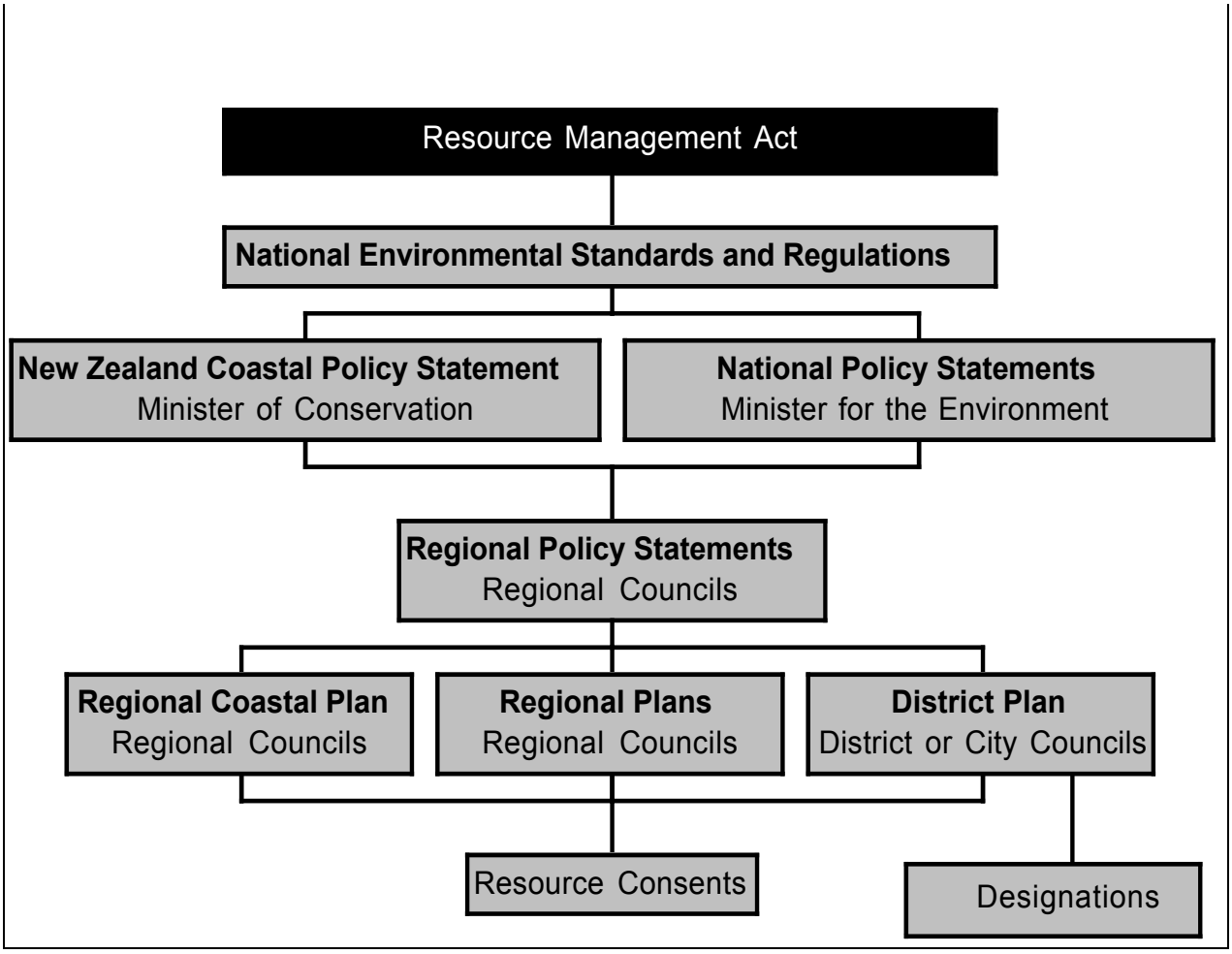

Fig. 53 Resource Management Act Flow diagram, after the “Everyday Guide to the Resource Management Act Series 1.1. Source: author

Therefore both national policy and regional district plans influence private land use and may have rules and bylaws controlling questions of:

• house location and number of houses
• location of farm buildings and stock yards
• disposal of household sewage and stock effluent
• taking water from the ground or rivers
• discharges to ground and water
• burning of open fires
• distance of shelter belts and plantation forestry from boundaries
• noise
• removal of scrub or trees
• earthworks to build access tracks

There may be particular or additional controls in areas that have special landscape or ecological importance. (cf. Ministry for the Environment brochure *Thinking about living in the country?*)

In this case study private disputes that were not be able to be resolved differently have also been taken to the higher level of control, the environment court, to be settled there. (Disputes about the driveway, the resource consent use, etc.)

Notes on Ground and Airspace

Because the relationship between different SESs based on legal properties was the main interest during data collection, the wider area of the entire air and ground space of RVF was not incorporated explicitly into the empirical research. But because it is essential to any concept that works in a three dimensional space (as the SEM concept does), it has been discussed in the theoretical part of the thesis. Although no data has been collected exclusively for the purpose of investigating air and ground space, some aspects that can be subsumed under *ground and air space* were part of already presented results and shall be briefly outlined here:
No matter how permeable the physical border of RVF is, energy in form of sunlight, rainwater, organic and inorganic particles (dust, smoke, sprays, smells) and small organisms can constantly enter the SES. If the sources, respectively the way of transportation of such inputs are solemnly of natural origin, then the possibility of control is very limited because changing the structure of the SEM will have no effect on the source. Examples from RVF would be seeds of the Kahili ginger spread by birds or lime from runoff water off the main road. Both events cannot be controlled preemptively and also legal actions are difficult to implement.
The case is different if the source is manmade. Through communication with the originator his or her behavior can be changed and unwanted inputs might be altered, redirected or stopped before they can occur. This can be achieved by means ranging from simple conversations over group pressure up to legal actions.

There were no examples of any ground boundary events, but the theoretical possibility was addressed in section 1.5.4.

A rose is a rose is a rose
Gertrude Stein

A tree is not a tree is not a tree.

5. Discussion of Results

During the course of this paper it has been continuously pointed out that SESs are very complex structures in time and space. A narrow view on them and their management does not offer adequate solutions. (Holling et al. 2000) Although the results were presented separately by their overall category (ecological or social), the combination of different aspects provides a more accurate understanding of the resulting phenomena. And since the research question was aiming for a describing synthesis of physical and conceptual elements in SESs, the results of RVF's SEM shall be discussed through a combined approach.

The physical elements of RVF's SEM are quite homogenous throughout the different sections. The **size** of different boundary sections does not seem to influence the exchange or overall relationship the different SESs have with each other, although they range from 100 meters to 587 meters length.

The size only becomes relevant if one looks at it in combination with **permeability**. The whole SEM was considered semipermeable and the main elements that were regulated by making the boundary impermeable were cows.

Because the cattle on property C1 are the main interest of their owner, the length and permeability of section C1 was of some concern to him (C1: "And I suppose it would be nice to have a fence through this bush around here"). Because the boundary is so extensive and goes through thick bush area at some parts, fencing was not done throughout the whole length because of high financial costs.

Another interesting feature of the SEM structure was not searched for, but came up in a legal document of the Environmental court, in which the property was described: "None of the buildings on any of the properties can be sighted from any building on another property and a combination of site factors including vegetation and topography give a high degree of privacy to each of the landowners." (see p. 68)

Generally one can say that permeability is of great importance but only in connection to what each SES regards as wanted or unwanted intake. A3 and C2 for example simply did not care if cows came onto their property. (A3/2: “Occasionally a cow came across. But that’s ok.”) And the occasional visit of RVF’s ducks (Fig.8) did not worry C1 as well, if he was even aware of it.

Orientation of the different sections influenced the SEM to some extend. Because prevailing cold winds come from the South, the owner of property A1 didn’t want RVF to cut down the Macrocarpa trees on their side of the boundary because they served as a shelterbelt for his property. Because of RVF’s understanding of A1’s situation, this never turned into a conflict.

The lack of sunlight, which could be of interest in relation to orientation, posed no problem to any of the SESs.

The **contrast** along the SEM showed no specific influence on the systems. Only if the sections had divided into smaller observation parts, the high contrast between the pasture area of C1 and RVF’s shelterbelt would have been displayed in the results. But because there is also a large fraction of the boundary running through bush area, the overall result became medium.

Structures and channels are highly influential but can also only be understood out of the different perspectives of the SESs. The sheer presence or the number of structures did not show any relevance for the systems. But besides individual people, they are the main elements of connection or separation. Interestingly they can serve as both at different times or for different elements. If they are **natural structures**, there is only a limited possibility for control of the flow through them. A tree barrier (for view for example) can be easily cut down, but if it is wanted back at some point, it cannot be as easily re-established. Trees have shown to be of great variability and importance for all SES, even though for different reasons. The shelterbelt along boundary C for example was the reason C1 has no direct view onto RVF, which influenced what he said about the look of the farm. (C1: “I have no problem aesthetically how this looks. But then, I don’t see it.”) Having a barrier for neighbouring looks might be quite beneficial at times, but the main reason for the shelterbelt is its function as barrier against cold winds. The type of trees that were selected, were chosen because of their value for timber and their fast growth. But they are a matter of concern to the neighbour because of their effect on his cows.

A solution that could turn the whole structure into a win-win situation for both sides would be the planting of species that could serve the purpose of RVF and at the same time supply fodder for the cows on C1, like oak or mulberry, for example.
Although the shelterbelt serves mostly as a barrier, it can also be seen as an indirect channel for weed seeds, because seeds are distributed by birds, which use the trees as roosting places. Then again if they are dens enough, they shade out other weeds, which cannot grow in the under storey of the trees. The safest thing one can say about the trees as structures in the SEM is that a tree is never just a tree.

Because the stream was no direct resource of any kind (water, recreation, etc.) it did not influence the properties it is running through. Nevertheless it did serve as an ecosystem health indicator to people. Both owners, of RVF and C1, proudly pointed out to me in informal talks that the stream was very clear and had rare fish in it.
Artificial structures are a more effective tool for control than natural ones. Gates allow a very flexible level of control. The gate at the bottom of the driveway was only closed when the need for privacy was given, generally allowing easy access to the farm.
A kind of intermediate level is reached through signs. At the other side of the bottom drive, a sign informing visitors to not go beyond this point was enough to keep unwanted visitors off neighbouring properties. A gate would have been a more complicated tool of control as it would have to be opened and closed by residents as well each time they pass it (Fig. 29 and 30). Cattle grids proved also to be a good solution as they are semipermeable through their immanent structure and no further control mechanism is necessary.
Without pathways and especially without the driveway, no access to RVF and the bottom properties would be possible. The existence of the driveway was the single factor that made it possible to open up the valley. Every future activity, especially the problems and conflicts with the shared right of way were a result of this driveway. This is an example of a literal path-dependency.
It can be pointed out as well that the scientific evaluation of the SEM was also dependent on the different paths into the bush. Sections that were easily accessible because they were running along a path or open vegetation, like pasture for example, were easy to evaluate. But the large boundary area B for example, was almost completely inaccessible, except for one pathway that ended in a dead end at

the top of the hill. This area would have been really difficult to cover, in order to accomplish a complete ecological evaluation. But because it was so inaccessible to everybody, it also did not directly influence the SESs. Some people, for example, mentioned the presence of ginger in this bush area, but because it was not present to the owners, it was neglected more than areas that were visited more frequently and easier to access. (C1: “Yeah, but it [ginger] could well be up in there too because I haven’t been up in the bush there for ages.”) If anything, this boundary could be considered a buffer zone, with no main conflicts. Only single occurrences with people hunting in that area were mentioned during informal talks but they had no substantial effect on RVF.

Besides the fact that ecological factors influence human behaviour and result in different outlooks, depending from which side one looks at the problem (wind direction for example or invading animals), they are also used to express the **opinions** and personal lifestyle of the owners. Be it accurately maintained lawns (A3/2: “Mowing lawns all the time. […] They don’t like untidiness. They don’t like things just left.”), or letting plants grow in a (seemingly) chaotic way. (C2/1: “He was saying he’d liked the place to have been a lot more overgrown and things but he always tried to keep it relatively tidy so that people didn’t feel that it was, you know, like a Hippie commune or whatever.”) Signs are a more direct way of communicating the owner’s opinions (Fig. 20, 35-49.), but in both cases visitors already get an idea of basic internal opinions while they are entering the SES.

Knowledge about what is happening inside a system can help to avoid insecurity and raise understanding. The neighbours with the least problems with RVF all had at least some understanding of Permaculture and were often applying Permaculture principles to their own lives as well. There was a direct correlation on how people approached the “weed problem” and how much they were involved in Permaculture. Even though the common need to control Kahili ginger, because of district and national regulations, the degree to which this was considered stressful, was quite variable. (A1: ”this is an ecological problem that we have” A3/2: ”But to me, and Joe taught me that, what is a weed? What’s a weed? There are some beautiful looking weeds. What’s a weed? I don’t bother.” RVF: “There is other weeds as well but they are not really a problem, like ragwort. That’s toxic. […] It’s very, very unpopular with farmers. But sheep eat it. So it’s not toxic to sheep. So that’s the good thing about

having the sheep here. When we first came here we had a lot of ragwort but now there is very little. Occasionally I see some. And if I see one, I pull it out. But it isn't really a problem here. Ragwort. That's an invader. There's some other weeds that come in more recently, like, ahm, wandering willie. And that's supposed to be a noxious weed but our cows love it. That's the first thing they will eat if they can get at it. So I don't see that as such a problem." C1: "The most severe problem would be the weed problems" and "All the other neighbours don't have issues with Kikuyu because they are not farmer.")

RVF, a private home with the aim to live sustainably, enact Permaculture ethics, use only organic systems, etc., has a very different system purpose to the commercial cattle farm on property C1. And weeds are only one example, because they were such a prominent topic in all interviews, but there are many more, like the trees in RVF's shelterbelt and their effect on cows or the spraying of pesticides.

This means, depending on their individual system purpose, the different landowners interpret the prevalent ecological situations differently, which inevitably results in a collision of interests. The difference starts with what is even considered a problem and leads on to how to solve the problem. There is no one solution that fits all systems perfectly.

As much as different values, lifestyles or aesthetics result in some conflict, so do similar values and life styles lead to cooperation. The exchange between properties that practiced a green lifestyle with no commercial interest and RVF was very vivid. The SESs profited from the support they got from their neighbours through exchange of space, time, labour, or even money.

The different **social unit sizes** on the SESs showed only two effects on the SEM. The high number of RVF visitors using the driveway, was a matter of concern to one of the (not direct) neighbours who also share the right-of-way on the driveway. If each property had its own access, this negative effect would disappear. On the other hand did the increasing number of unexpected visitors at some point become a problem for RVF, which they solved by regulating the visitors flow through their gate and signs. (Fig. 27 and 31)

Whereas the permeability of the SEM provides information on what or who is physically capable to enter the system, the right of access and its control adds another layer to the accessibility of the system. For people the general access to

their property is obviously extremely important, because it is the prior condition for their activities on the property. The driveway of RVF strongly emphasized this relevance. (RVF: “And then, that’s why no one bought it for so many years but because he could see a way in, that’s how it all happened.”)

Because traffic flow in and out of the SESs is focused on the driveway, it is also an important interface with possibility for contact and exchange (positive or negative). Figuratively speaking, one could describe it as an extension or invagination of the SEM, an area bringing the outside into the system without truly incorporating it. And here too, the social aspects are closely intertwined with ecological ones (surface water run off, stability and shading through vegetation).

The legal aspects of RVF’s SEM are also interwoven with many different factors. The legal property boundaries define the area as a geographic space and as a legal unit, combining physical elements (“land”) with mental ones (“property”). Countless legal disputes over land all over the world illustrate that the relationship between these two are anything but clear and distinct. But legal boundaries bring positive and negative effects to SESs. The mills of law usually grind slowly, and although the legal boundary might not change over years, the physical one might change drastically. This allows for a great deal of flexibility and security at the same time.

Unlike other territorial animals, humans can rely (at least in countries like New Zealand) on the legal system to guarantee the stability of their territory. In general they can afford to use their energy on other things than constantly defending or marking their property boundaries. Within the bounds of New Zealand law, landowners are allowed to use their properties however they like. Nevertheless there are laws and rules they need to obey, which can be to their advantage or disadvantage. (RVF: “Some years ago the local council designated areas that were native bush. They’ve called them significant natural areas because there is so little native bush left in this County. So any areas of native bush were designated significant natural area, which means that you can’t cut down any trees in there. So, it didn’t matter to us, ‘cause we didn’t intend to anyway. But some farmers were very angry because that meant they couldn’t use their own land.”) Owners can also use the legal system to carry out disputes they cannot solve otherwise. Rules that are put upon the system from the hierarchy level of legislation can often be implemented more effectively. Because all SESs were bound by the district rules about weed control, a commitment to collaboration was more necessary than if it were only a

problem of one or two properties. (RVF: “Because we didn’t want to be the only ones in the whole catchment who wouldn’t take part in this community project.”)
Through the different hierarchy levels of the legislative system itself, even more layers are put onto the systems, making them more complex but also more versatile.

RVF’s SEM showed characteristics of all the different boundary concepts presented in the theoretical part of the thesis. As proposed by the SEM concept, they showed various connections to each other, thereby influencing the effect they have on the system. They created the picture that, together, they limit the system just as much as they enable it to survive. In any case they participate vividly in the system processes, facilitating exchange or blockage.
Illustrating characteristics on both sides of the SEM, factors concerning ecological and social issues, serve to understand differences and similarities across the SEM, offering a great source of information about each individual system.
Because they are a dynamic part and change over time and through different actions, they are not just a mirror that reflects what is happening inside, but they are an active part of the inside as well as the outside. This characteristic makes the SEM a useful leverage point for system change and adaptation. It is further a more or less harmonic combination between natural and social elements, making visible which is evident, but often neglected: that humans are a part of nature and nature is a part of humans.

6. Outlook

The aim of this thesis was the development of a theoretical “crutch” to tackle complex SESs. To reach this goal, a very broad view was necessary to create an underlying matrix. I would dare say that almost every single characteristic presented here, would offer sufficient opportunity for an extra study and in fact do need further examination.

The end is a popular point for looking back to the beginning. In a 43 year old textbook about cell walls and membranes the general introduction reads, “ At first sight it may seem perverse to concentrate attention on the outer layers of cells when so much that is of interest and importance to biological science is usually regarded as happening inside. More mature reflection, however, immediately poses the question as to what is to be regarded as the inside of the cell and what is outside. […] Much of

what we have been saying lies either in the future or right on the frontier of advancing knowledge, and the present book aims at something simpler, namely to give a basic understanding of the nature of the walls and membranes of cells and of the biosynthesis of some of the polymers in them. Even this is a considerable undertaking, and it has certainly proved too large for the individual subjects to be dealt with comprehensively. However, it is believed that a general picture of the situation has emerged that is sufficient to form a basis for future thinking along the lines we have been discussing. […] In writing this book the authors have frequently had to trespass far outside their own specialization and experience […] Unevenness of treatment has been inevitable, and in certain fields it is probable that the reader can expect no more than an overall, though, we hope, accurate picture. ” (Rogers et Perkins 1968)

There is nothing to be added to this but even more humility (the authors were writing a 400 pages book, whereas this is merely a beginners attempt to join the scientific game) and to change the word cell to SES.

The presented line of thoughts hopes to support any theory or approach towards creating, maintaining, working or living with complex SESs. The presented thoughts are not fully developed and a myriad of question lies open for future endeavours. They are in no way a panacea, for all problems relating to SESs. (cf. Ostrom 2007)
It might not be possible or even necessary to understand such complex systems like SESs, but one of the advantages of complex systems is that it is often not necessary to understand each and every part of it, but only a few crucial ones. And some control hopefully can be given up in trust of self-regulation, resilience and adaptation.
Besides refining the already discussed, some future questions could be: How are the different SEM factors arranged, what can be said about development and variation over time (information storage, adaptability, etc.), what are effects of division of land (through partial inheritance or subdivision for example), computational analysis, where does the biggest leverage point lie for academia, can the concept of SEM be adapted for public land, how do economic factors influence the SEM etc.

This is a complex, but also highly interesting process and even if things cannot be changed (although this is possible at times) they might be understood for a moment.

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Abstract

Social-Ecological-Systems (SESs) are complex systems with human and natural components that are difficult to understand and almost always impossible to fully control. Because of this high complexity, focusing on a single level or singling out the relationship of only a few key components is a common approach. Another possible way of reducing complexity and still looking at the system in a broad range is focusing on the boundary of the system. There is no theory combining different aspects of SES boundaries and therefore the aim of this thesis is to develop a model of an extensive description of a SES's boundary area.

On the basis of different boundary concepts (from natural and social sciences) a combined definition is offered in the concept of the Social-Ecological-Membrane (SEM). The model does not aim for a description of a physical reality but for a describing synthesis of physical and conceptual elements in SESs, grouped into spatial and physical characteristics, social and symbolic characteristics and exchange characteristics. To address the different aspects of the SEM, quantitative methods were used as well as qualitative ones.

This concept and the presented characteristics are illustrated by example of a Permaculture farm (a private property) and its surrounding systems.

For better and clearer understanding, the results are presented separately following their category (ecological or social), but the following discussion required a combined approach in order to understand resulting phenomena. The farm's SEM showed characteristics of all the different boundary concepts presented in the theoretical part of the thesis. As proposed by the SEM concept, they displayed various connections to each other, thereby influencing the effect they have on the system itself. They created the picture that, together they limit the system just as much as they enable it to survive. In any case they participate vividly in the system processes, facilitating exchange or blockage.

Illustrating characteristics on both sides of the SEM, factors concerning ecological and social issues, serve to understand differences and similarities across the SEM, offering a great source of information about each individual system.

The presented line of thoughts hopes to support any theory or approach towards creating, maintaining, working or living with complex SESs.

Zusammenfassung

Social-Ecological-Systems (SESs) sind komplexe Systeme mit menschlichen und natürlichen Komponenten. Sie zu verstehen ist schwer, sie zu kontrollieren beinahe unmöglich. Um ihrer hohen Komplexität Herr zu werden ist es üblich, nur eine Ebene oder nur die Beziehungen einiger weniger Komponenten auszuwählen und zu analysieren. Ein anderer Weg um Komplexität zu reduzieren und dabei aber nicht die Gesamtheit aus den Augen zu verlieren, ist der Fokus auf die Systemgrenze. Da keine Theorie existiert, welche verschiedene Aspekte von SES-Grenzen mit einander verbindet, ist das Ziel dieser Arbeit eine Modellentwicklung zur extensiven Beschreibung des Grenzgebietes von SESs.

Ausgehend von verschiedenen Grenz-Konzepten (aus den Geistes- und den Naturwissenschaften) wird eine kombinierte Definition vorgeschlagen, das Konzept einer Sozial-Ökologischen-Membran bzw. Social-Ecological-Membrane (SEM). Dieses Konzept zielt nicht auf eine physische Realität ab, sondern auf eine beschreibende Synthese von physischen und konzeptionellen Elementen in SESs. Diese Elemente wurden in verschiedene Sparten gruppiert: Räumlich-Physische Merkmale (spatial and physical characteristics), Sozial-Symbolische Merkmale (social and symbolic characteristics) und Austausch Merkmale (exchange characteristics). Um die verschieden Aspekte der SEM adäquat untersuchen zu können, wurden sowohl quantitative als auch qualitative Methoden angewandt.

Das Modell und seine Merkmale wurden an Hand einer Permakultur Farm und ihrer umliegenden Mensch-Umwelt Systeme illustriert. Für eine anschauliche Darstellung wurden die Ergebnisse separat in ökologischen oder sozialen Kategorien präsentiert, für die Besprechung der Ergebnisse wurde aber ein kombiniertes Verfahren gewählt. Die Farm wies Merkmale aller Grenz-Konzepte auf, die im Theorieteil der Arbeit präsentiert wurden und wies weiters, wie im SEM Konzept angenommen, zahlreiche Verbindungen zwischen den Merkmalen auf, welche wiederum das System und die SEM selbst beeinflussen. Zusammen genommen begrenzen sie das System ebenso sehr, wie sie es ermächtigen zu überleben. In jedem Fall nehmen sie intensiv an Systemprozessen teil und ermöglichen Austausch oder Blockaden an der Systemgrenze. Die dargestellten Gedanken hoffen all jene Theorien zu unterstützen, welche die Schaffung und Erhaltung, die Arbeit und den Umgang mit komplexen SESs zum Ziel haben.

Lebenslauf

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