Mapping the Environmental Footprint of the Central Plains Water Irrigation Scheme

A thesis submitted in partial fulfilment of the Masters of Design

Mapping the Environmental Footprint of the Central Plains Water Irrigation Scheme

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Acknowledgements

A final decision on the proposed Central Plains Water (CPW) scheme needs to be left to the consent-granting authorities, according to Christchurch City Mayor Bob Parker. The basis for this position is that the issues raised by the proposed irrigation scheme are simply too complex for members of the public to grasp. (The Press, September 10, 2007).

Abstract

In the statement Mayor Parker is referring to a complexity of issues that involves a plethora of hard-scientific and statistical information. The diversity of opinions regarding the scheme's benefits and potential negative implications also create misunderstanding for the general public. This prompts the hypothesis of this design thesis, which suggests that statistical data when visually mapped and in the context of its physical environment can provide significant cognitive and ecological awareness for the viewer to understand the economic and environmental implications of the proposed irrigation scheme.

Both the areas of cartographic mapping and the dairy industry contain controlled vocabularies, which present opportunity for graphic modeling and explanation through visible phenomena. The Canterbury Plains has a well-established historical and agricultural narrative. However, due to the recent dramatic and substantial transition of the region's dairy industry between the periods 1995 – 2008, subsequent demand for freshwater now represents the real prospect of uncharted future environmental instability.

The development of a visual language system capable of the interpretation and construction of the irrigation scheme's benefits and potential negative implications, provide this thesis through graphic modeling the possibility to compare the proposed CPW scheme's issues. While some industry groups consider public participation as arbitrary and unnecessary, recent surveys indicate water quality and fertiliser management as the most significant areas for environmental concern. The debate should not exclude the public, but rather include communication systems capable of reaching all communities.

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1.0 Introduction.

Introduction

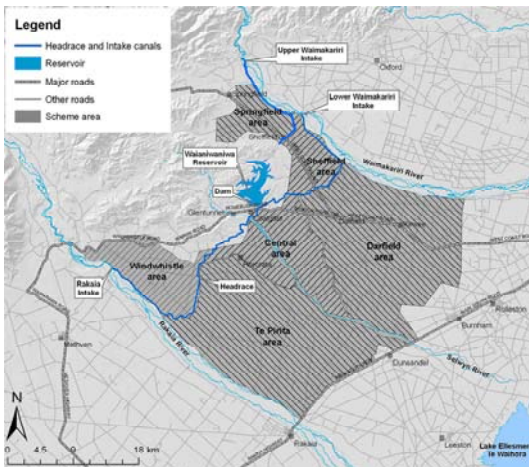*Image 1:* Canterbury plains.

Image 2: Central Plains Water irrigation scheme.

Media coverage and the presentation of information to the general public regarding the Central Plains Water (CPW) scheme is divided and incomplete when considering the potential significance and long term consequences of the irrigation scheme's proposal. The decision to exclude public participation is both unacceptable and unfortunately represents the reduced capacity for public engagement in future environmental planning (Memon, 2007). Under the existing legislation both the Environmental Court and elected local authorities are charged with the responsibility of resource management, and with the possible expectation should the irrigation scheme be granted approval in late April 2009, both public consultation and discussion will have been sorely missed.

The scheme itself will be one of the largest construction projects ever undertaken in the South Island, consisting of 60,000ha of land between the Waimakariri and Rakaia Rivers on the Canterbury Plains. The proposal consists of water diversion, damming, reticulation, and irrigation in order to supply the dairy farmers with an increased guarantee for future irrigation requirements. The scheme is privately owned and backed by local and corporate farming interests and is supported by both the Christchurch and Selwyn District Councils. Benefits of the scheme are significantly weighted towards these interest groups, including a $650m annual addition to the Canterbury economy and estimated employment opportunities including 2,800 jobs (1,300 in agriculture and 1,500 in processing) (Cronshaw, 2005).

Opposed to the scheme are a significant number of community, recreation, and environmental groups. Exemplified by the response to the Canterbury Regional Council's public notification of the resource consent application in June 2006 – when they received 1316 applications opposing the CPW scheme and 172 of support (ECan, 2006). This number reflects concern regarding potential environmental, recreational, and social threats that are expected should the irrigation scheme be granted consent. The construction of the storage dam and lake would displace local farmers, result in habitat loss for the endangered Canterbury Mudfish, and in the event of possible sudden dam failure take the lives of a predicted 201 people (URS, 2006). The CPW scheme environmentally will impact the ecology and natural characteristics of both the braided Waimakariri and Rakaia Rivers. The intensification of dairy livestock as a result of the guaranteed supply of water will cause increased nitrate contamination of the aquifers and rivers, and increased carbon emissions.

Existing public information regarding both the CPW scheme's comparative benefits versus its negative impacts is extremely limited and consequently results in the public being forced to wade through large amounts of misinformation to come to an understanding (Mackenzie, 2007). Information is mostly provided from stakeholders, lobby groups, or technical experts and subsequently its appropriateness for objective appraisal needs to be questioned. The merits of this debate are definitely divided and are found situated within two vehemently opposed camps, the battle of which is eloquently illustrated by the cautious regard each shares for their adversaries' public relations. Here the CPW proponents are accused of providing 'woefully inadequate' information from expert witnesses who have 'considerably underestimated potential adverse effects' (Silkstone, 2008c). Dairy industry accusations of the public include the comments 'in general they eat too much, exercise too little and they abuse and blame the producer' (TVNZ, 2008a) and while the critics suggest that 'it would be better if they just stuck to the facts' (Silkstone, 2008a).

Discussion of Context

This research through design thesis explores the environmental and economic potential impact of the CPW scheme. Focusing on the history, narrative, and transition of the Canterbury Plains, it begins with a comprehensive discussion of the complexities and instabilities of New Zealand's dairy industry. In particular relationships between irrigation, the environment, and the economic reliance increasingly afforded upon the dairy industry are considered with regard to the broadening attitudes of both the urban and rural communities. The CPW scheme and the ensuing Environmental Court hearing does in the context of this thesis represent a significant precedent with respect to future intensification and expansion of the dairy industry throughout the Canterbury Plains and beyond.

Through the formation of ideas originating from scientific complexity and statistical evidence, this thesis suggests that the translation of information into a visual language system will enable readers a greater understanding of the CPW scheme. This visual language system will attempt to connect the scheme's comparative benefits identified as financial gain and employment throughout the Canterbury community with the negative environmental impacts associated with intensive dairy farming. This is an opportunity for quantifiable and objective statistical research to be displayed graphically and within context so as to assist explanation and cognition for an informed and discursive impression of the irrigation scheme's related issues, and for an audience that is presently starved of reliable information.

An examination of the larger contextual surroundings that frame the scheme suggest the connection between both historical attitudes of the original pioneering settlers of the Canterbury Plains and the contemporary environmental and sustainable disregard of present dairy industry farmers. The wanton and accidental destruction of the region's native forests during 1850 – 1880 act as both a metaphor and a precursor for the potential environmental consequences that surround the irrigation scheme. While representative of different ecological precedents, the destruction of native forests is employed by this thesis as a micro-narrative and introduction to further examination of the relationship between economic and environmental cause and effect as is related to present agricultural industry practice.

The emergence of patterns from the visual display of statistical information are capable of expanding context, while the visualisation of concepts are increasingly used in the communication of icons, visual signage systems and data presentation. Limitations however exist in the cognitive display of icons for complex actions and states of being (Zender, 2006). In order to extend the possible visual transfer of icons and their potential illustration of the combined effects of the CPW irrigation scheme, this thesis attempts to engage icons within the cartographic map. Through the combination and modification of icons the CPW map seeks to expand the visual language capabilities and cognitive functionality of the icon through layering, abstraction, and sequence, using the existing environmental context of the map.

The discussion and application of cartography within this design thesis includes its engagement as both rhetorical and scientific tools for effective communication and persuasion. By acknowledging the map as provider of valuative connotations (MacEachren, 1995), and through map construction – the environmental evidence researched within this design thesis is assigned political power and influence with regard to the CPW irrigation scheme's argument. The appropriation of cartography and its quasi– employment as community propaganda mapping shifts the traditional role of map-making from that of privileged political, economic, and state authorities, to anyone with an audience prepared to listen.

Central Proposition

Diagrams are powerful information resources through the use of graphic metaphor, though these can cause problems in respect to interpretation. This research through design thesis proposes information presented as visual icons and within context of the cartographic map will provide cognitive community understanding of the Central Plains Water irrigation scheme. Through the modification of icons so as to enable and expand the expression of complex concepts this thesis advances that a visual language system capable of model building will aid the CPW interpretation through diagrammatic presentation.

2.1 Environment.
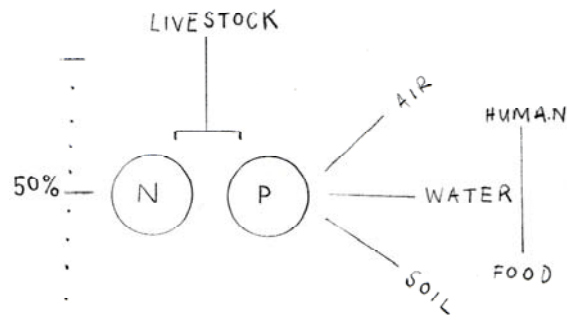
**The Impact of Irrigation on the
Canterbury Plains**

The drought that affected New Zealand agriculture in early 2008 was a brutal reminder to farmers of how much the agricultural industry is at the mercy of the weather, and is estimated to have cost the dairying sector between $500 million to $1 billion (Hembry, 2008a). It further strengthens the popular notion of putting too many eggs in one basket when considering New Zealand is now more dependant on agriculture and pastoral production than ever within the last 25 years (Scherer, 2008). The Reserve Bank of New Zealand is prepared for just two economic disaster models: the first being a cataclysmic earthquake centered in Wellington, the second is the outbreak of Foot and Mouth disease amongst the nation's burgeoning dairy herds (Federated Farmers, 2008a). Irrigation development, whilst initially intended as drought proofing insurance, today is used more as a factor for farmers and therefore the economy to diversify (MAF, 2004). The Ministry of Agricultural and Fisheries (MAF) identify irrigation as bringing a greater diversity of business activities and therefore improved security to local economies, particularly the Canterbury Region where farm-based production is anticipated to be the community's basis and likely to remain so for the foreseeable future (MAF, 2004). Until the 1980s, Governmental policy considered irrigation as part of national interest with Canterbury's farmers being allocated approximately 100 million cubic metres (cumecs) of groundwater per year, current permits for this region now exceed 350 million cumecs (Crombie, 2007). Accordingly, the levels of community based ecological pressure between both economic development and environmental conservation are also rising (MAF, 2004).

The demand for irrigation on the Canterbury Plains is such that Derek Crombie, Project Manager of CPW Limited considers the environment will be worse off should the proposed CPW scheme not proceed, because of the individual and corporate farmers lined up behind the CPW scheme (Crombie, 2007). Opinions throughout the region are polarised, where the scheme is seen as a 'white knight' delivering increased economic prosperity and a 'bogeyman' with the potential threat of water aquifer pollution and an over-reliance on dairy farming (Norris, 2007). The CPW irrigation scheme however was considered the second most important issue concerning the recent 2007 Canterbury Regional Council Election (Opinions, 2007), responses provided by mayoral candidates were in most occasions reduced to those requiring single-word answers and with the resounding answer being in the negative (Norris, 2007). The elected councilor Mayor Parker being the exception, his response throughout the campaign was consistently 'maybe, maybe not' and he is accused of being non-descript, ill-informed, and uncommitted regarding this significant community and environmental issue (Norris, 2007).

Parallel to the Canterbury Region's unanswered election questions are the concerns of Environment Canterbury (ECan) who describe information supplied by CPW proponents as 'woefully inadequate', and accuse the irrigators' expert witnesses of having 'considerably underestimated [the] potential adverse effects' of the scheme (Silkstone, 2008c). Peer review of a CPW-funded archaeological report concerning the suitability of irrigation on the Canterbury Plains concluded it also as inadequate and containing considerable ambiguity. This was highlighted by the fact that this CPW archaeological report did not inspect any of the nine potentially threatened sites and yet it suggests consent should be granted for the scheme to proceed (Silkstone, 2008b). The Canterbury Region is the largest user of freshwater resources in New Zealand, however none of its four councils have as yet developed an approved water allocation plan. The Food and Agriculture Organisation of the United Nations (FAO)
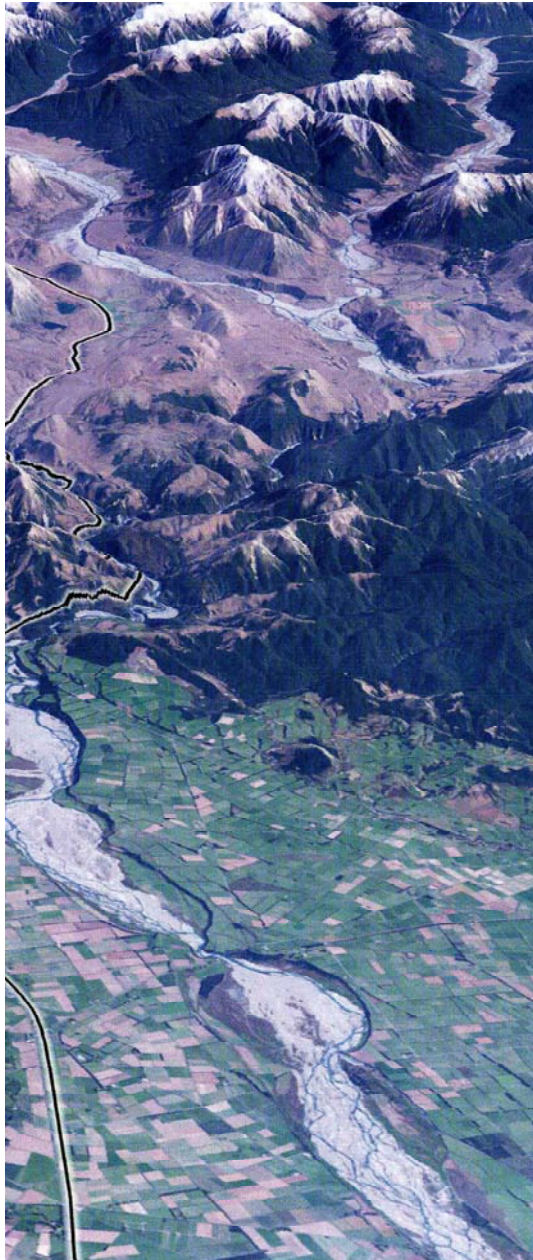

Image 3: Livestock fertiliser diagram.

Image 4: Canterbury plains from space.

identifies a direct link between this lack of appropriate water resource management and the ongoing depletion of the world's water supply (Steinfeld, Gerber, et al., 2006). ECan suggest that the CPW scheme will increase the period in which the Waimakariri River is at minimum flow to double from its current duration of just under three weeks a year to eight weeks once implemented (Silkstone, 2008a).

A generic farmer on the Canterbury Plains who farms sheep (dryland farmer) will typically generate a gross farm income of $1200/ha (Mackenzie, 2007). The same farmer with a limited irrigation system (arable farmer) will comparatively make about $3000/ha, while the farmer with full irrigation and a reliable supply of water will generate $7500/ha. ECan (2005) identify the amount of land used in the Canterbury region for dairying as having increased from 63,000 ha (1995) to over 146,000 ha (2004) and the region's dairy cow population increased 287 percent to 592,745 (2007) over the same period (Statistics N.Z., 2007). Gaining an economic increase on the irrigation investment requires associated increases from other inputs, this results in the on-going intensification of the dairy industry placing increased pressures on soil and water resources (Monaghan, de Klein, et al., 2006). Environmental and health related costs are 'borne by society at large' and the dairy industry is accused of failing to factor them into consideration when considering profit maximising decisions (Tail and Cullen, 2007, p.1). The FAO suggests both Government and Council programmes are implemented after significant environmental damage has already occurred due to the swiftly developing and transforming livestock sector (Steinfeld, Gerber, et al., 2006). Successful environmental resource management requires more than the undertaking of one-off projects on farms and should include the coordinated responses of many stakeholder groups, communities and agencies (Valentine, I., E. Hurley, et al 2007, p. 316). ECan believe the limits of the Canterbury Plains' irrigation potential have already been reached, and are suggesting now is the time to pause and look at the impacts already occurring (Cronshaw, 2007). However, with associated dairy farm expenses in the order of 60% of gross, and the before mentioned dairy farmer with full irrigation committed to spending $4500/ha in the local community (Mackenzie, 2007). This potential $650 million per annum addition from the CPW irrigation scheme may simply be too much for Mayor Parker and his constituents to refuse.

**New Zealand's Dairy Farming
Landscape**

New Zealand's economy is 'utterly dependent on its primary industries' according to the Federated Farmers President Don Nicolson and the lobby group's *2008 General Election Manifesto* which is aptly subtitled *New Zealand's Economic Backbone* (Federated Farmers, 2008a, p. 3). Frank Brenmuhl, the Federated Farmer's Dairy Section Chairman while addressing the New Zealand and Australian Dairy Farmers Council in February 2008 assured his audience they in fact were the true backbone of the industry (Federated Farmers, 2008b). These metaphorical backbones combined statistically, identify agriculture as contributing 65% of New Zealand exports, generating $18,926 million gross revenue, and when including downstream processing 15% of total GDP (Federated Farmers, 2008a). With 34.2 million sheep and 5.6 million dairy cows occupying 14.7 million hectares or 55% of New Zealand's total land area, the last decade has seen agricultural productivity grow annually by 1.8% double the economy as a whole. This growth can be seen particularly in the Canterbury Plains' transition to dairy farming during the last decade, where Ashburton, Christchurch, Selwyn, Timaru, and Waimakariri (note these regions for the purposes of this thesis constitute the Canterbury Plains) in 1995 totaled in number of dairy cows 170,253; by 2007 this number had increased by 287% to 592,745 (Statistics NZ). Compared to the 69% increase nationally in the dairy cow population since 1995, the Canterbury Region represents a significant transition and intensification of livestock numbers.

'Food is the new oil' enthuses Fonterra's General Manager of Strategy and Economics, Alex Duncan, citing the world's demand for food is expected to double over the next 25 to 50 years (Scherer, 2008), this country produces so much milk that only 4 percent is sold domestically, while the dairy industry is targeting 4% growth per annum, and doubling of production within 17 years (Deans and Hackwell, 2008). These trends however are expected to produce 'proportionately higher levels of pollutants and contaminants from our primary production' according to the Ministry for the Environment (MFE) 2007 Draft Chapter (p. 1). The agricultural sector contributes 48.5% of total New Zealand greenhouse gas emissions (average 2002·04), an increase of 15% over 1990 levels (MFE, 2007a). This increase is primarily attributable to emissions from enteric fermentation, which account for 31.0 percent of New Zealand's total emissions. Methane emissions from dairy livestock have increased 70.3% since 1990 (Tail and Cullen, 2006) creating significant environmental problems as methane has 23 times more global warming potential than carbon dioxide (Steinfeld, Gerber, et al., 2006). The second significant contribution is the increased use of inorganic nitrogen and phosphate fertilisers, having risen by 420 and 100 percent respectfully since 1990 (0ECD, 2008). Due to the natural deficiencies in four major nutrients required for plant growth, it is estimated New Zealand's soil would be capable of supporting between 25 and 50 percent of current livestock numbers without the additional of fertiliser (Statistics, 2006, p. 1).

The Government's decision to bypass the scrutiny of the Commerce Commission was designed to give New Zealand 'more clout in the global dairy market' resulting in the creation of Fonterra New Zealand (Adcock, 2003, p. 112). The booming dairy industry is now almost completely controlled by the giant dairy co·operative, where Fonterra's contribution to total export revenue is 25% driven by record high commodity prices, and the company now processes 95% of the milk solids produced in this country (Ninness, 2008). While these figures might indicate expansion of rural New Zealand, the consolidation of farm ownership in fact means farmers are instead deciding to sell their family farms to syndicates

of investors, illustrated by the declining number of Fonterra suppliers, from 12,600 in 2003, to now 10,500 in 2008 (Ninness, 2008). Further decline is expected as Fonterra chairman Henry van der Heyden suggests within the next 10 to 15 years dairy farmer numbers in New Zealand are likely to drop to 4,000 or 5,000 (Ninness, 2008). 30 years ago the national average dairy herd was 125 cows, today the average herd numbers 347 cows and even at this size you're just scraping along (Ninness, 2008). A BERL report (2008) identified Ashburton as New Zealand's leading dairy farming region with the largest average herd numbering 779 cows (TVNZ, 2008b). Brenmuhl in his Dairy Farmers Council speech recognised New Zealand's international dairy reputation as consisting of individual and family farmers while claiming that private interest and environmental groups are 'distorting the image of the dairy industry ... claiming that it is a group of giant corporations' (Federated Farmers, 2008b).

2.1.3
Self-Regulation and Clean Streams

The *Clean Streams Accord* demonstrates that on-farm environmental management is firmly on the dairy farmers' agendas according to Barry Harris, Fonterra's Sustainability Leadership Team Chairman (Fonterra, 2008). While long-term sustainability is seemingly assured with Brenmuhl adding that the dairy industry is constantly looking for new ways to improve environmental performance (Federated Farmers, 2008b). The *Clean Streams Accord* is touted by farmers as an agreement that has solved or will solve the negative impacts of farming on freshwater (Joy, 2008). The Federated Farmer's *2008 General Election Manifesto* asks for 'scientifically verified metrics for sustainability' (2008, p. 34) yet the voluntary *Clean Streams Accord* holds farmers unaccountable with soft targets and has failed to include any conditions that changes in water quality be measured (Deans and Hackwell, 2008). A MFE report suggests it will take at least five years, and more likely 10 to 15 years, before definitive trends can be identified with respect to water pollution (Cowie and van Voorthuysen, et al., 2006). Dr Erik Jeppesen, from Denmark's National Environmental Research Institute, substantiates this further by warning of a 'time bomb' of polluting nitrate's existing in the ground and these will continue leaching into rivers and aquifers for several decades still (Rowan, 2008).

So while it may take many years before the impact of past nutrient applications becomes apparent, MAF warns of a link between irrigation and the intensification of land use resulting in 'a concomitant increase in nutrient application' today (2004a, p. 26). This is exhibited in Canterbury, when in 2004 the region become the heaviest fertilised in the country, on the back of substantial dairying and irrigation expansion (Statistics, 2006). The *Clean Streams Accord* provides figures implying that the Canterbury region has only 3% significant non-compliance with their dairy effluent discharge resource consents (2006-07). However, ECan reports serious non-compliance of 17.7% (over 110 incidents), and minor non-compliance of 42.7% while noting that sound dairy shed effluent management plans have failed to be adopted by many farmers (Deans and Hackwell, 2008). Nationally serious non-compliance is more than 14% of dairy farms, twice the 7% reported by the *Accord* partners that includes Fonterra, MFE, MAF, and Local Government New Zealand. Considering most regional council figures are calculated after well-publicised annual inspections that include prior notification (Deans and Hackwell, 2008), and since most pollution is believed to go unrecorded (Steinfeld, Gerber, et al., 2006) such high levels

of non-compliance is concerning. The voluntary scheme is failing to deal with serious poor operating practice on dairy farms (Deans and Hackwell, 2008), with Fonterra acknowledging disappointment with respect to farmers who are failing to comply with regional council requirements (Fonterra, 2008).

The *Accord* partners assumed that voluntary 'best' practice measures would deliver improved water quality, but this has not been the case. The adoption of Good Environmental Practices (GEPs) on dairy farms is not generally driven by environmental considerations – environmental sustainability has at best a limited role with regard to on-farm decision-making (Tait and Cullen, 2006). Instead logistics and economics are important – adoption of GEPs is seen to occur only when 'there is a congruence of farmers' economic and environmental goals' (Monaghan, 2008, p. 3). The Accord was intended to send a strong message to both domestic and international customers, acknowledging environmental management as an integral and important component of the dairy industry, and that industry self-management as the most effective means of achieving this. The *Accord's* commonly used phrase 'best practice' is problematic due to the inference among both farmers and public of the impression that this adopted practice is sufficient in achieving the required water quality goals (Deans and Hackwell, 2008). Added alarm is the implication that the *Accord's* voluntary approach is being used strategically against alternative and further imposed regulations that would arguably necessitate more invasive restrictions on dairy farming practice. Suggestion that voluntary agreements can succeed when farmer concerns of environmental quality reflect those of society is unlikely considering the obvious disparity in the current practices and attitudes of the dairy industry (Kara, Ribaudo, et al, 2008, p. 1530).

2.1.4
The Battle of Urban-Rural

New Zealand is heavily urbanised, to the extent that 86% of the population are categorised as urban, while farmers represent fewer than 4% of the population. For the Federated Farmers this urban-rural divide is a major concern when considering their position as 'the engine room of the economy' they 'must be at the forefront of public policy' and not an afterthought (Federated Farmers, 2008a, p. 3). With regard to environmental practice the public should give farmers a break, according to Charlie Peterson 'be grateful for the food on their table, not constantly criticising the people who produce it' (TVNZ, 2008a). Professor Jacqueline Rowarth, director of Massey Agriculture insists the public should 'stop blaming farmers for our environmental woes' warning that doing so may 'impact adversely on the consumer further down the track' (Coddington, 2008). Considered from within the dairy industry as being the minority cause within a complex environmental issue, the rural sector view themselves as publicly scapegoated by ignorant environmental politics, and 'feel good eco-friendly' urban majorities (Friedman, 2007). Federated Farmers identify these lobby groups as having driven a wedge between both communities, and encourage Governmental financial support for Federated Farmer's initiatives to improve relations between urban and rural (Federated Farmers, 2008a). The Government is already assisting farmers, to the tune of $72.1 million – the cost of cleaning up the worst of Rotorua's polluted lakes which are suffering from toxic algal blooms resultant of high farm nutrient levels (Rowan, 2008). Lake Taupo, presents a different kind of Government involvement, where intervention of fertiliser caps is presented by Federated Farmers as abusing producers who feel under siege, and while admittedly

cleaning up Lake Taupo will help the rest of the country it is seen by farmers as 'totally unfair how its ended up the farmers having to pay for the lakes protection' (TVNZ, 2008a).

Bruce McNab, Federated Farmer's spokesman, sees the reliance on information received from lobby groups as counter-productive. He believes both opposing groups should 'get together and focus on what they have in common, instead of creating conflict' (TVNZ, 2008c). The Resource Management Act (RMA), he suggests, is being taken advantage of by urban environmental groups in order to stifle farmers' developments. Farmer opinion of the RMA laws is likened to where 'draconian provisions are enforced' and consequently enables 'an idiot with no idea of the industry' to complain through the RMA process (Adcock, 2003, p. 115). These opinions are echoed by Federated Farmers who accuse the RMA of 'eroding the productive capacity' and 'compromising the long-term viability of farming', resulting in the failure to achieve promotion of sustainable resource management (Federated Farmers, 2008a, p. 30). The RMA process is considered frustrating with respect to public participation, Lincoln University Environmental Management Professor Ali Memon describes the RMA as uneven 'from the perspective of those who do not stand to gain financially from favourable outcomes' (Memon, 2007). The privilege of expert knowledge from lawyers, scientists and technical experts is identified over the practical knowledge of local residents, thus further illustrating the expanding differences, economic resources, and challenges that confront a balanced view of the CPW irrigation scheme.

The most likely urban grievance identified by this thesis is related to the *Emissions Trading Scheme* where households, road users and small to medium businesses, that generate one third of the nation's emissions, will meet 90 percent of the payment (Terry, 2008). Federated Farmers want renegotiations of New Zealand's Kyoto agreement to exclude all livestock emissions claiming the potential impact for future farm viability (Federated Farmers, 2008a). Simon Terry, Director for the Sustainability Council refutes these suggestions, insisting that urban communities will pay the largely disproportionate share in order to insulate farmers' incomes through capital gains protection money (Terry, 2008). Seen from an environmental perspective, the urban community's relationship with the CPW scheme is expressed by a recent Lincoln University survey, indicating increasing concern for the quality of rivers, streams and lakes, with water quality overtaking air pollution as the respondents number one concern (Lincoln, 2004). Management of farm effluent and runoff was identified as the least well managed of all the environmental problems. Federated Farmers however share little time for these sociological studies, as they 'detract from pure research and development investment' (Federated Farmers, 2008a, p. 29). This separation typically illustrates the urban/rural divide, where large groups and sections of New Zealand's society insist the dairy industry must include ecological and ethical considerations beyond just profit and include social and environmental costs in future developments (Williams, 2007).

2.2 Cartography.

Political Power Structure

From the outset of cartography, connections between map-making and pretensions to political power, rule and conquest have been apparent. By the sixteenth century, maps that had previously symbolised sovereignty over the world, and were used in religious and portrait painting as regalia accompanying those of authority and nobility, were beginning to develop new connotations. Brian Harley cartographic theorist, expresses in *Maps, knowledge, and power* the sixteenth century map as 'primarily intended to convey the extent of the territorial powers, ambitions, and enterprises' and when used to accompany emperors, monarchs, and statesmen, the map functioned as 'graphic shorthand for the social and territorial power they were expected to wield' (1988, p. 295). A theme often accompanying European Renaissance attitudes, namely 'celebration of the individual' would see the symbolic attributes of the sixteenth century map transferred from the church to the individual. By the seventeenth century, it would be the state that would adopt the political currency implicitly present in the cartographic map. Seventeenth century maps were typically emblematic of the social, architectural, and technological progress celebrated by most major European cities of the time (Dubbini, 2002). Here engraved city views featured pristinely appointed buildings housing governmental, public institutions, commercial agencies, and infrastructure. Seen as visual proclamations of 'the triumph of good government and public and private laboriousness' this attention to civic achievement developed into a 'conception of the whole city as one harmonious body and perfectly functional organism' which 'the atlas seemed the ideal instrument for creating a compendium of the architectural form of a given civilisation' (Dubbini, 2002, p. 26).

The exertion of power through cartography is identified in *Deconstructing the Map* (1989) where Harley proposes the existence of a patron behind most maps, where 'monarchs, ministers, state institutions, and the church, have all initiated programs of mapping for their own ends' (p. 12). Harley accuses the map of reinforcing 'distinctions of class and power' through the use of cartographic tricks, identifying those most prominent, that is, the patron as a most likely recipient of the map's power and influence. It is the cartographer or patron whose assumptions are most represented by the map, Jeremy Black cartographic author describes the map as 'not simply a means of displaying historical evidence' but rather 'interpretations of that evidence' (1997b, p. 20). This argument concerning the map's valuative connotations is discussed further by geography professor Alan MacEachren in *How Maps Work* (1995) acknowledging the presence of a social hierarchical structure, as is suggested also by Harley (1995). MacEachren however proposes that the single most important rule responsible for this structure is that 'presence on the map, therefore, connotes importance,' and describes a related rule concerning locational proximately on the map, whereby 'centrality, then, also connotes importance' (p. 343).

Image 5: Ruth Watson, *Another Map of the World*, 1989.

Valuative connotations were particularly apparent in the maps of the eighteenth century, specifically during the period of New Imperial European Colonisation. Where the previous century used the map to advance social unity and celebrate civic achievement, the eighteenth century map unashamedly spoke of victorious empires and nationalist propaganda. This is especially illustrated through the European Imperial powers claims of occupation and entitlement within the newly discovered lands, and through the employment of cartography decreeing non-map-making nations as without either right or claim (Remarkable Maps, 2005). Cartography was the most 'convenient and accepted legal means to claim the land masses of the New World' (Remarkable Maps, 2005, p. 87). Relationships between European

Image 6: The Historical Development of the British Empire, 1926.

colonisation and cartography continued into the nineteenth and twentieth centuries, and was present within the historical atlases that closed their map section with a colour coded world view featuring the might of the imperial powers. Most famous of these was the vast expanse of the British Empire, which was indicated by the colour pink and covered a quarter of the globe, serving as impressive reminders of Britain's supremacy (Remarkable Maps, 2005). These atlases provided several important roles in the process of representing and educating existing, as well as new members to the imperialist potency of the British Empire.

The potential of maps as a means to extend imperial control over places not already claimed by other cartography presents opportunity for the CPW irrigation project to engage with and benefit from the possible inferences of the map. So where the political agendas of European colonisation are matched with the worldviews presented through the cartographic map, so too the Canterbury Plains and the presence of dairy cows, irrigation, and environmental causation may also be afforded political power on this map. Where the exertion of power through cartography is traditionally reserved for those in government or with entitlement, and environmental conservation not usually a part of this category, maps that present the CPW scheme may serve to create importance and prominence for it and be assigned political power by it simply with through this engagement with cartography.

2.2.2
In Search of Scientific Truth

Parallels between cartography and science have been intrinsically connected from since Ptolemy's *Geographia* (2nd century AD) and its discussion of the geographic knowledge of Greco-Roman worlds. Within a contemporary context it is the cartographer and author Arthur H. Robinson (1915–2004) and *The Look of Maps*, published in 1952 which is widely regarded as seminal within the development of modern scientific and cognitive cartography. With parallels to the emergent scientific disciplines of psychology and psychophysics, Robinson's approach was similarly influenced by thematic, military mapping, photography, and the Impressionist Movement (Montello, 2002). Cognitive cartography can be expressed as 'systematically applying the theories and methods of science, particularly psychology' to assist 'perception, learning, memory, thinking, reasoning and problem-solving, and communication' for the map reader (Montello, 2002, p. 284). MacEachren identifies cognitive cartography as analysis of the 'characteristics of perception as they apply to maps' and resulted in future decisions based on objective rules (1995, p. 2). This scientific approach shifted the emphasis in modern cartography from production and graphic design, and instead toward map functionality and systematic analysis.

The disappearance of art from cartography can be paralleled similarly with the disappearance of the author. Wood and Fels identify the author's disappearance from the map as necessary to enable the notion or pretense of maps as representative of reality, and enable the viewer to 'take for granted – as natural – what is never more than the social construction of a map' (Wood and Fels, 1993, p. 71). For 'were it not reality, why then it would just be … opinion' and suddenly the things represented by the map would be open to discussion and debate (Wood and Fels, 1993, p. 18). The word 'transparent' is discussed by many in the context of cartography, where it is afforded the implication as an objective

medium. Defined as the obvious and evident result in the process of functioning with the user being unaware of its presence, the word also serves to further imply of the disappearance of art and the author from modern cartography (Oxford, 1999). Maps connote accuracy, impartiality, and authority that inspire confidence because of the seemingly obvious lack of a particular viewpoint (MacEachren, 1995). This is further enhanced by the 'connotation of integrity' where governmental and/or scientific involvement is believed to connote freedom from bias. MacEachren identifies this as having resulted from the eighteenth century development of systematic governmental surveys that served to connote modern cartography with the 'single and apparently impersonal view of the world' (1995, p. 341). Importantly this established contemporary cartography's most cherished myth, that of apparent 'dispassionate neutrality' (Wood and Fels, 1993, p. 22).

The belief in the objectivity of maps is somewhat thanks to the implication that behind the map stands scientific honesty and precision. Expressed as the 'impartial scientific realisation of reality' and where map–users equate cartography as having been made increasingly accurate through modern advances in technology (Black, 1997b, p. 17). Cartography benefits from scientific, production, communication, and technological advances, which can be argued increase accuracy and map representation. However the implication is that these scientific components have become now so dominant as to completely overshadow any subjective implications (Wood and Fels, 1993). Wood and Fels argue the 'pretense' of this reality represented by the map now negates any questions of authenticity or objectivity that the map may contain. Further stating 'that no sooner are maps acknowledged as social constructions that their contingent, their conditional, their ... arbitrary character is unveiled' and then suddenly open to debate (1993, p. 20). With regard to the CPW irrigation debate the scientific objectivity provided from the map is central to the communication process where the implied factual and objective evidence and therefore truth provided by the presentation of information through cartography connote accuracy and distance from propaganda. The CPW map while a representative instrument of a persuasive argument should be far removed from the emotional or overtly sensitive manner in order to be an effective voice.

2.2.3
Deconstructing Rhetorical Mapping Devices

The depiction of power and politics within the conventions of cartography is dominated by symbols according to Black, where problems inherent in mapping cartographic places and communities are that 'these worlds have to be created for readers who know nothing of them' (1997b, p. 101). The use of novel and unfamiliar imagery whilst enlarging the cartographic repertoire, also introduces questions regarding the graphic rhetoric of maps and the required unpicking of texts (Black, 1997). Postmodern condemnation of scientific rationality, and its futility in the communication of accurate knowledge is exhibited amply in Harley's *Deconstructing the Map* (1989). Harley invites the reader to consider the honesty of the image, its silences and contradictions, by reading between the lines of the map and in the 'margins of the text' (p. 3). While the scientific approach identified by Robinson had its insistence on a standardised set of rules and language (Montello, 2002, MacEachren, 1995), Harley argues for the deconstruction of cartography, insisting that 'text is certainly a better metaphor for maps than the mirror of nature' (1989, p. 7).

Acknowledging that all maps can be interpreted as both cultural and constructed texts, and through deconstruction identified as systems containing individual layers, associations, and contexts. Harley suggests 'rhetoric is part of the way all texts work and that all maps are rhetorical texts' (1989, p. 11). Consider maps as containers of the persuasive devices synonymous of rhetorical language, including invocations of authority, colour, decoration, and method justifications. Harley identifies the process of map making as inherently rhetorical, because of its tendency for 'selection, omission, simplification, classification, the creation of hierarchies, and symbolisation' (1989, p. 11). Use of Colour within maps serve to increase the density/complexity of information, although as argued by Black, colour conveys no more information than could be obtained by black and white with graduations (1997a, p. 216). In fact large variations can create colour puzzles as suggested by information designer Edward R. Tufte, while also limited as visual ordering systems because of their inability to give a visual order to colours (2001, p. 153). However colour is often a favourite propaganda tool employed by cartography because of the unconscious associations it evokes (Muehrcke, 2001).

The use of solid colour can imply the existence of harmony and agreement between states or nations upon the cartographic map (Black, 1997a). Though this impression may be untrue, for conflict and turmoil may well reign within this land, although the solid and stable colour suggest otherwise. Where occurrences in which the map casts metaphorical judgment, such as proclaiming pristine Caribbean blue water, devoid of the eroded silt, or the industrial waste, is where this colouration falsely dresses the map with 'the most reassuring tones' (Wood and Fels, 1993, p. 121). Application of colour in the description of the Canterbury Plains' landscape has the potential to present direct associations of the dairy industries negative environmental impacts. For example the tone of green used to identify the irrigated pastures might juxtapose sharply with the dry and unfertile surrounding land. This colour while used to imply the locational presence of the industry may also represent emotive privilege when seen in the landscape and within context of the map's subject matter.

Maps simplify our surroundings by offering a selective and incomplete view of reality, which is the cartographic paradox, to present both a useful and truthful picture 'an accurate map must tell white lies' (Monmonier, 1991, p 1). Therefore presenting the CPW scheme has the liability of removing the viewer from confronting reality, providing instead a view that is schematic and lacks complexity. These omissions not only impact what is omitted from the irrigation debate, but also the variety and quantity of information that is shown, and thus by reducing, the CPW maps must also generalise. Through both selection and spatial depiction, maps 'abstract, exaggerate, simplify and classify' each of which is misleading (Black, 1997b, p. 104). This is evident when considering the proximity of objects visually expressed on a map, where simply because features are presented close together doesn't in fact mean they're related (Muehrcke, 2001). Distortions are inevitable when considering that decisions are made concerning colour, size, style, quantity, and arrangement of symbols, to the extent that thematic maps of numerical distributions the only rule suggested by Muehrcke is make it 'look right' (2001, p. 527).

Mapmaker as Creator rather than Reflector for Counter-culture Agendas

When compared with literature, art, or music, Harley identifies the map as having very 'few genuinely popular, alternative, or subversive modes of expression' and supposes mapping as 'preeminently a language of power, not of protest' (1988, p. 301). Pointing to the retention of cartographic power by dominant groups, such as government, military, news media, and the multi-nationals as reason for this. The recent emergence of personal computing, incorporating powerful mapping tools amongst more organised vocal community and lobby groups should have to some extent balanced these issues. However, geographer Chris Perkins in *Community Mapping* (2007) points to the practice of community mapping as 'much less frequent or emancipatory than might be expected' (p. 127). For which Perkins in *Cultures of Map Use* (2008) identifies participation barriers that include: the perceived specialist or technical demands, and the prohibitive expense of survey and official mapping, as possible reason for this. Black considers the 'lack of uniformity in data collection' due to the politicalisation in collection, presentation and analysis as further evidence of this deficit (1997b, p. 23). While Parker suggests that the collaborative engagement with external entities may create interpretative and/or cultural barriers or difficulties, and also argues that the notion of community itself may be problematic with respect to the acknowledged cartographic sense of privilege and authority (2006).

Alternatives to traditional mapping practices have of recent included more participation from within the arts community. According to MacEachren they offer an 'intuitive and holistic' approach, and that whilst drawing on scientific research and developments, the art community's achievements can enable 'critical examination' (1995, p. 9). This model is no more clearly expressed than the Tom Van Sant / GeoSphere Project, which included the assistance of a NASA Jet Propulsion Laboratory, multi-spectral scanners and thirty-five million pixels – producing the amply titled *A Clear Day (Image 7)*. This global image map was created after a serious medical condition threatened to blind Van Sant, and it is the result of a year-long obsession and intention to highlight environmental themes (Wood, 1993). The map serves to illustrate these personal concerns, and those of National Geographic whose *1990 World Atlas* cover it adorned. The map is employed to publicise their committed 'vision of the earth as scared, as having an existence... apart... from that of man', and where the map represents an earth so still it is seemingly 'holding its breath' while both paper thin and fragile (Wood, 1993, p. 66). The Van Sant map intended to generate environmental activism, connotes a request for help before it is too late, before this 'beautiful "picture" can no longer be taken' (MacEachren, 1995, p. 349).

Image 7: Van Sant GeoSphere, *A Clear Day,* 1990.

Decisions including the particular wave length to stress – infra·red being characteristically generous for vegetative surveys and water resources, or the amount of cloud cover included or in the Van Sant example excluded, are a part of any artistic, and hence, cartographic process. Artistic maps illustrate the evocative power of cartography engaged with both art and science (Perkins, 2008). This is further emphasised by Harley who sought to reject the previously dominant binary opposites of 'art/science, true/false, objective/subjective' (1989, p. 11), and 'scientific integrity' as opposed to the 'ideological distortion' (1988, p. 278). MacEachren accepts that while no exact rules exist for the combination of art and science required for any given cartographic problem, their collaborative function provides both valuable tools and resources for cognitive map communication (1995). This is exemplified in both the 'intuitive and holistic' approach of art, whilst science offers a more 'inductive and often reductionist' method of breaking and examining a complete picture into individual parts (MacEachren, 1995, p. 9).

As suggested by Crampton and Krygier critical cartography assumes that maps 'construct reality as much as they represent it' (2006, p. 15). They define critical cartography as challenging that of the more traditional scientific and academic ethos and as 'linking geographic knowledge with power, and thus [mapmaking] is political' (2006, p. 11). By implication the contents of the CPW irrigation scheme maps are then political and these decisions expressed through mapping are representative of political expressions. No longer restricted to limitations of observation, the CPW maps assume their natural and logical position as instruments for statistical data processing, and reasoning about quantitative information and persuasive argument (Wood and Fels, 1993). Functioning as inciteful and emotive communicators, Canterbury is presented through the author's intention to convince, persuade and suggest particular relationships. This persuasive function occurs 'explicitly or implicitly' traditionally through the overtly deceitful nature of propaganda maps, or the subtler forms of persuasion that are inherent in the majority of government and scientific maps produced (MacEachren, 1995, p. 348).

Dynamic Mapping of Information, Environmental Causation and Place

Dynamic mapping is the expression of change over time, which as opposed to the static territorial or distribution maps, can be identified as the expression of processes and actions such as centralisation, decentralisation, and can result in the formation of national identity (Black, 1997a). Information when expressed through dynamic maps creates dual modes of connectivity for the viewer, enabling both the recognition of patterns between 'disparate entities, events, locations and phenomena' whilst occurring concurrently with presentations of relationships within a social and/or cultural context (Black, 1997b, p.20). This is explained as where an active construction takes place between both the knowledge and experience – connectivity – of the map and with the map's viewer (Turnbull, 1993). This interaction differs significantly from that of written text, which delivers information sequentially and is ultimately removed from the contextual surrounds when considering relationships of spatial and/or physical representation (Black, 1997a). The naturally abstract quality of the map provides for the location and visualisation of 'concrete description[s] and explanations that would be otherwise overly abstract' in written text form (Black, 1997a, p 213). This allows the map to visually describe the entire context of a situation, thus permitting the viewer a wider appreciation and the opportunity to form connections

within the larger surrounding picture of an issue, event or concept.

Maps establish context through the engagement of three linked systems: 'space, time, and object' (MacEachren, 1995, p. 325). These provide the framework of the dynamic map, and the ability to present a discourse or argument through an agreed relationship of complex iconic or linguistic codes. However, Wood and Fels argue that the map is more than just a single solitary image presented to the viewer, and instead this image is accompanied by a crowd of additional rhetorical signs: 'titles, dates, legends, keys, scale, images, emblems, texts, references, footnotes, potentially any device of visual expression' that combined creates a cognitive and coherent proposition and/or 'legitimate discourse' (1993, p. 131). Opportunity exists for the map to use the arrangement and interaction of and between any graphic/visual codes of representation, provided they can be conventionalised. So while mapping surpasses the possible practical exchange of most other communication systems, Wood and Fels acknowledge that the limitations are clearly prescribed by the limitations of our own visual culture and also the conventions of how effectively we determine and equate graphical marks and their defined meanings (1993).

The representation of reality through mapping permits a clearer understanding and appreciation of the world's natural and physical environments. Black acknowledges that when presented visually and through diagrammatic means, instead of as 'locational specificity', we start viewing place as an aspect of 'model building' (1997b, p. 26). This simplification of maps subsequently allows for the diversity and complexity of the CPW irrigation scheme to be presented on the map and within its cartographic context. Muehrcke notes that without maps, the world seems a chaotic place of unrelated phenomena and through model building we are able to separate ourselves from confronting this reality and also its overwhelming and confusing state (Muehrck, 2001). The possibility of presenting the CPW scheme as a diagrammatic model draws directly from the maps convenience as a useful picture that people are prepared to let stand for reality. While environmental features such as rivers, soil, and mountains do traditionally feature on atlases with an illustrative function, the CPW map will encourage the viewers to consider these within a wider ecological, economic and social regard. The potential for environmental transition and causation in the CPW map is similar to suggestions by Black where cartographers maps become both necessary as descriptive and as explanatory tools. Furthermore, the interpretable nature of cartographic summary will therefore enable the CPW map to draw upon visual description as both a source of information to aid decision-making and behavioral practices in space.

2.3 Information Design.

The role of Context in Cognition

Perceptual psychologist Rudolf Arnheim (1969) affirmed that everything in this world is affected by context, identifying an object's context as the initial and primary influence upon its general cognition. Therefore, in order to understand an object's perceptive qualities, Arnheim suggests two possibilities: either remove the object from its context (abstraction), or analyse both the object and its contextual content. Mike Zender, an information design researcher/practitioner considers that most traditional communication design has followed the first of Arnheim's two suggestions (2006). As exhibited in airport and highway visual language systems, Zender describes the abstracted object as being 'peeled from its context' and presented as limited iconic signs 'on a plain, unadorned, blank background' (2006, p. 182). There are various other contextual influences acting upon these (airport and highway) signage examples and all visual language systems in general. These include, *Environmental Context*, where in the example of the airport the distinctive physical and locational features themselves identify and promote the icon's meaning and/or interpretation. Zender describes the *Proximate Context* as the interactive field contained in and employed by a visual language system, such as its 'framing devices' and with respect to roadside signs, a distinctive triangle shape (2006). Third, and most significant for Arnheim and Zender is the *Immediate Context* where the elements within an image interact with each other to enable an integrated message (2006). Instead of the solitary communication limits inherent of individual signs, Arnheim and Zender suggest that advancing *Immediate Context* will create the possibility for a more complex and descriptive visual language system by expanding rather than limiting cognition through context (2006).

Visual language's limited capacity in conveying information is described by communication Professor Jorge Frascara as resultant of the modern perseverance in the reduction, simplicity and isolation from context (2001). This scientific insistence upon clarity of information, Frascara describes as having been fostered from verbal languages' linear process and bias toward sequential explanation (2001). The reliance of current icon-based systems on both *Environmental Context* and verbal language has translated into the isolated development of communicating physical objects. Zender acknowledges that whilst effectively describing nouns, visual languages are rarely able to communicate processes and actions (2007). So while Frascara is among many who suggest the employment of visual language for the integration of information into meaningful wholes, Zender warns existing examples are like a 'spoken language with no verbs' (2007 & Crutcher, p.29).

What all graphic language share is an organisational structure that allows for the elements within any system to interact with each other, therefore communication depends on the stability or convention of these to an audience. This analysis of pictographic systems, by textual scholars Johanna Drucker and Jerome McGann also identifies two fundamental principles critical to all graphic languages; 'a set of entities and a system of relations among [these] entities' (2001, p. 96). With this in mind it is evident how airport and highway signage systems whilst utilising both external *Environmental* and *Proximate Contexts,* are potentially missing the before mentioned significant influence of *Immediate Context* when containing single elements. The addition of multiple icons within shared spaces suggests relationships between individual icons and the potential to develop new meanings (Zender, 2006). This process is described as 'expanding context' and allows for the combination of separate icons through layering, abstraction, and sequence (Zender, 2006). The Aztec Codex pictographic narrative (*Image 8*) uses a
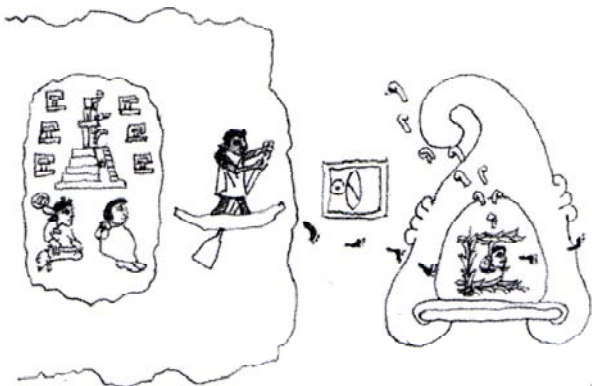
Image 8: Pictographic narrative of Aztecs leaving their homeland in year Flint 1. Codex Boturini

spatialised arrangement of separate icons in order to describe its scene. In this example the layering of icons represents a journey of leaving home (left) and traveling to a destination (right). The inclusion of multiple signs within the *Immediate Context* allows the pictograph to present a vivid and detailed communication condensed into one single diagrammatic picture. The narrative's 'expanding context' is now 'choreographed into meaningful relations by the use of several rhetorical principles' that include proximity, scale, direction, and the orientation of various sign relationships (Drucker, McGann, 2001, p.99). Through the presence of spatial delineation, a dynamic instruction is issued to the viewer inviting one to experience this ancient traveled journey by connecting the two separate locations.

Representational pictures tell a story through their illustration of spatial and accompanying relational information, such as the mysteries of a Cholera Epidemic, or the protagonists within a hotly debated local community irrigation scheme. The opportunity to visually describe the quantitative comparisons of the CPW scheme using the cartographic map is based on the principles of two specific historical data maps. The Cholera Epidemic in London, 1854, (*Image 9*) provides the example of Dr John Snow revealing cause and effect relationships between the cholera epidemic outbreak and the proximity of the Broad Street pump (Tufte, 1997). Achieved through the locational display of the 83 cholera related deaths on a topographic map of London, this illustrates the persuasive argument made from the representational display of statistical data. Charles Joseph Minard's data-map expressing the failed Russian campaign by Napoleon 1812 – 1813 (*Image 10*), however, uses the direct comparison of visual quantities and the narrative journey through time to explain the devastating losses of 412,000 men. This expression of causality is illustrated through multivariate analysis where the duration, temperature, and natural obstacles of the environment are presented as cause and effect (Tufte, 2006).
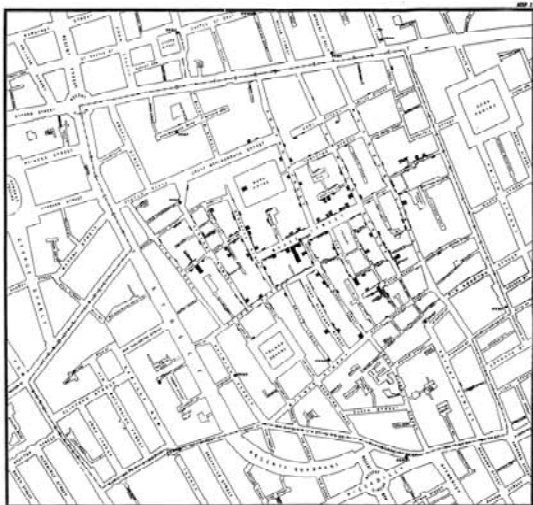

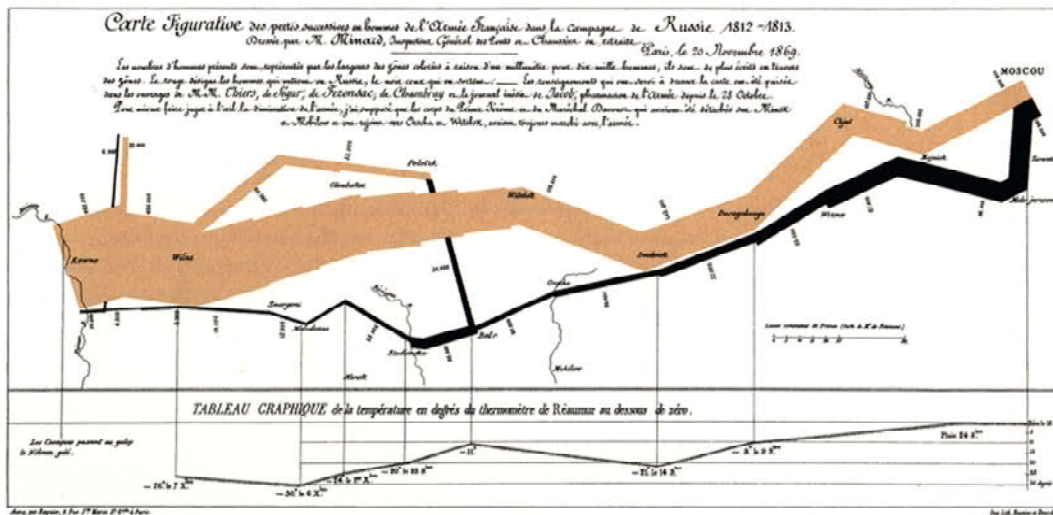Image 9: John Snow, *The Cholera Epidemic, London, 1854*.

Image 10: Charles Joseph Minard, *Figurative Map of the successive losses in men of the French Army in the Russian Campaign 1812–13*.
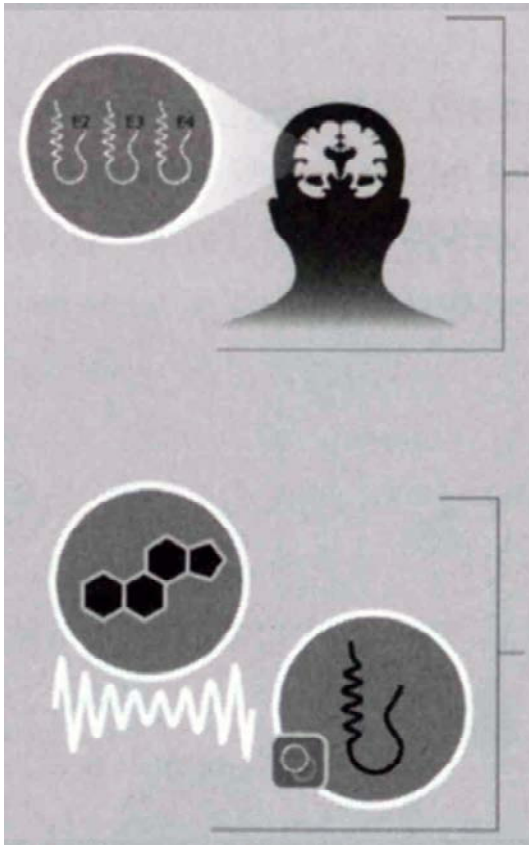
The communication of complex and abstract messages through a visual language system is expected to remain unachievable whilst visual language is limited only to the expression of nouns, and unable to communicate verbs and adjectives/adverbs (Zender, 2006). These concepts are analogous to the description of things, actions and modifiers, and are essential for the operation of any explanatory language system. While icons are used increasingly throughout the world to identify airport terminals, Olympic events, and computer desktop functions, etc., as a universal visual language system existing icon design is restricted to a limited application. Originating from the Greek word for image, the icon shares characteristics and a resemblance to the thing it signifies, hence the provision for describing nouns (things and objects) with an economy of means. This feature of iconic display, however, is also the icon's downfall with regard to specific modifiers, actions, and states of being which are generally not communicated in existing icon systems (Zender, 2006). The interaction of separate icons through layering, abstraction, and sequence previously described as *Expanding Context* presents the possibility of employing the *Immediate Context* as a significant influence in the communication of data. In areas with 'controlled vocabularies and clear ontologies' physical and/or spatial relationships between icons have the visual potential to effectively communicate expansive themes and content within constituents (Zender & Crutcher, 2007, p.47).

Efficacy in communicating information is 'proportional to the extent to which it is comprehensible' to a target population (Young & Wogalter, 2001, p. 124). Otto Neurath and the ISOTYPE visual language system established this utility through two rules: the reduction of graphical style and the consistency in appearance of a coherent system (Lupton, 1989). The combined effect of this resulted graphically in the silhouette, and was used by Neurath for the perceived dispassionate, scientific, and impartial authority it implied (Holmes, 2001). The silhouette's stylistic consistency indicates unity as a statistical set, establishing agreed formulaic conventions that allow for consistent user comprehension (Lupton, 1989). An indexical image made without human intervention, the silhouette implies truth originating from a pre-chemical photography technique that emulates the shadow (Lupton, 1989). This flatness and stylistic consistency reinforce that the ISOTYPE silhouettes are read as signs, which design critic Ellen Lupton associates to letters with a 'language quality', and by implication, groups of letters within a 'self-sufficient language' (Lupton, 1989, p. 151).

Zender suggests the addition of 'highly abstracted visual forms' to an individual icon might 'serve to evoke or modify the meaning of [this] more representational image' (2006, p. 187). This process effectively extends the *Immediate Context* of the icon through the addition of abstract modifiers, thus enabling a visual description of action, transformation, or a proposition to be expressed through the icon. An example of two such proposition statements are shown in *(Image 11)* where the combination of physical (noun) icons and action (verb) modifiers illustrates two technical concepts of the medical condition of Alzheimers (Zender & Crutcher, 2007). The example shown in *(Image 11)* illustrates the potential for icons to be elevated from their traditional role as limited descriptive pictures, and instead become providers of complex information and therefore makers of dynamic functional propositions.

Image 11: Mike Zender, *Interactive information design – Alzheimers display,* 2007.

Graphics compared to words have historically been used as decorative extensions of the text, and are generally perceived as 'less-effective, after-the-fact conveyors of ideas' (Hansen, 1999, p. 197). This notion is currently being challenged through the contemporary belief and practice that visual language has the potential, not to replace written language, but to summarise its verbal content (Zender and Crutcher, 2007). Cartographer and theorist Jacques Bertin advanced that through the interaction with graphic information display would promote insight and the conversion of data into knowledge (1983). Bertin recognised this through three basic functions he considered inherent in graphic diagrams – to record, to understand, and to communicate (Bertin, 1983). Communication professor Jorge Frascara suggests that by synthesizing the various dimensions or components within a simple model, diagrams are capable of intelligent exploration of otherwise elusive interrelationships (Frascara, 2001). Used in relation to environmental sustainability, diagrams bring large-scale and overwhelming global problems down to a local level, Frascara notes the obvious suitability of visual presentations in describing both physical and environmental constructs (Frascara, 2001).

The present environmental situation is in part borne of an education process that 'compartmentalises and isolates information' and this has resulted in 'egocentric decision-making processes' ignorant of the negative environmental consequences (Frascara, 2001, p. 169). An understanding that 'everything is part of something larger' would assume that when presenting data situations they are included as part of a larger and more contextual whole (Hansen, 1999, p. 206). This dysfunction within traditional language is perhaps an excuse why in consideration to the CPW irrigation scheme the information is unable to be presented to the public. Where to start and how to display are the first two questions that come to mind? Regardless of the CPW scheme's possible degrees of evaluation, the opportunity exists for environmental concern to be combated with science and information diagrams… 'the world doesn't need more wringing of hands' (Ede, 2005, p. 162). Instead the presentation of the CPW scheme needs to evolve into an environmental argument with hard science and not the flagrant emotion accused of urban lobby groups, environmentalists, and artists. The enhancement of both art and science and the bringing together of their simultaneous capacity to respond emotionally and to rationalise objectivity will allow scientific detachment within an aesthetic model and resulting in illustration of an evidenced CPW research presentation (Ede, 2005).
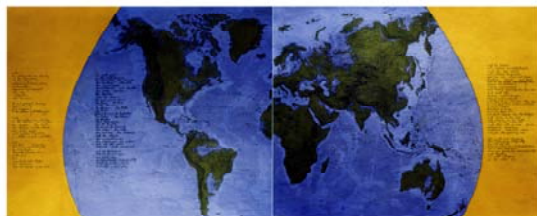
Science provides explanations, this it achieves through asking difficult questions and prompting extra-ordinary hypothesis, to the point that art critic Sian Ede asks …'is science the new art?' (Ede, 2005, p. 1). Answering this question by way of interactive ecological research and modeling, and through the incorporation of cartographic communication with scientific conceptual forecasting are the Harrisons (Helen Mayor and Newton). A product of the Environmental Art Movement, when in its infancy, the Harrisons now choose consultation partners from such fields as engineering, hydrology, biology, history, political science, journalistic, and the business community. 'You have to be informed to do this work' says Newton Harrison, whereby prophesying the effects of global warming the Harrisons are effectively recontextualising the narrative, and developing new stories both independent of the power elite and mutually beneficial to all life (Art in Action, 2007). The Harrison's work is assisted by the employment of large-scale maps used to illustrate and navigate accompanying texts and providers of visual cause and effect descriptions. *Peninsula Europe* is an example of presenting the complexities of

Image 12: Helen Mayor and Newton Harrison, *And the Waters Will Rise Gracefully, (From the Book of the Lagoons)*, 1981

climate change as subject matter to an audience through art making, and via a dialogue between the Harrison's and the public consisting of icons and other text/image strategies. The Harrison's belief is that the marketplace will not solve the environmental problems, which are currently piecemeal, or fragmented in consideration and instead require a whole systems approach to a whole new narrative.

3.0 Methods and Processes.

3.1 Statistical Data Collection, Selection, and Presentation

3.1.1
**Historical Analysis
and the Chronological Display
of Keywords**

In order to communicate the environmental significance of the CPW scheme, this contemporary issue needs to be placed within an historical context. Consideration of the history, narrative, and transition specific to the Canterbury Plains provides a detailed chronological timeline and is able to establish a contextual placement of the irrigation scheme. Accounts by authors including Knox (1969), Acland (1975), Speight (1927), and Eldred–Grigg (1982) converge to generate an abbreviated whilst still representative flow of the themes and subject matter central to the Canterbury Plains social, cultural and physical identity. This research presents a number of symbolic subjects including the pioneering spirit as exemplified by the Dean's family, and the constant battle between settler and environment, especially represented by the struggle to control the various raging rivers of the Canterbury Plains. The selection and refinement of these popular themes from their initial subject matter of historical accounts to single-sentenced summations and finally keywords, subsequently allow for their display and arrangement into categories and ultimately into their visualisation upon graphed timelines. This material from an historic perspective permits a more factual and less subjective account as might be otherwise accused of more contemporary and directly associated literature i.e., protagonists websites, newspaper, and public discussions. The previous condemnation of community mapping as overtly political and hence its reduced transparency (Parker, 2006) also supports quantifiable and historic data sources and non-association with data from perceivably biased lobby and/or stakeholder groups.

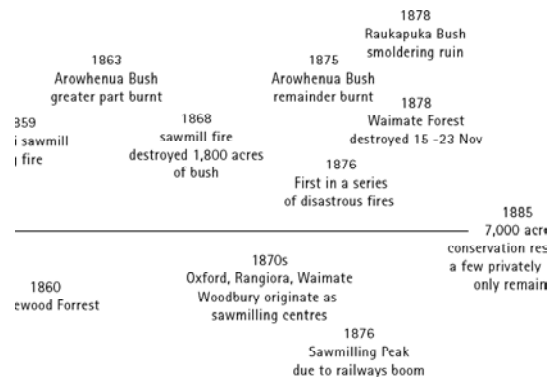*3.1.2*
**Settlement and Destruction of the
Native Forests**

The mapping of keywords upon a chronological timeline (*Image 13)* allows this collection of statistical information to be presented and evaluated together and in respect of surrounding events. Although reliant on traditional written language to communicate, this graphical display is beginning to employ the visible and spatial relationships usually restricted from this more conventional word format. The emergence of observable connections, parallels, and correlation between the various keywords and the statistical summations allow for the identification of prominent cause and effect issues from within Canterbury's agricultural history. Stretching approximately 150 years, the timeline illustrates the initial reluctance and difficulty experienced by the early settler. This however dramatically changed upon the realisation of farming potential by the early pioneers, and resulted in the settlement and turning of soils during the years 1850 – 1880 of 1.3 million acres of the Canterbury Plains. The environmental consequences of this subsequent swell in human habitation are glimpsed in the wanton and accidental destruction of the regions very limited resource of native trees, and ultimately reduced the area of millable timber to about 12% of the original forests during the same 1850-1880 period. Combined these two statistical statements provide a metaphorical frame encapsulating the attitudes and relationships between the new settler and the environment amidst the early years of settlement.

Image 13: Canterbury's agricultural history

3.1.3
Industry Transition through Statistical Data Collection

While the chronological display of historical and statistical evidence is an entry point into the cognitive communication of the Canterbury Plains' environment, it remains still limited of direct evidence and association to the CPW scheme. To explain the dramatic change that has occurred in the agricultural industry during the past decade 1995 – 2008, the selection of two distinctive moments enables the display of this transition through statistical comparison. With support from the databases of Census and Statistics NZ, MFE, MAF, ECan, DOC, this huge scale of change occurring within the Canterbury dairy industry is objectively revealed, as most vividly expressed through the comparative swell in dairy livestock numbers between the Census years 1995 – 2008, where the evidence from these numbers is awaiting to be articulated within its contextual setting. Of most relevance to the CPW scheme is the correlation between dairy livestock numbers and their directly attributable negative environmental consequences. The presentation of these associated relationships between industry and environment is central to this design project's stated proposition, and currently lacking from most media, political, or lobby group presentations to the general public of this scheme.
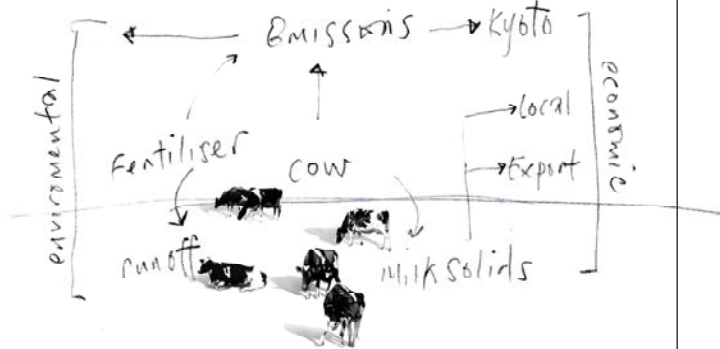
3.1.4
The Diagrammatic Display of the Cow

The opportunity to describe the one significant and iconic component of the dairy industry – the cow, provides other information to be connected and thus further expand the contextual understanding of the dairy industry's environmental and economic implications. Through the isolation of this one cow, a series of related statistical data can be attributed to the creature's industrial cycle illustrating volumes of fertiliser, milk solids, carbon emissions, and economic profitability. Statistical evidence of this one cow creates a compelling picture of the positive and negative consequences with clear and accessible relation to each other. The structure of this diagrammatic model bears direct parallels to the natural sequence of events as they realistically occur in the dairy cycle (*Image 14)* Dairy cow cyclic graph (concept). The implication that 'everything is a part of something larger' provides this diagram significant cognition in representing large amounts of separate information and then integrated into a meaningful whole (Hansen, 1999, p. 206). The various quantities of fertiliser, emissions, and economic benefit directly juxtaposed, invite individual weighting or significance to be selectively attributed to the balancing of this environmental equation.

Image 14: Dairy cow cyclic graph (concept)

3.2 Cartographic Visual Presentation and Landscape Design

3.2.1
Contextual Background and Isometric Perspective

The opening section to many of the written historical accounts of the Canterbury Plains make use of the topographical map in depicting the region's scale, environmental, and natural features. For the text and visual descriptions to follow, this map provides contextual setting and assurance permitting the

Image 15: Albrecht Altdorfer, *The Battle of Issus*, 1528-29

Image 16: Canterbury plains from space

reader to comfortably and with confidence enter the literal and reflective world of the author. Similar use is made of the Canterbury Plains' map for the purposes of establishing location and environment in which this project concerning the CPW scheme is based. The functionality of maps in demarcating the boundaries and spatial dimensions of physical objects and concepts is already well acknowledged regarding thematic mapping. Statistical information is seen to be presented as both convincing and with scientific and objective accuracy when accompanying the map. An invitation is extended to the viewer for immediate exploration and investigation of the map and visual content, while secondary to this are questions concerning the information's origin or possible degree of objectivity (Tufte, 2001).

The decision to present the CPW map from an isometric perspective allows a topographical overview of the distribution of resources and provides connection with the traditional navigation of road maps. The isometric angle while allowing x and y axis movement both horizontally and vertically throughout the map also allows for z depth, thus the Canterbury Plains is to some extent represented as a three dimensional space. The cartographic background subsequently provides for a description of dramatic and compressed action in a single frame, similar to Renaissance 'battle maps' where epic storytelling expanded the 'centrality of a single narrative' (Kraus, 1999, p. 7). The transferring of topographical reality into artistic composition was originally achieved by Albrecht Altdorfer (1480-1538), and is most evident in *The Battle of Issus* (1528-29), (*Image 15),* where an assemblage of natural and constructed features are subjected to the conventions of two-dimensional organisation (Wood, 1999).

A similar visual pretension to the expressive natural qualities of the Canterbury Plains' landscape is illustrated on the CPW map. The foreboding Southern Alps with its iconic and rugged mountain peaks serve to contrast the genteel slope of the Canterbury Plains as it gradually lowers to meet the ocean. The centralisation of the Canterbury Plains on the map allows a descriptive diagrammatic explanation of the landscape's natural ecology, where pure glacial rainfall upon the Alps, feeds braided rivers that stretch to cross the once baron and dry land. The dairy industry's interference in this natural cycle is visually exacerbated on the map through bold and easily seen irrigation races that divide and section across the plains surface. Likewise the rivers while functioning to identify the various regional council borders similarly define and evoke the environmental concern within this narrative. The mapping and rhetorical construction is subjectively evident in selection and interpretation of environmental features, and where as expressed by the Harrisons 'we reduce the roads, privilege the rivers, and intensify the mountains' (Harrison and Harrison, 2007, p. 4).

Cartography provides immediate connection and a sense of physical relationship with an audience through identifying the places of residence, and areas of spiritual and historical regard. The dramatic scale and diversity of the Canterbury region is equal to any other New Zealand scene with respect to the strong visual recognition inherent in its physical and cartographic depiction. This sense of local identity and pride when viewed on the map is similar to the nationalism and Eurocentrism expressed where the vast expanse of the British Empire is instead replaced by the chequered fields of the dairy farm (Remarkable Maps, 2005). The industrial juxtaposition of the dairy industry is intentionally illustrated upon the Canterbury map, or combination of maps – as is the case in the construction of the CPW map. The combined merits of the atlas, aerial topographical survey, and the satellite scan, each with their own separate and distinct graphical style and scientific function, produce the finished map article pertaining to reveal truth. Through the accuracy and attention to objective observation, the CPW map provides a value judgment of the pastoral production and economic prosperity of the plains.
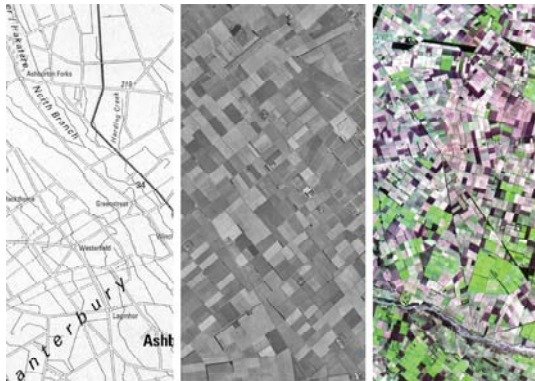

Image 17: Ashburton District, *Reed New Zealand World Atlas*, 2004.

Image 18: Orthophotos, L37 · Ashburton (NZMG), 1998/99.

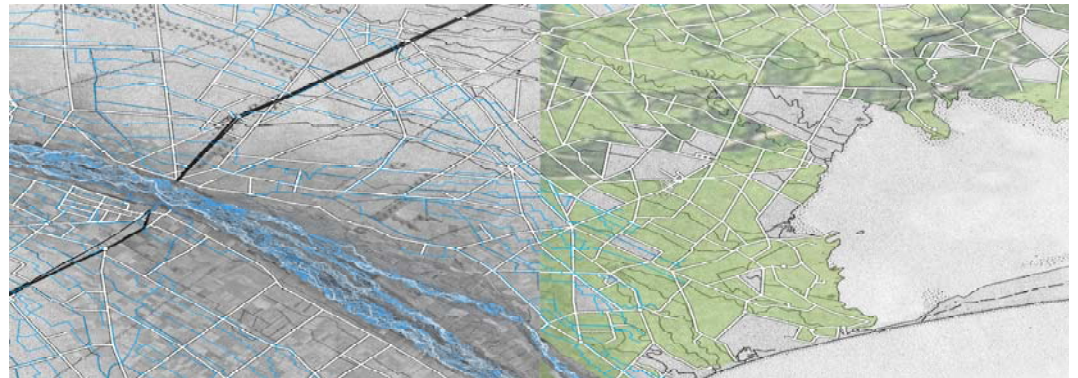Image 19: Canterbury plains from space.

Image 20: Rakaia River (section)

Image 21: Lake Ellesmere with Dairy Pasture (section)

The employment of rhetorical language upon the CPW map will appear obvious to some viewers, while oblivious to others. This depends upon prior experience with the visual propaganda of cartography, appreciation of the Canterbury Plains' ecosystem, or personal attitudes toward the dairy industry. As exemplified by the decisions of the Tom Van Sant / Geosphere Project to present the earth on a clear day and with environmental activism also a central message, the CPW map also relies on the emotive selection of colours and content, with the arrangement of these acting to sensationalise the otherwise overtly scientific portrayal of the Canterbury Plains. The irrigated and lush green pastures of the dairy farms chequer the landscape with increased frequency between the two maps 1995 and 2009, their reliance upon the supply of water drawn from the rivers it made obvious with the visual description of reduced flow and deterioration evident in the rivers of the 2009 map. The presence of water races is exacerbated and parallel to the increased dairy cow population in the later map, identifying the fertile and economic attraction of the industry with brighter colours and a more pronounced visual presence.
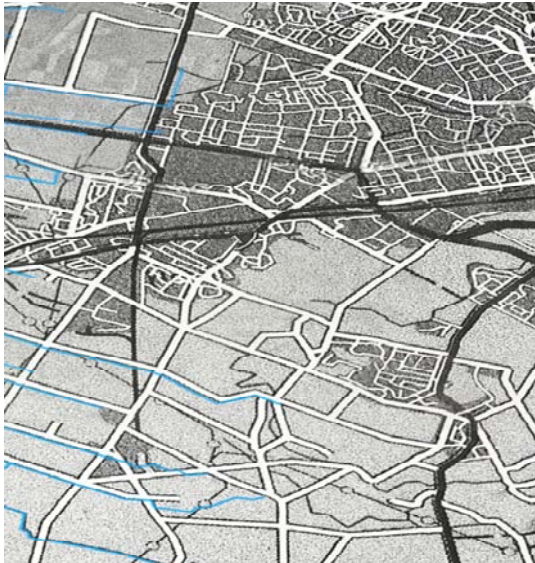
The application of rhetorical tools in this description of both the Canterbury Plains' environment and the dairy industry is in order to actively project an opinion and a comparison between the two maps 1995 and 2009. Black (1997b) suggests that while thematic mapping is capable of expressing these quantitative differences, it is however incapable of explanation or the ability to allude to the nuances and complexities within such systems. The CPW map is at this moment in the discussion of methods and processes without its icons and symbols, and so the map is purely a descriptive background for the future application of this information content. Black's comments, while they may seem founded with respect to the mapping of political information, and while the CPW map is still well short of the cognitive communication desired in this response to the Canterbury Plains, some distinctions can however be made between the two. The ability to express the resultant environmental consequences, such as the river deterioration, flow rates, and the moisture levels of the dairy farm pastures upon the CPW map, it could be argued that these do constitute the presentation of a complex description. While the map is acknowledged as a simplification of reality, it also permits reality construction, and so these subtle environmental changes do represent complex explanation.

3.2.3
Scientific Evidence and the
Valuative Judgment

Image 22: Christchurch (Western Suburbs)

The CPW scheme map evolves from the pages of the Reed New Zealand World Atlas (2004) where the Canterbury Plains are featured on maps 80 – 87 and are categorically presented within a factual and objectively scientific authority. The function of this disguise is used to achieve the maps seemingly 'dispassionate neutrality' (Wood and Fels, 1993). This includes the precise execution of visual content, which is interpreted as inspiring confidence and implying truth. The disappearance of the author and subsequent replacement with scientific objectivity allows the CPW map to seem removed from bias and apparent valuative judgments. An absence of locational descriptions and place names on the map serve beyond the mere functional purposes of reduction, and instead become an assertion of authority that presents the Canterbury Plains' region with an independence and romantically pictorial tone. The removal of this cartographic code transfers a degree of the perceived ownership from the people who inhabit the towns and cities, and instead recontextualises this space back to the natural landscape. Surveillance connotes the impression of identity, inclusion, exclusion and a position from where the map serves as a graphic inventory of the Canterbury Plains. The presence of cows and irrigation connotes the dairy industry's vivid impact and reflects a valuative judgment where presence on the map signifies importance, to the extent that the plains seem solely dependant on the cow's presence.

The CPW map intentionally simplifies the Canterbury landscape, where the lack of signs indicate the absence of a community, society, and/or human presence. While maps offer a statement of our relationship with the environment, therefore in this case implies the abandonment or abolition of contact with the rural landscape. To an extent this depiction or separation in some way affirms the comments made by the Federated Farmers, warning of the increasing divide between the urban and rural communities. As indicated by the concern of those polled in the Christchurch Regional Council Election survey (Opinions, 2007) and the Lincoln University Environmental survey (Lincoln, 2004) where the degradation of the rural environment had cause for the most alarm from respondents.

Image 23: Richard Misrach, *Atomic Bomb Loading Pit #2*, 1989

The CPW map instead of presenting a landscape ruined to an extent glorifies and embellishes the plains. Similar to comments made from the photographer Richard Misrach (*Image 23*) who suggests if the environment is captured as ugly, people will be encouraged to consider the place as a wasteland and content should it remain left that way (Selz, 2006). Conversely, the romantic notion of the Canterbury landscape hasn't departed; merely now engaged in battle with its most aggressive and compelling adversary.
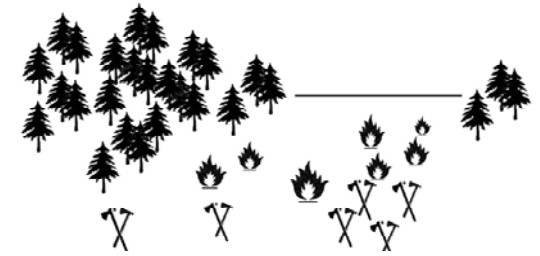

3.3 Information Display and Visual Argument

Image 25: Canterbury native forest fires icon map

3.3.1
**Icon Design and the
Canterbury Dairy Farm Model**
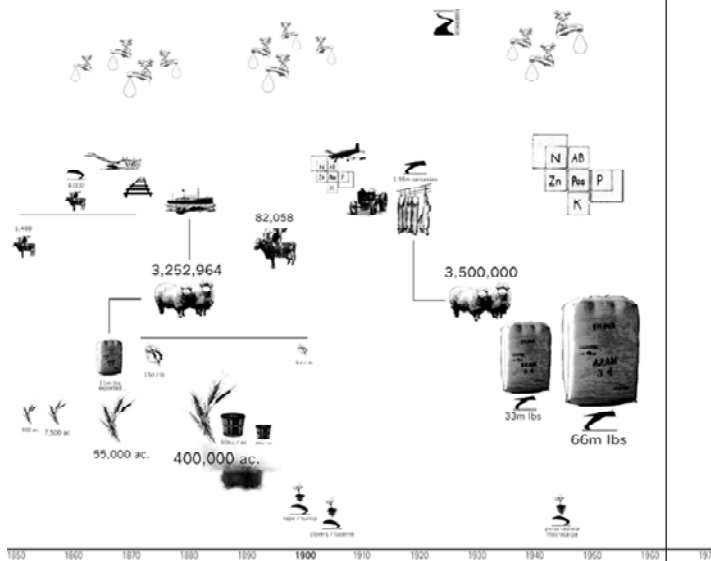
Initial expectations of the icon's design and functionality were established early in the design process, the collection of statistics and keywords generated from the historical research and once presented in visual icon form enabled an indication of the future requirements that would be expected of the icons. This engagement between the visual icons and the raw statistical information of the Canterbury Plains indicated the capabilities of the icons as data mapping vehicles. This is especially so with regard to the controlled vocabulary and immediate context of the agricultural and dairy industries which both have strong and vivid visual identities, affording the icon's potential to communicate expansive themes and content with an apparent efficiency.

The Canterbury agricultural history icon map (*Image 24*) attempts to translate the visual equivalent of the Canterbury Region's agricultural history into a series of pictorial relationships between icons upon a chronological timeline. Through the resemblance of the icon and its referent, this map establishes spatial connections with both proximate context between the icons and within the agreed conventions of the graph. Employment of scale and quantity also allows the icon to represent change over time through sequential position relative to the horizontal axis and timeline. While a degree of cause and effect relationships are visible between the various individual icons, such as the decrease in forestry due to fire and milling (*Image 25*). These visual explanations are primarily based on the expression of nouns, and are devoid of the verbs and adjectives/adverbs identified as essential in the success of explanatory visual language systems (Zender, 2006).
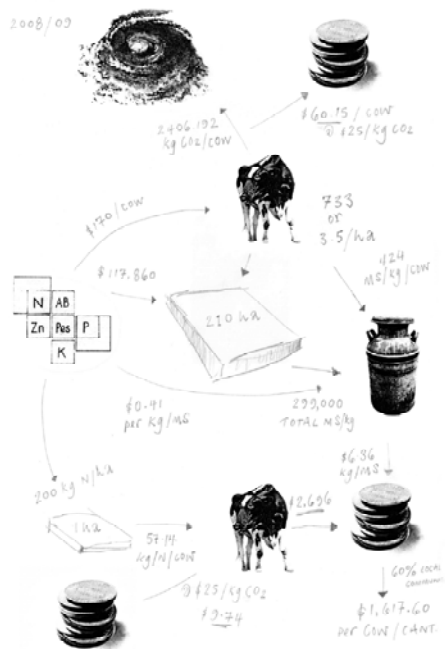

Image 24: Canterbury agricultural history icon map (section)
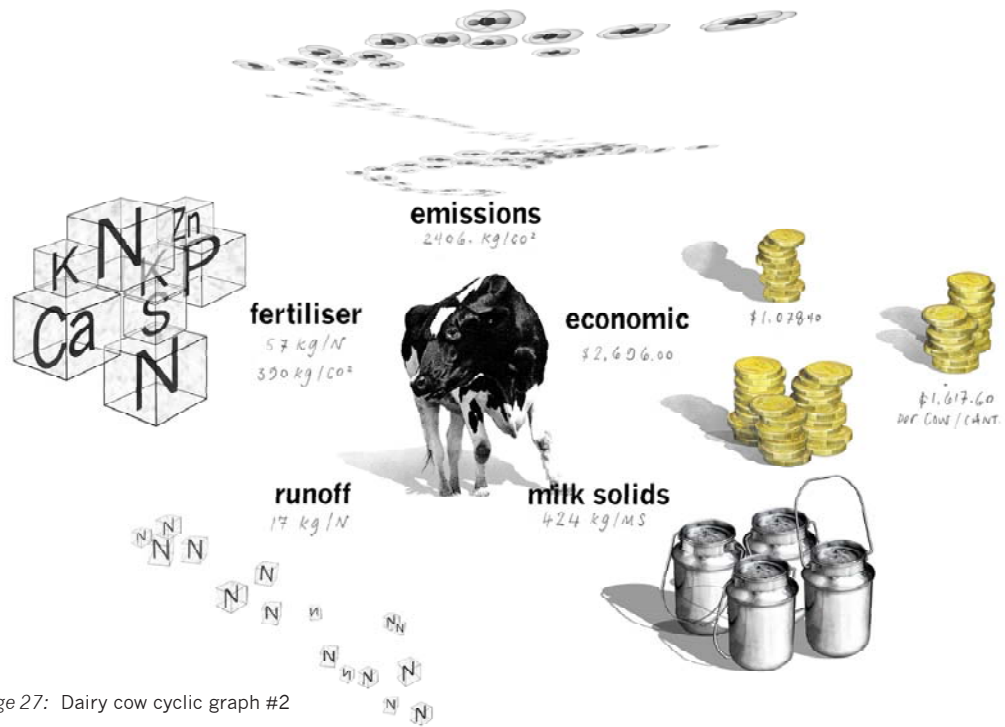
Image 26: Dairy cow cyclic graph #1

Image 27: Dairy cow cyclic graph #2

The necessity for information design to identify connections and present cause and effect explanations is central to the Dairy cow cyclic graph #1 (*Image 26*), where the icons now have become engaged in a cyclic explanation of the dairy industry. The linking of arrows on this map connects the various significant dairy industry themes into a series of casual relationships that includes statistical data of proportional volumes and quantities. The icons collectively share immediate context with each other and are therefore assisting to inform and provide cognition with respect to their own individual referents and those surrounding icons. The importance of this map is the establishment of synthesis and correspondence between the individual icon elements. The reduction of this complex and diverse issue into clearly defined stages is reliant on the suitability and connection of the icons within this information mapping to present easily conceived impressions and summations of the CPW scheme.

The Dairy cow cyclic graph #2 (*Image 27*) extends the cyclic organisation of the icon through their separation and arrangement into distinctly different categories of information. The cow is affirmed central to the visual equation with economic and milk solid production expressed on the cow's left and the applied fertiliser and nitrogen leaching on the cow's right. Above the cow is the quantity of carbon emissions released per annum, as are the other volumes of information expressed per annum. The map's display of icons and content is more clearly defined and further reduced, allowing the potential sub-categories to illustrate secondary cause and effect scenarios through the visual hierarchy and z depth now present within this isometric perspective map. The three-dimensional configuration of the CPW map permits the icons to interact with the cow and the picture plane in a natural and expressive way, further representative of the icon's true referents.

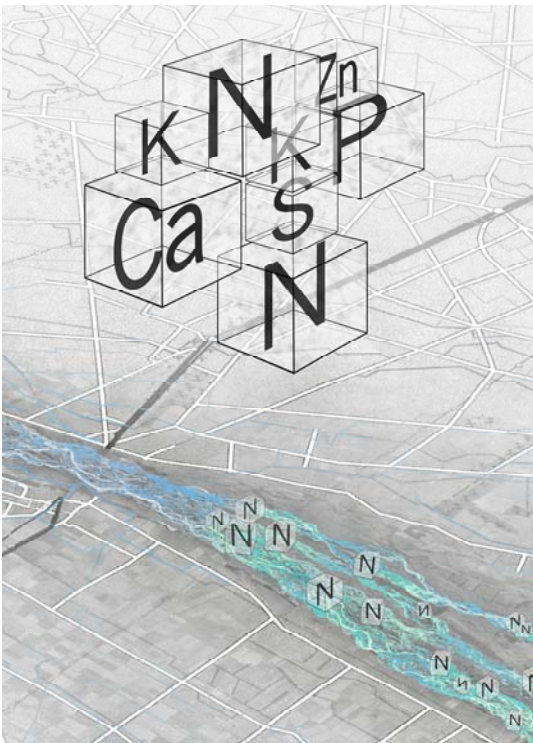*Image 28:* Native forest fire (Alford Forest)

Image 29: Fertiliser and runoff (Rakaia River)

Limitations in the communicative function of icons have significantly restricted their useful purpose in the expression of complex messages and highly abstract concepts, and in particular those involving actions and/or states of being. Icon modifiers have to some extent proven capable in the expansion of context through layering, abstraction, and sequence (Zender, 2006). However these attempts have been limited to the focused domain of scientific concepts, and are therefore aided by the specialist knowledge and language comprehension already existent in the reader. The CPW scheme has been excluded from the general public for the exact opposite reason, where the complexity of the data and the perceived lack of knowledge has determined the public as incapable of grasping the intensive and hard-scientific information regarding the irrigation scheme. The success achieved by Zender is very much reliant upon the interaction of the icon's *immediate context*, where the combination of icons or the addition of separate modifiers are able to assist in generating a third and thus new modified icon and referential meaning (Zender and Crutcher, 2007).

The opportunity to combine or group icons for statistical presentation has long been proven suitable in the expression of social and economic information, as exemplified by the Isotype pictorial language system. The presentation of icons within the CPW map is a combination of the models used by both Zender and Neurath, with the addition of the Canterbury Plains' map providing environmental context. Illustrated in the example Native forest fire (Alford Forest) (*Image 28*) is the combination of individual native New Zealand tree icons, each is representative of a particular species and they are combined to identify the size and type of forest with reference to a specific location on the Canterbury Plains. The addition of the burnt tree stumps and the obvious change in colouration of the map's surface is indicative of the subsequent burning or forest fires that devastated over 40% of the region's native timber resources during 1850-1880. The spatial location and size of the native forest has been visibly altered through the addition and/or combination of icons, as explained in the equation, native tree + burnt stump = native forest fire.

Fertiliser is applied to the Canterbury Plains to advance and maintain the nutrient levels required for pasture growth in the intensive grazing systems and high stocking rates current in the dairy industry. It is acknowledged that 30% of the applied nitrogen is leached into the aquifers and rivers (DairyNZ, 2008). The fertiliser icons are displayed as a transparent cube and include their scientific abbreviated terms. Hovering above the map's surface allows the fertiliser icons to be distributed to a number of different locations including as shown in Fertiliser and runoff (Rakaia River) (*Image 29*). As expressed through the change in colour of the river water once contact is made with the nitrogen, the relationship between fertiliser and the environment is now presented through the modification and extension of the icon within the map. The visual presence of the river is able to convert scientific causation into the comparison between prior and post nitrogen runoff as a result of the dairy industry. The map's spatial and isometric display further explains the natural process through the journey of nitrogen down the river and into the ocean.

**Map Comparisons and the
Visible Transition of the Dairy Industry
Over Time**

The comparison of quantitative information is a fundamental question within the analysis of statistical evidence (Tufte, 1997). The Canterbury Plains' dairy industry is unquestionably developing in respect to livestock numbers, milk solid production, and the community's economic reliance on its continued success. The presentation of irrigated dairy pastures within the Canterbury Plains map shows that the integration of statistical evidence and the physical presence of irrigated dairy pastures is unavoidably made when compared next to the sheep or arable farms. The visual impact uses a combination of both the statistical evidence of land use by hectare and the livestock numbers within the Canterbury region. The integration of green pastures and the dairy cows are a rhetorical description using icons and the context and comparison of the map to provide a construction of reality as interpreted through a visual language system of statistical evidence.

For the general public to be informed of the future economic and environmental potential of the CPW irrigation scheme, the same cyclic model used to explain the comparative two years 1995 and 2009 is employed for the mapping of the 60,000ha Central Plains Water irrigation scheme. Considering the Canterbury Plains' map and the icons have already been presented in two previous maps, the cognitive communication and visual language should already have been well established for this final map. By responding to the initial central proposition of this project, which asked for a visual language system capable of translating information of the irrigation scheme for consumption by the general public, this map makes use of both icons and cartography in order to meet this communication task.

Icons

The CPW icons are incorporated into the environmental context as opposed to being isolated from it, Zender also suggests advancing the *Immediate Context* resulting in the integration of the CPW icons through layering, abstraction, and sequence (2006). The icons have adopted a consistent visual style which includes hints of Neurath's silhouette, while colour is applied when necessary as a rhetorical device. The integration of the CPW icons into a cyclic model shows natural process, narrative, and the display of cause and effect relationships. The icons communicate verbs and adjectives/adverbs through being effected by modifiers and highly abstracted visual forms and engagement with the map.

Image 30: Dairy cow icons

Cartography

Even on a single map, features can vary dramatically (Muehrcke, 2001). The CPW map attempts to practice this observation through the visual proclamations of pros and cons, scientific integrity and rhetorical construction. The CPW maps exert power and connote truth through both functionality and systematic analysis. This allows them to construct reality and advance political and emotive content. Combined the maps draw upon historical summations and events, they present dynamic narrative and allow environmental causation. Right or wrong, they ask questions, build models and discuss money, emissions, grass, cows, identity, location, water, history, narrative, and vast dramatic transitions.

Conclusion

Image 31: Lake Ellesmere and Selwyn District

Image 32: Selwyn District with dairy pasture and cows

This thesis explores the Canterbury Region's dairy industry, from the economic benefits and financial security bestowed within the wider community to the environmental and aesthetic transition forced upon the landscape. Global demand for primary production through burgeoning middle classes now result in expanding and intensive dairying practices where previously nonexistent. Dairy giant Fonterra who contribute a quarter toward New Zealand's total exports and processes 95% of milk production illustrate this dependency upon agriculture. Making the analogy between food and oil, Fonterra warn of ecological sacrifice and degradation in order to meet supply and maximise environmental resources as they define them. Contributing half of total greenhouse gas emissions, the agricultural industry are seeking to further strengthen their 'environmental management' with a 420% increase in the use of nitrogen fertiliser and 70% in livestock enteric fermentation since 1990 (MFE, 2007). This increased pollution parallels environmental degradation that Federated Farmers insist must be publicly accepted if we want to feed the world and maintain a healthy economy (Joy, 2008). The MFE warns tourism, our single largest foreign exchange earner relies on a '100% PURE' image for international promotion, yet also noting that the primary production sectors 'trade heavily' on this perceived environmental claim, while the dairy industry advances that 'leveraging New Zealand's positive environmental image adds value' to dairy products (Environment Waikato, 2006).

The gathering of statistical data and scientific evidence from the agricultural industries, governmental agencies, and research institutions provide this thesis the opportunity for an objective and quantifiable expression of the dairy industry's interrelationships. Resulting in the diagrammatic model of the cow and its associated pros and cons as they have increased with the intensification of both industry and global market commodity prices. The combination of science and art enhances both perspectives with rationalised objectivity amidst emotional representation. This possible readjusting of the way we view the Canterbury Plains' dairy industry results from the contextual perspective of the cartographic map and visual display of livestock in terms of habitat and ecological narratives. Where previously accused of compartmentalising and isolating information (Frascara, 2001) the CPW map intentionally engages in a whole systems approach through the cyclic modeling of the cow within an environmental context. The ability for diagrams to express ecologies of information is illustrated in the CPW map's synthesis of economic benefit versus environmental consequence through its main protagonist – the dairy cow. The acquisition and display of quantitative comparisons allows the emergence of pattern phenomena and a clearer understanding of the future implications as they relate to the proposed CPW irrigation scheme. Though neither the 'white knight' nor 'bogeyman' actually appear on the maps, their presence is seen everywhere throughout them, and ultimately the CPW maps provide an introduction and brief narrative journey into their world, and the Canterbury Plains' dairy industry.

Investigation into the history and application of icons as a visual language system presents this public community map with significant cognitive information transfer that demonstrates the agility of icons for efficient and economic communication. Through the expansion of both *immediate* and *environmental* context, the icon is able to display transition with cause and effect evidence, also expressing verbs and adjectives/adverbs. Assisted by the controlled vocabularies of cartography and the dairy industry, the icon communicates the physicality of cows, milk solids, and fertiliser, while also permitting processes and actions such as native forest fire and nitrogen leaching to convey the environmental and economic

implication of the dairy industry on the Canterbury Plains. In arguing for environmental consideration this thesis also acknowledges the economic importance of the dairy industry with an emphasis on the impartiality, logical argument, and rational expression. The visual connections imposed by the maps are intended to evoke consideration, discussion, and investigation, therefore providing the construction and transfer of power to a general public who have been intentionally negated of this civic right. Where previously the cartographic map was reserved primarily for those in power, this CPW mapping project reflecting the sense of mapmaker as creator rather than reflector, represents the aggressively powerful spatial potential of the map. Though this map is not territory, it demonstrates through representation as metaphor for the culture that inhabits this space, and so by implication the importance of not just the dairy industry but also the environmental when considering the Canterbury Plains' landscape.

Considering the intention for serious and non-bias communication, the Central Plains Water (CPW) mapping project represents and embellishes both arguments of the scheme insofar as providing an opportunity for the general public to develop conclusions based on their own appraisal and reaction to the various icons/themes depicted. Exemplified by the mountainous gold bullion, while opposed through the toxic teal as the fertiliser runoff enters the waterways – the viewer is prompted to make their own calculations of the economic benefits and environmental trade-off. The obvious comparison between the 1995 and 2009 maps is expressed through the dramatic increase in cow population and consequently transferred into the size of both the economic and productive gains of the scheme.

Beyond the accumulative comparison in volume, presence and symbolism of the dairy industry, is the rhetorical construction of the Canterbury Plain's cartographic landscape. Cartographic mapping used as contextual backdrop within the maps provide disparate data sets of information (seen in the *cyclic modeling*) to present narrated cause and effect explanation for the viewer. The ease in which navigation is achieved through both the traditions and geography of mapping comprehension and the principles and graphical techniques of landscape paintings allow these maps to communicate on multiple levels. Firstly, the environmental representation seen through the selection of topographical features (rivers, trees, soil, etc) and their transition over time, simulate the dairy industry's ecological byproducts. Consequently, these visible effects are then directly juxtaposed with the volumes of cows, milk-solid's production, and economic gain. The viewer is invited to consider the industrialisation of the Canterbury Plains in direct contrast to a changing environmental landscape and the potential ecological footprints.

The map's scale (2.5 x 1m) provides space for the staging and development of sub-narratives, and the relationships and proximity between cows and the individual rivers, the contrasting gold with the teal run-off, and the encroachment of farmland into the native forests. A sense of provocative rhetoric is unashamedly employed to establish the significance of this subject matter while also allowing for the opposing arguments to battle with pride and vigor. The layering of this visually based language system consisting of icons, and with the topographical elements as backdrop eliminates the need for complex keys and descriptions. The maps present a mix of objectivity and rhetoric… where the inclusion of statistical information and measurable datasets are offset by an expressive and emotive colour palette. At this stage the viewer now more confident and comfortable with the symbolic language and narrative can investigate more closely the subtle or quantitative information displayed within the separate maps.

The exclusion of public consultation and discussion from the CPW irrigation scheme and regardless of the possible reasons and degrees or levels of communication required is unacceptable! The fact that these cartographic maps illustrate the possibilities for when accurate statistical information is used in a manner-befitting objective and cognitive communication – represents this. This combined transfer of information through both the visual and the traditional written language systems permit the viewer to experience both impressionistic and lineal transfer of the statistical information. So while the initial design project concept sought to remove alphanumeric language, this is unavoidable when using such large volumes of data and when also requiring the degrees of accuracy and accountability for public consideration. And beyond this, *Mapping the Environmental Footprint of the Central Plains Water Irrigation Scheme* challenges the role of cartography and information design within a new contemporary context.

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