Four Scenarios for the Manawatu Catchment, New Zealand: integrated energy, economic, and environmental choices

Anna Wilde, Jacoba Aldersabaes, Robert Cardwell, Dean Manson, Xiangzheng Meng, Daniel Shaw, Shannon Wallace

February 18, 2012

Professors Costanza, Forgie, and van den Belt

Abstract

This paper outlines four plausible scenarios for the future of the Manawatu Catchment on the lower north island of New Zealand. The scenarios look at the effects of increasing energy prices and different economic paradigms, conventional and ecological. Each of these variables are linked to one or more of four basic types of capital: natural, social, built, and human. The four scenarios are based on: (1) low energy prices and a conventional economics framework, (2) high energy prices and a conventional economics framework, (3) low energy prices with an ecological economics framework, and (4) high energy prices and an ecological economics framework. The results show that there is a need to adopt an ecological economics framework, particularly when facing rapidly rising energy costs. The most desirable scenario is one in which people employ an ecological economics paradigm and also rapidly develop renewable energy to keep energy prices relatively low. In this scenario the economy, environment and society are in sustainable balance. Central to this thesis is the urgency of making this transition, which is tied to the concept of path dependency.

Introduction

As the world's economy has developed in recent decades and the world's population has increased its dependence on fossil fuels, energy prices had been relatively low and stable. However, oil prices are now rising due, in part, to the peaking of global oil production, while new energy alternatives are not being made available quickly enough. The uncertainty that we can find a suitably cheap substitute for oil as well as the earth's rising population coupled with its accompanying demands mean that energy prices may continue to rise. These rising energy prices will have notable and regionally specific effects .

The world has reached ecological limits that the current throughput growth in the global economy cannot sustain (Goodland, 1992, Rockstrom et al 2009). Earth Overshoot Day in 2011 was in late September, which means that humanity had consumed a sustainable level of ecological services by that time for the entire year (Global Footprint Network, 2011). Chris Martenson attributes this predicament to the prevailing economic paradigms formed during the industrial revolution, which emphasizes economic growth without consideration of the natural world (Martensen 2011). Overshooting these limits could have dire consequences. In their book, *Limits to Growth: The Thirty Year Update*, Meadows, Renders, and Meadows compare the past thirty years of reality with the predictions made in 1972 and find that changes in industrial production, food production, and pollution are all in line with the book's predictions of economic and societal collapse in the 21st century (Meadows et al., 2004). Based on the work of these authors and others, it appears that peak energy prices and ecological overshoot are two of the most pertinent challenges of the modern era accompanying the world's population and economic growth. Ecological economics proposes to address these problems by incorporating "sustainable scale". For example, as a fundamental principle, future environmental carrying capacity should not be discounted as done in present value calculations.

In this paper, we use scenario planning to outline possible outcomes resulting from these changes in the Manawatu Catchment, located on the North Island of New Zealand. Here, effects will be most notable around farming and urban land use. The Manawatu River catchment is a central focus of our scenarios.

The Manawatu Catchment

The availability of cheap energy has already had effects on the Manawatu River and

Manawatu Catchment in the form of changing agricultural trends. Cheap and efficient transportation has created incentives for intensive dairy farming for export instead of traditional sheep and beef farming. Largely due to intensive dairy farming, the main factors affecting the river are erosion and subsequent sedimentation, nutrients and pathogens from point-source discharges, over-use of water, and habitat destruction (Manawatu Leaders' Accord Action Plan 2010). These factors are exacerbated by flooding as well as the unintended consequences of flood protection schemes, and also by cycles of drought. The effects of these can be seen in effluent runoff from concentrations of dairy cows, which increases nitrogen levels in the river (Collins 2007, 268). There is also increased sediment in the river due to the "highly erodable" nature of the land's steep slopes, caused by more cows on farmland as well as deforestation in higher lands (Fuller 2008). Finally the river contains excess phosphorus from both urban and agricultural areas (Handley, 2012, *pers. com.*). These imbalances have adverse affects on the biotic populations, particularly fish (McQueen, 2012, *pers. com.*). However, they also have economic effects, both on the recreational use of the river as well as the capital investment required for wastewater treatment on a larger and more intensive scale.

It is conceivable that higher energy prices will have effects on the agricultural and recreational use of the river, as well as the patterns of living in communities that depend on the ecosystem services the river provides. Hanlon and McCartney (2008), to give one example, predict "[s]ignificant oil price rises will reduce the feasibility of international trade for goods and services reliant on aviation, shipping and motor vehicles". With less incentive to export dairy, a decrease in dairy farming will have multiple effects on river use in each sector of involvement. Therefore, we can see the inevitable complexity of planning for an uncertain future. However, it is also possible that with the tools available to us, such as scenario planning, we may be able to

better understand and prepare for these effects.

Scenario Planning and Framework

Scenario planning is a tool that allows us to “create plausible, relevant stories about how the future might unfold, which can be told in both words and numbers” (Raskin, 2005, 36). By using data as well as thinking creatively about the possible effects of decisions on specific variables, we can create different visions of the future. With these visions as a base, we can better determine an effective course of action. Scenario planning has been used in several previous applications. For example, in the Millennium Ecosystem Assessment, it was used as an envisioning tool to provide a base for policy recommendations (Scenarios Working Group, 2006).

In this exercise, we are operating from the framework of ecological economics, which is a trans-disciplinary approach to the economic problems of efficient allocation, fair distribution, and sustainable scale (Costanza et al., 2008). H.E. Daly writes of these concerns, "the first two have a long history in economic theory and have their specific independent policy instruments. The third, scale, has not yet been formally recognised" (Daly, 1992). Central to ecological economics is the consideration of four basic types of capital: built, natural, human, and social. Unlike the traditional economic view of capital, which considers mainly the built variety, in the ecological economic view each of these capitals is necessary for human well-being in a balanced and ultimately non-substitutable way. Furthermore, according to the ecological economics framework, the interaction of these capitals can give a more accurate picture of collective well-being.

The first, built capital, is considered in both conventional and ecological economics, and

"includes all the machines and other infrastructure of the human economy" (Costanza 2006, 168). However, there is a difference between the way traditional and ecological economists view built capital. In the traditional economic view, economic value increases with the increase in quantity of built capital; conversely, in the ecological economics view, economic value increases with more efficient use of built capital, as well as by measuring its affects on the other three.

Natural capital, often not considered in conventional economics, is "the biologically productive and mutually exclusive areas necessary to continuously provide for people's resource supplies and the absorption of their wastes" (Wackernagel et al., 1999, 376). It "includes ecological systems, mineral deposits, and other aspects of the natural world" (Costanza 2006, 168). Natural capital is both the raw materials that go into the production of built capital as well as the systems that cycle human-created waste. It is considered in ecological economics in the form of ecosystem services that contribute both directly and indirectly to human functioning.

Human capital and social capital are likewise areas that are not often considered in conventional economics. Human capital "includes the health and education of the human population, both the physical labor of humans and the know-how stored in their brains" (Costanza 2006, 168). It is gauged by looking at the health or education of a particular group, for example.

Social capital is "the networks of social relations characterised by norms of trust and reciprocity that can improve the efficiency of society by facilitating coordinated actions" (Lehtonen 2004, 204). It is the "interpersonal connections, institutional arrangements, rules, and norms that allow human actions to occur" (Costanza 2006, 168). Social capital is the most difficult of the four to measure, but studies have shown that social capital is inextricably linked to natural capital as ecosystem services are positively correlated with life satisfaction, and less

competition for resources leads to more harmonious social relationships (Vemuri and Costanza 2008; Wackernagel et al., 1999).

Our scenarios run along two axes: one of high and low energy prices and one of ecological and conventional economics. Because ecological economics incorporates the value of human, social, natural, and built capital into the process of achieving efficiency, we wish to examine the possible outcomes of high energy prices on these four capitals, particularly as they link to variables specific to the Manawatu region. Alternately, because conventional economics tends to value only built capital in the form of gross national product and other traditional tools, we wish to highlight the differences between the two by placing them on the same axis. We hypothesize in this exercise that the differences between conventional and ecological economics will be noteworthy, and further underscored by changes in energy prices.

Methodology

Our scenario planning exercise was used to explore the interrelationships between economic, environmental and societal factors within the Manawatu region. This exercise was conducted with respect to the price of energy and the economic paradigm applied in developing the region. Specifically, we considered the effect these two dimensions would have on the state of the four capitals discussed above. Scenario planning is not about trying to forecast, project, predict or recommend; it is merely a means by which to explore the many possible scenarios that may arise in an uncertain future. The purpose of this exercise is to identify potential risks.

The scenarios are plausible situations that illustrate a story about how the future may unfold under certain circumstances. The purpose of exploring each of these is to allow the reader to conceptualize the future and how it may come to pass. In doing so, the scenario will hopefully

identify potential problems. Subsequently, having identified these problems, research could develop in order to either increase understanding or consensus across all relevant stakeholders. To this end, scenario planning can act as an initial step towards adaptive management by helping stakeholders envisage the future realities (Sustainable Pathways, 2010).

Scenario Development

The four scenarios were developed by a team of university students attending an Applied Ecological Economics course at Massey University in January of 2012. The process of developing the four scenarios began with attending lectures by a number of scientists regarding the Manawatu River's state of health. As the atelier course progressed, the team visited various stakeholders around the region. These included a dairy farm, a local ***marae***#, and community groups protecting downstream ecosystems. These visits helped identify key issues and problems from the stakeholder perspective. The issues identified in the discussion, formed the starting point from which the team further explored the issue and researched relevant literature. The purpose of these activities was to gain different perspectives as an initial step in increasing consensus on the issues and risk facing the Manawatu region.

Four members of the project team developed the four scenarios. Each was developed by first assessing the nature of the scenario and making reasoned assumptions on what this particular future might entail. After these making these assumptions, the team gathered information from stakeholder visits and lectures, using it as a starting point in exploring possible outcomes in key indicators across the four scenarios. Because the intuition and reasoning are subject to the base information from lectures and stakeholders involved, caution must be exercised. While we are confident in the information provided and the team's ability to question

the validity of the reasoning used, for the purposes of objectivity it is important that possible bias be identified and acknowledged.

We chose a number of variables specific to the Manawatu region that could possibly be used as gauges for the status of the four capitals in each scenario, and therefore the level of desirability for each scenario. Our variables are the following: fish stock and habitat; recreation; dairy farms; sheep and beef farms; waste water treatment; regional councils; cultural diversity (with specific reference to the local ***iwi***#); oil and investment in alternative energy; and flooding frequency. Of these variables, fish stock and habitat are most closely linked with natural capital. Secondly, dairy farms, sheep and beef farms, wastewater treatment, and alternative energy are linked most closely with built capital. Finally, regional councils, recreation, and cultural diversity are liked most closely with human and social capital, they themselves being closely linked together. By tying in the variables with the four types of capital, we hoped to build our macro-level conclusions on measurable micro-level indicators.

The purpose of the scenario development by the process mentioned above is to form a base of variables pertinent to the Manawatu. These variables will be used to proxy the four capitals across the four scenarios so that comparisons can be made and assessments conducted. Due to the nature of scenario planning, analysis was conducted by focusing on identifying problems, reaching group consensus and increasing understanding of the issues. Analysis focused on identifying major risks, issues in analysis, key points of uncertainty, major drivers, factors that won't change and the identifying indicators of each scenario. We asked these questions with the intention of solidifying our scenarios and creating a reliable basis on which we could suggest directions for future research.

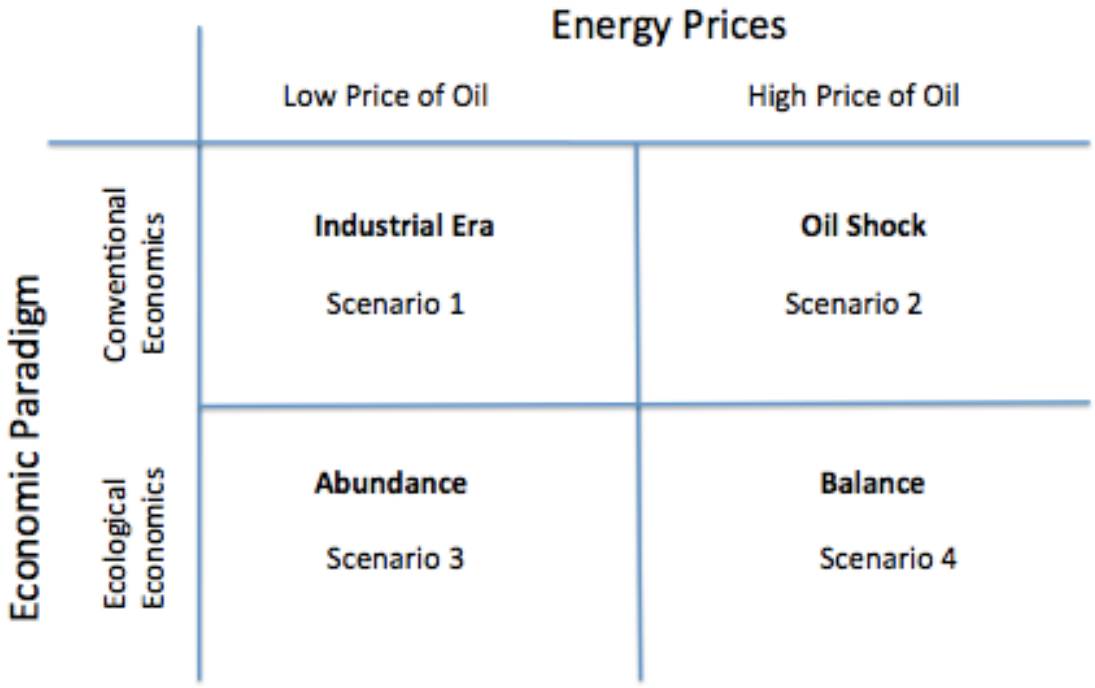

Figure One: Our scenarios were created along two axes: economic paradigms and energy prices. From these we developed four possible scenarios for variables in the Manawatu Catchment.

SCENARIOS:

Scenario One (*low energy prices, conventional economic paradigm)*

Scenario one is characterized by a low overall price of energy and a conventional economics paradigm. The economic paradigm is focused on maximizing profits, often at the expense of the environment. The low cost of energy enables businesses, whether dairy farms, councils, meat works, or industrial activities, to easily exploit the environment and its resources to turn a profit.

Due to increases and advances in exploratory and extraction technologies (ultra deep water oil drilling, etc.), new oil reserves have opened. With the subsequent increase in the supply of oil without the accompanying economic valuation of the other costs of drilling, energy prices are low and the idea of peak oil is generally considered an old wives' tale.

Those who wanted more lenient regulations have gained control of the Horizons Regional Council. As a result, the Council has relaxed its monitoring and compliance procedures. In addition to this relaxed attitude, the belief the Manawatu River is already in such a polluted state has been used as an argument to cease regulating discharges. The Council owns several farms of various sizes to enhance its yearly revenue.

The relaxing of regulations has allowed the dairy industry in the Manawatu to blossom and profits are increasing on a yearly basis. Farmers have increased their cows per hectare and increased fertilizer usage. This has a ripple effect through the economy, increasing profits for suppliers of fertilizer, farm capital and such. There is no concern for fencing waterways, or on farm treatment of effluent. The regional council does complete compliance monitoring of resource consents. The river is already polluted out of control and it is seemingly acceptable for farmers to pipe effluent directly off of their farms. Farmers have increased the grazing areas of their paddocks by allowing their animals to graze up to the waters edge. Riparian zones are unprofitable and thus are removed in place for additional pasture. Dairy encroaches on the sheep and beef land in a bid to increase profits further.

Similarly, sheep and beef industry encroaches on the marginal hill country leading to deforestation of the Ruahine and Tararua ranges to open up more valuable grazing land; this increases erosion of the hill country. The sediment from the runoff increases water turbidity and the amount of reactive phosphate suspended in the water.

River engineering is employed the length of the Manawatu River. Extensive and high stock banks contain the river during periods of flooding. Unnecessary bends are removed to open up more profitable farming area.

Due to the low cost of energy, there is an urban density problem. The profitable farmland

is choking the city limits in towns around the Manawatu, which has caused the house prices to skyrocket. Farmers on the fringe of these towns are selling their land for massive sums to property developers, and urban sprawl is a reality. The population relies heavily on cars as public transport in these outer areas is relatively non-existent. Storm water run off in towns is highly polluted.

Wastewater treatment plants in the local towns are overwhelmed; it is not profitable to increase the quality of water exiting the treatment plant. The Manawatu River is polluted from other areas of society, and so pumping inadequately treated discharge into the river is not seen as a big problem.

Fish habitat has been decreasing at an alarming rate due to the increase in sediment entering the river and the river engineering projects. The pollution increase from point and non-point source discharges as a result of relaxing the Council's policies, as well as the fact that people have no concern for the state of the river, has resulted in fish stock decreasing substantially. Some species have disappeared from the river and region all together; in the near future there will be none.

Recreation in the region has decreased as the pollution has increased. People are not allowed to swim in any area of the river or beaches along the coast. Fish or seafood cannot be consumed.

Due to the destruction of ecosystem services, local iwi have lost their traditional food sources of eel, fish, and shellfish. This deeply degrades the traditional values of the local Maori. Iwi do not have the money to make changes that are needed and society has no regard for their values. The Mana of the river is lost and society has, in terms of ecosystem services destruction, reached the point of no return, in exchange for economic growth and profit.

Scenario 2 ***(high energy prices, conventional economic paradigm)***

This is a possible situation in which the prevailing economic paradigm is conventional economics, which as stated above has a focus on profit margin and ignores environmental degradation. The price of energy has drastically risen from the present value because investments have not been made for other forms of sustainable, alternative energy sources.

Due to the profit driven nature of society and the increased inclination to ignore environmental factors, the fish habitats in the Manawatu have been destroyed. Firstly, the water quality in the river has been polluted beyond repair and left habitats unsuitable. This is due to increased nutrient levels and sediment runoff driven by conventional, economic intensive farming practices. Secondly, the fish in the river could serve as an inexpensive, short-term substitute if they could be kept healthy enough to harvest.

The poor quality of water leads to the type of recreation that occurs in the river to change. The price of energy will increase, leading to a decrease in discretionary income and unnecessary travel. The water quality of the river will discourage aquatic based contact recreation such as fishing, swimming, rafting and the like. Decreasing incomes may motivate landowners to start charging for use of their land to maximize potential profit. Those in lower socio-economic brackets would choose to forgo recreation because they cannot afford to pay the fee now associated with the land.

The increased costs in petrochemical heavy fertilizers have dramatically skyrocketed costs of production for dairy and sheep and beef farmers. The cost increase has led to a disregard for costly environmental considerations including fencing streams, erosion control and effluent management. With less concern for the health of the river, farmers will become profit driven and

start clearing forestland to open up new land for pasture. By clearing forests, the soil becomes less stable and erodes from the land as sediment input into the river. This makes a regulatory and political argument for the treating wastewater from point sources more difficult. Improperly treated waste water will be pumped directly into the river as council funds are diverted away from environmentally friendly practices. This is acceptable because the overall quality of the river is so poor to start with.

The role of the Regional Council as an environmental watchdog is lessened as they direct their focus towards fundamentals such as water and farm management. In an effort to cut costs, the Council has given up all environmental obligations. They are focused on cheap energy production and have become lenient to corporate energy producers and large industry (Fonterra, Meatworks) that have no regard for environmental standards. Monitoring efforts of environmental factors are a non-affordable luxury to a financially struggling Council.

Cultural values are unimportant within this economic paradigm, and thus fail to have any power to influence change. The need for agricultural production has superseded cultural claims of the land as set up through the treaty process. This also negatively affects the natural floodplain areas, which are being encroached upon by agriculture industry.

The increased cost of traditional energy production in conjunction with an economic paradigm that does not value the environment drives the need for any sources of attainable energy at all. However, alternative sources are not considered, or are very expensive. This leads to harmful extraction procedures that cause irreversible environmental externalities.

Scenario 3 (*low energy prices, ecological economics paradigm)*

The Abundance scenario is perhaps prima facie the most appealing of the four scenarios.

Energy prices remain at low levels while society makes the choice to adopt an ecological economic paradigm.

Relatively inexpensive conventional energy makes energy dependent technological solutions are practical solution to ecological problems such as using carbon sequestration to reduce CO2 levels in the atmosphere. The practicality of technological solutions motivate industry to conduct further research into technological solutions expanding the range of environmental issues technology can mitigate.

These inexpensive technological solutions drive advances in artificial flood protection and wastewater treatment. The value of maintaining habitat and having clean, beautiful rivers combined with cheap energy will result in the creation of artificial wetlands which provide increased fish habitat and flood protection but remain reliant of constant human upkeep. Wastewater will be treated to the highest standard using energy intensive methods, which result in potable water entering the river.

Clean water and increased fish stocks due to habitat improvement draw more recreation into the catchment area as New Zealanders have made clear they value clean rivers (Hughey, Kerr, & Cullen, 2011) and the prevailing ecological mindset leads to the creation of new forms of outdoor recreation on and around the clean river.

As the values of forests, the river and riparian zone, and the ecosystems services they provide are recognised, the value of conventional farmland that was previously highly valued falls sharply (Carbon Farming Group, 2009). This in turn reduces the total area of dairy, sheep and beef farmland. Some historically unproductive farming is returned to native bush and forest driven by an economic system that rewards such action. Remaining farms adopt artificial solutions to both improve on farm ecosystem services and output. The loss of some farming

results in net losses in overall dairy, sheep and beef output but due to technological improvements, this decline is small in proportion to the land lost to farming.

The clean river and surrounding area encourages people to move away from the city, and cheap energy and advanced communication technology make this a practical option (Karlenzig, 2010). This decreases urban populations, thus reducing urbanisation. Instead of sprawl, there are small, self-sufficient yet interconnected commercial centres.

The role of the Regional Council morphs into that of a quasi-ecological stock exchange. To place proper monetary values on ecosystem services, a range of cap and trade systems would be set up. Monitoring and administering these are be the role of the Regional Council and cap and trade systems with broad scope replace many of the strict legalistic Regional Plans.

Cultural influence remains at a steady level, although many of the goals of those promoting more cultural influence have changed. Rather than fighting for the protection and restoration of land, many cultural groups have raised alarm over using monetary rather than intrinsic values as the primary valuation method for ecosystems.

Scenario Four ***(high energy prices, ecological economics paradigm)***

In this scenario, energy prices are high and ecological economics is the dominant economic paradigm. High energy prices result in urban density instead of urban sprawl, while still placing value on small ecological footprints and sustainability.

Fish stock in the Manawatu River increases due to increased water quality and improvement of habitat. This is because the ecological economics paradigm has switched the focus of the community onto cleaning and restoring the health of the river. Native fish species, such as Whitebait, live healthier and longer lives in water that has fewer pollutants (Ravine,

2007). The habitat of all native species in the river increases, which facilitates healthy living and breeding. As the habitat and fish stock both increase, recreation comes back to the river as well. People are more willing to swim and play in the river, as well as getting back to sustainable, traditional fishing. As the current situation stands, swimming and fishing in certain parts of the river is not safe or healthy.

By focusing on ecological economics, the number of farms do not necessarily decrease or increase, but rather change. There are boundaries set on the natural riparian areas of the river to decrease erosion and sediment buildup. Dairy farms are placed far away from the river to ensure the added nutrients that come from these farms do not make it to the river. This also allows for the natural flood plain to serve its purpose. The flood plains are not disturbed and keep the riparian area healthy and flourishing. By doing this, it also increases the health of riparian species, and species that are naturally found in the Manawatu River.

Significant cultural practices that enhance the social fabric and structure are also linked to the Manawatu River and its sub-catchment regions. Many local iwi have traditional values placed directly parallel to the river and the sustenance that can be harvested from this source (Ravine, 2007). As the river quality increases, these resources become more abundant, adding to the ***mana***# and tradition of the iwi located in the Manawatu region. The river also has impacts on the Regional Council, and how these areas are managed. Within the ecological economic perspective, an importance is placed on sustainability, but the high price of energy means that this will most likely be done without big built infrastructure. The Regional council places a higher value on keeping the river in a healthy state, which will lessen the stress placed on the water treatment plant and other government agencies.

Alternative energy also plays a big role within this scenario. The local waste water

treatment plant is benefiting from both the production its own energy as well as fewer contaminants in the water at the source. Therefore, it does not have to work as hard to clean the river water and can be more usable in its current state. Other alternative energy sources become available and sources such as hydroelectricity are lessened. There is a movement away from fossil fuels and chemical additives. Because the price of fossil fuel energy is so high, the emissions from these sources also lessen, which positively affects other aspects of the local environment.

Discussion

Comparison of key variables in each scenario

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dairy farming	High output, intense grazing right up to water's edge	Medium output	Medium output, lower total area used	Medium output, lowest total area used
Sheep and beef farming	Medium to high	Medium output	Medium output, lower total area used	Low output, lowest total area used
Riparian zones	Minimal	Minimal	Plentiful	Plentiful
Nutrient run-off	High	High	Low	Low
Sediment run-off, Erosion	High	High	Low	Low
Flood protection and risk	Flooding is prevented by large stop banks	Low stop banks, high flood risk	Artificial flood plains, low risk	Natural flood plains, low risk
Fish habitat, fish population	Highly diminished	Destroyed	Plentiful	Plentiful
Forest	Cleared for sheep and beef farming	Cleared for sheep and beef farming	Medium cover	Medium-high cover
Waste water treatment	Low quality	Low quality	High quality	Medium quality
Investment in alternative energy	High	Low	High	Medium
Urban density	Sprawl	Medium	Medium, decentralised	High

Regional council	Over-represented by those who want lenient regulations	Dominated by the interests of energy producers and agricultural industry	Quasi-ecological stock exchange, equal representation	Quasi-ecological stock exchange, equal representation, lower focus on built infrastructure
Culture	Disregarded	Disregarded	Steady, but with concerns for how nature is valued	Easy for Maori traditional way of life to exist
Recreational Value of river	No recreational fishing or swimming	No recreational fishing or swimming	High	High

Figure Two: Inspection of Figure Two quickly makes apparent the key differences between the scenarios. These differences are the intensity and total land use of agricultural industry, the quality of water in the Manawatu River, and its corresponding recreational value and fish habitat. The scenarios also strongly suggest a more desirable future would eventuate when society operates under an ecological economics paradigm. Therefore, overall, we find Scenario 3 to be the most desirable scenario.

As described in our methodology, we determined in each scenario the issues and major risks, key points of uncertainty, major drivers, factors that won't change, and outcome of indicators.

The scenarios demonstrate the issues and major risks as follows: first, under a conventional economics paradigm, the Manawatu River will lose nearly all value as a fish habitat and recreational resource; second, the adoption of an ecological economics framework and high energy costs, each by themselves and especially together, could entail significant reductions in the size of the region's main industry.

In forming and examining the narratives for each of the scenarios, we also determined key uncertainties. First, we noted the response of the agricultural industry to high energy prices. In particular, we were uncertain what land-use patterns (in terms of area covered and intensity) would accompany this response. The high and low combinations of each would likely entail different responses. Secondly, we were uncertain about the effect of high energy prices on the

export market for the region's dairy products. We posit it would be interesting to examine the effect of high energy prices on New Zealand's competitive advantage in the dairy market. Third, we noted the role of finance. Further investigation would be required to determine the kinds of institutions and financial mechanisms required for an ecological economics framework to function effectively in the Manawatu.

The underlying reasoning for each of the scenarios illustrates how an economic paradigm operates as a major driver. An ecological economics paradigm offers the ability for business and government leaders to understand the trade-offs between built, environmental, and financial assets and the four capitals. For example, in the ecological economics scenarios, regional decision makers have used ecological economics tools to value the flood prevention services of highland forests. Farmers and the Horizons Regional Council may agree that it is in fact cheaper to fund purchase of the land on which the forests lie than to build flood protection barriers and pay for flood risk insurance, whereas in the conventional economics scenarios the framework did not exist for decision makers to take such action.

A factor that does not change in each of the scenarios is the dominance of the dairy industry. This presents an opportunity to question whether this is a valid assumption, to ask what would happen if this were no longer to be true, to question why stakeholders think the dairy industry is so dominant. By doing so, we can develop a better understanding of how their region operates.

We determined that useful indicators for high energy prices eventuating would be the cost of petroleum and the level of investment (both internal and external to region) in alternative energy sources. For the prevalence of a conventional or ecological economic paradigm, we determined the quality of the river water and the content of council and business policies to be

good indicators.

Our scenario analysis illustrates the potential to identify key issues and risks, major economic, social and environmental drivers in the region, unchanging factors and indicators in scenarios of conventional and ecological economic paradigms as well as low and high energy costs. Developing such a shared understanding among business and community leaders ought to provide them with the knowledge of which factors they can manipulate to most effectively engineer a desirable future (major issues, risks and opportunities), which to not bother trying to influence (factors that won't change) and factors of which to be wary and to monitor (key uncertainties and indicators of each scenario transpiring).

Future Research

We note that scenario planning offers potential insights that other future planning tools do not. As Peterson et al. conclude, scenario planning is the only useful tool when uncertainty is high and controllability is low (Peterson, 2003). This is indeed the situation the Manawatu region faces. Manawatu leaders cannot predict the region's future over such a long time frame and while they do have some control over the region's economic paradigm, they have little over the global economic paradigm and on energy costs, especially transport.

Forecasting, unless combined with some form of scenario planning, does not account for unprecedented future events (Bradfield et al., 2005). A SWOT analysis (strengths, weaknesses/limitations, opportunities, and threats) may reveal the same risks but we consider it less likely to reveal issues and risks the Manawatu region would face in the distant future. Recommendations for future analysis could include: first, conducting a feasibility study and a (qualitative) cost-benefit analysis of an ecological economics financial decision-making

framework for the region; second, integrating awareness of rising energy costs into local business support networks; and third, investigating and implementing options for low-energy transport. Similar studies have been completed which developed similar outcomes. The City of Portland Peak Oil Task Force, for example, makes the recommendation to "develop mechanisms to keep community decision-makers informed of trends in energy markets". (City of Portland Peak Oil Task Force, 34).

There are also several areas that present potential for further investigation. One we find compelling would be to conduct a study on the quality of councilor decisions when made with the benefit of scenario planning versus without. We posit that it would be informative to develop scenarios using the probabilistic modified trends school of scenario development and compare with the scenarios we have presented. This would involve using models and statistics and setting major changes corresponding to variables in scenarios.

Conclusion

The possibility of future high energy prices and ecological overshoot warrant consideration of alternative economic paradigms. This paper developed four scenarios for variables specific to the Manawatu Catchment, and we have demonstrated that scenario planning can be a useful tool for the Manawatu region to address these future issues. The information gained from this exercises provides a basis from which to develop recommendations to mitigate potential future problems, as well as ideas for future research and analysis.

REFERENCES

Bradfield, R., Wright, G., George B, Cairns, G. Van Der Heijden, K. (2005, May). The origins and evolution of scenario techniques in long range business planning. *Futures 37, 795–812.*

Carbon Farming Group. (2009, May). *Farming Carbon in New Zealand: Info Sheet 14.* Retrieved from Carbonfarming.org: http://www.carbonfarming.org.nz/documents/InfoSheet_14130809_000.pdf

City of Portland Peak Oil Task Force. (2007). Descending the oil peak: navigating the transition from oil and natural gas. *City of Portland Bureau of Planning and Sustainability*. Retrieved from http://www.portlandonline.com/bps/index.cfm?c=42894&a=145732.

Collins, R., McLeod, M., Hedley, M., Donnison, A., Close, M., Hanley, J., Horne, D., Ross, C., Davies-Colley, R., Bahshaw, C., & Matthews, L. (June, 2007). Best management practices to mitigate faecal contamination by livestock of New Zealand waters. *New Zealand Journal of Agricultural Research 50(2)*. 267-278. Retrieved from http://web.ebscohost.com.proxy.lib.pdx.edu/ehost/pdfviewer/pdfviewer?sid=dac5865b-eb23-4e21-bd3a-6bbcde9eea3c%40sessionmgr113&vid=2&hid=112

Costanza, R. (2006). Thinking broadly about costs and benefits in ecological management. *Integrated Environmental Assessment and Management 2(2),* 166-173.

Costanza, R., Cumberland, J., Daly,H., Goodland, & R., Norgaard, R. (2008). An Introduction to Ecological Economics. *The Encyclopedia of Earth*. Retrieved from http://www.eoearth.org/article/An_Introduction_to_Ecological_Economics:_Chapter_3#gen1.

Daly, H.E. (2002). Allocation, Distribution and Scale: Towards an economics that is efficient, just, and sustainable. *Ecological Economics 6(3)*, 185-193.

Fuller, Ian. (2008). Geomorphic impacts of a 100-year flood: Kiwitea Stream, Manawatu Catchment, New Zealand. *Geomorphology 98(1-2),* 84-95. Retrieved from http://www.sciencedirect.com.proxy.lib.pdx.edu/science/article/pii/S0169555X07002085.

Global Footprint Network. (2011). September 27th is earth overshoot day. Retrieved from http://www.footprintnetwork.org/en/index.php/GFN/page/earth_overshoot_day/.

Goodland, Robert. (1992). The case that the world has reached limits: more precisely that throughput growth in the global economy cannot be sustained. *Population and Environment* 13(3):167-182. Retrieved from http://www.springerlink.com/content/l46w3x8145672617/

Handley, J. (January 6th, 2012). Personal Communication.

Hanlon, P., & McCartney, G. (July, 2008). Peak oil – will it be public health's greatest challenge? *Public Health 122(7),* 647-652.

Hughey, K. F., Kerr, G. N., & Cullen, R. (2011). Perceptions of freshwater and its management in New Zealand: 2000-2010. *Royal Forest and Bird Protection Society Annual Conference 2011.* Wellington.

Karlenzig, W. (2010). *The Death of Sprawl: Designing Urban Resilience for the Twenty-First-Century Resource and Climate Crises.* Santa Rosa: Post Carbon Institute.

Lehtonen, M. (2004). The environmental–social interface of sustainable development: capabilities, social capital, institutions. *Ecological Economics (49),* 199–214.

Manawatu Leaders' Accord. (2010). Action Plan. Retrieved from http://www.ifs.org.nz/assets/Uploads/HRC-Accord-Sumary-WEB.pdf.

Martensen, Chris. (2011). *The Crash Course: The Unsustainable Future of Our Economy, Energy, and Environment.* Hoboken, NJ:John Wiley & Sons.

Meadows, D., Renders, J., and Meadows, D. (2004). *Limits to Growth: A Thirty-Year Update.* White River Junction, VT: Chelsea Green.

McQueen, S. (January 6th, 2012). Personal Communication.

Peterson, G.D., Cumming, G.S., Carpenter, S.R., (2003). Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17, 358–366.

Ramos-Martin, J. (2003). Empiricism in ecological economics: a perspective from complex systems theory. *Ecological Economics* 46, 387-398. Retrieved from http://personales.ya.com/jesusramos/pdf/jramos_ecol_econ.pdf

Raskin, P., Monks, F., Ribeiro, T., van Vuren, D., and Zurek, M. (2005). Global scenarios in historical perspective. *Millennium Ecosystem Assessment*. Island Press, Washington, DC. Retrieved from www.millenniumassessment.org/documents/document.326. aspx.pdf.

Ravine, D. (2007). Manawatu River Estuary RAMSAR Management Plan. *Manawatu Estuary Trust.* Foxton, New Zealand. Retrieved from http://www.horizons.govt.nz/assets/horizons/Images/Council/Regional%20Council/Cncl%2010%20Feb%2009/09-01%20Annex%20A%20Manawatu%20Estuary%20Management%20Plan.pdf

Scenarios Working Group. (2006). Scenarios assessment. *Millennium Ecosystem Assessment*.

Retrieved from http://www.maweb.org/en/Scenarios.aspx.

Sustainable Pathways. (2010). Mediated modelling. Retrieved from http://www.sustainablepathways.org.nz/about-the-project/mediated-modelling/.

Vemuri, A. & Costanza, R. (2006). The role of human, social, built, and natural capital in explaining life satisfaction at the country level: toward a national well-being index (NWI). *Ecological Economics 58(1)*, 119-133.

Wackernagel, M., Onisto, L., Bello, P., Linares, A.C., Falfa´n, I.S.L., Garcia, J.M., Guerrero, A.I.S., and Guerrero, M.G.S. (1999). National natural capital accounting with the ecological footprint concept. *Ecological Economics 29,* 375–390.