Application of economic models within the Healthy Rivers Project

Graeme Doole (3 February 2015)

Different limits and policies proposed by the Collaborative Stakeholder Group (CSG) in the context of the Healthy Rivers Project (HRP) will have diverse impacts on economic and environmental outcomes throughout the Waikato region. A central contribution of the Technical Leaders Group to the HRP process is the development and use of economic models that will estimate the size and distribution of costs associated with different limits and policies, at the farm, catchment, and regional scales. These frameworks draw together information from a broad range of other models, too. The goal of this document is to outline the key reasons why certain models have been selected for use within the HRP process. It is important to recognise that developing economic models requires careful balancing of the benefits of increased model complexity with the cost of this activity. Accordingly, while there may be alternative, perhaps more comprehensive, means to study a given aspect of a problem, these are often not appropriate because of budget, data, and time constraints.

A standard economic framework will be used to assess how land use, land management, and industrial and municipal sources might have to change across the Waikato River catchment, in order for environmental limits to be satisfied. The model is a tool by which we can explore different scenarios, comparing the impacts of each limit and policy, while integrating our best information regarding the cost of reducing contaminant loads from these sources and the flow of water through the catchment (for example, through accounting for attenuation and lags). It is not a simple model consisting of a small number of equations; rather, it is considered more important to incorporate the best information we have regarding these processes.

A key input into the catchment model is how much of each of the contaminants is currently arising from different sources. Overseer software is used to estimate how much nitrogen and phosphorus is currently being lost from different agricultural enterprises in the region. Overseer software has been broadly validated in New Zealand, is accessible to industry experts, and is developed specifically for conditions in this country. Additionally, alternative tools are less accessible, lack user-friendly interfaces, and/or have not been broadly calibrated for New Zealand agricultural systems and soils. Current levels of *E. coli* loss from farm land are estimated using the SPAtially Referenced Regressions on Watershed attributes (SPARROW) model. This model has been broadly applied in the study region and around

New Zealand, appears to be the only predictive model for *E. coli* in this nation that can be calibrated and deals with decay, and provides for consistency between losses on land and at monitoring points. The amount of sediment lost from agricultural land in the region is estimated using SedNetNZ for the Waipa catchment—a primary source of sediment for the Waikato River—and for the remaining area, an empirical equation that relates the characteristics of a certain parcel of land to total sediment loss. SedNetNZ is the only sediment model in New Zealand that deals explicitly with streambank erosion, a major source in the Waipa catchment. Moreover, it has already been employed in this catchment, whereas the leading alternative—the Catchment Land Use for Environmental Sustainability (CLUES) framework—would need substantial updating before being applied here. For the remaining area of the catchment, the empirical-equation approach is employed due to it being cost-effective and having around 97% predictive accuracy in previous applications.

Another key input into the catchment model is how these current levels of contaminant loss are impacted by the use of specific management actions (mitigations). The most-suitable mitigation actions for each sector are determined through discussion with industry, interaction with scientists, literature review, and typical practice. How the use of these mitigations impact nitrogen loss is determined through the use of Overseer software. In comparison, the impact of mitigations on the loss of phosphorus, *E. coli*, and sediment are drawn from an extensive literature review and discussions with industry and key scientists. A key motivation for doing so is that there is a distinct lack of accessible software that estimates these levels of effectiveness within the study region.

The cost of mitigation activity is an important consideration in the model. The cost of reducing nitrogen loss on pastoral farms was evaluated using FARMAX, the leading software product in New Zealand utilised for evaluating alternative grazing systems. It has been extensively applied and validated under New Zealand conditions and is broadly used for extension and research. In comparison, the cost of reducing nitrogen loss on horticulture farms was established using gross-margin analysis, given that individual rotations are considered independent of others. The cost of mitigations for phosphorus, *E. coli*, and sediment were drawn from an extensive literature review and discussions with industry and key scientists. This is motivated by the fact that many mitigations, such as riparian fencing and wetland formation, do not affect farm management under typical circumstances.

The loads of contaminant lost from all sources are measured as weights (e.g. kilograms of nitrogen per ha). However, limits within the water are defined as concentrations (e.g. grams of nitrogen per cubic metre). A version of the CLUES model is used to convert the weights arising in each subcatchment to concentrations, while accounting for attenuation, decay, groundwater lags, and the flow of water between linked water ways. This model will be able to be embedded within the economic model, such that these important processes are considered within each model run. It is possible to develop more-comprehensive models of these processes, but a lack of information and the benefits of integrating the hydrological and economic models motivate the selected approach.

The catchment-level economic model focuses on the direct cost of mitigation to farms, industrial, and municipal sources of contaminants. Nevertheless, profits in these sectors also provides key regional benefits, in that they bring funds into a region that will lead to new, subsequent spending in other industries. An input-output model will be used to estimate the regional impacts of alternative limits and policies. They describe the complex interdependency between different sectors of a regional economy, dealing with numerous flow-on relationships. These are the most widely-applied method for doing so, and are one of the most popular economic methods applied globally because of their clarity and descriptive capacity. Additionally, this decision is partially justified by the existence of the Waikato Region Multi-Regional Input-Output Table, which allows us to benefit in the HRP process from concepts learned during its previous application.

More complex regional models exist, such as computable general equilibrium models and spatial decision support systems. However, it is difficult to effectively link these to the catchment-level model that is being constructed; they are costly to develop, in general; they are more comprehensive, but this is not necessarily based on quality data; and their complexity/size can impair their effective application and the communication of results to the CSG.

The models to be used within the HRP process at the farm, catchment, and regional levels are consistent with standard practice, both nationally and globally. Notwithstanding resource constraints and the inherent limitations of any models, the selected frameworks are deemed to provide an appropriate foundation for the economic analysis of alternative limits and policies.