Rural Water Infrastructure and Climate Change

When planning for any changes due to climate change the impact on current infrastructure can be overlooked. This is a brief summary of some of the potential impacts on irrigation and rural stock water supply schemes to consider in the future.

The type of schemes for both irrigation and stock water supply across New Zealand vary widely but they do have some common features.

- Water can be sourced from springs, run of river, run-off interception or pumped from underground; off-farm and on-farm storage can be involved; and distribution can be pumped, gravity fed, and via piped or open-channel networks.
- Irrigation schemes vary in their storage capacity, available application rate, and irrigation method (pivot, spray, and flood).

A study, undertaken in 2010, considered the likely impact on rural water supply systems of climate change projections indicating:

- A fairly uniform pattern of warming across New Zealand, with an average increase of about 0.9°C by 2040 and 2°C by 2090.
- Average annual rainfalls are expected to increase in most areas, with the exception of the far north of the North Island and the east coast. There are some seasonal changes, with reduced summer rainfall in the upper catchments of the Southern Alps and reduced spring rainfall in Northland.
- Extreme heavy rainfall is projected to increase in magnitude and/or frequency across the entire country.
- Similarly, the frequency of drought events is projected to increase nationwide.
- The occurrence of days with temperature in excess of 25°C is projected to increase, with the greatest increase in the north and the least increase in the south.
- Warmer water temperatures could lead to increased risk of new invasive organisms in source streams, reservoirs or distribution races.
- Warmer water temperatures and increased carbon dioxide levels could lead to increased aquatic plant productivity in source streams, with increasingly variable pH and dissolved oxygen regimes and increased algae biomass

The possible effect of these climate change projections on rural water schemes is dependant of scheme characteristics and location, Table 1.

Table 1: Likely Effects (from 'Climate change impacts on rural water infrastructure')

Climate Change	Effect
Increase in rainfall	Higher rainfall and average river and stream flows will provide benefits for in stream ecology and at times reduce pressure on the water resource.
Decrease in rainfall	Lower stream flows and potentially more rigorous residual flow requirements for source streams. Increased pressure on water resources.
Changing rainfall patterns	Seasonal variations may lead to increased pressure on water resources at times. Less water (or more water) available for storage at different times of the year.
Less snow fall and shorter snow melt season	Lower flows in spring and summer may lead to increased pressure on water resources at times.
Increased risk of drought	Increased frequency and durations of very low river and stream flows may at times increase pressure on water resources and stream ecology. Minimum/environmental flow could be reached more often and abstraction for schemes reduced or halted for periods of time.
Increase in average temperature; **Increase in very hot days**	Increased temperatures in source rivers and streams with potentially adverse effects on stream ecology. Increased temperatures in storages contributing to higher risk of nuisance algae blooms. Increased risk of weeds, pest fish or other unwanted organisms. May contribute to increased variability on DO and pH regimes. Potentially higher maintenance costs for scheme infrastructure due to clogging of screens and increased corrosion. May also increase the risk of invasion by other unwanted organisms (but possibly reduced risk associated with didymo). Increase in peak demand for stock watering.
Increased frequency of heavy rain events	Increased sediment and nutrient inputs to storages contributing to higher risk of nuisance algae blooms or weeds. Increased sediment yields and erosion in scheme catchments. Potentially increased maintenance costs for scheme infrastructure. An increase in the frequency of large flood may lead to re-evaluation of design parameters for storage lakes. Potential effects on pipeline stability.
Increased summer water deficit for un-irrigated land	Increased water demand for land currently in schemes.
Increased windiness	Coupled with an increase in temperature this could lead to an increase in erosion of topsoil.
Sea level rise	Bores near the coast will have an increased risk of saltwater intrusion.
Decrease in groundwater levels	Increase in pumping head.

The economic impacts of these effects on irrigation schemes is likely to vary, depending on region, the type of infrastructure and existing and potential land uses within the scheme. The case studies demonstrate a range of impacts and varying vulnerabilities.

Increased frequency and intensity of high rainfall events is likely to require reconsideration and upgrade of culvert and storage reservoir spillway capacity to comply with the new national dam safety regulations. Schemes with screened intakes are likely to require increase in capacity and installation of cleaning mechanisms to cope with increased weed growth induced by warmer water temperatures.

Increased wear on pumps, gates and valves, is likely through increased sediment load in source water. On canal-based schemes the significant issues were identified to be increased operation costs from more sediment and weed accumulation removal

The issue of water demand for rural stock water schemes needs to be reassessed in light of increased peak demands with time. Greater frequency of drought, higher temperatures and more very hot days are

expected to increase stock water intake. Pumping capacity and pipeline sizing may need to be reviewed, Table 2.

Table 2: Possible response to the impact of climate change

Climate Change	Impact	Response
Increase in drought	Reduced yields from existing storages Increased peak water demand Reduced pipe lifespan due to cracking from drought shrink	Reduced production or requirement for increased storage Increase in pipe repairs
Increase in flood risk	Increased flood damages to key infrastructure intakes, pipeline crossings etc.	Remediation measures to reduce flood damage Increase in repairs Increase in dam spillway capacity increased emergency planning and compliance costs
Increase in rainfall	Increased peak runoff	Increased culvert sizes Identification of secondary flow paths
Changes in wind speed and direction	Less stability in natural vegetation, more wind throw	Contingency planning and changes to emergency management procedures
Increase in air temperature	Change sin air temperature Changes in frost patterns	Possible change in land use Increase or decrease in frost protection mechanisms
Increase in stream temperature	Increase in weed growth Increased clogging of rural water infrastructure screen intakes Increased corrosion Smothering of river beds reducing infiltration gallery intake performance	Redesign intakes Increased maintenance
Changing rainfall pattern	Increased river flows Decreased river flows Aggradation of stream beds Degradation of stream beds Demand pattern changes Seasonal variations may lead to increased pressure on water resources	Additional water take maintenance Additional river training Additional dredging River works to maintain intakes Altered take regime
Sea-level rise	Impacts on hydraulic performance of drainage systems and drainage pumps	More pumps More maintenance Less production Remediation measures
Groundwater yields	Lowering or raising of groundwater levels Potential salt water intrusion	Change or adaptation of pumping systems Need for alternative sources of water or shift of bore location
Weed and algal growth	Fish screen blockage Canal cleaning Irrigator blockage Damage and clogging of service lines and spray heads	New technology for alternative screening Additional screen cleaning and intake maintenance Increase in operation and maintenance costs
Consent limit abstraction ability	Increased flow Decreased flow Altered sedimentation pattern	Additional take Decreased take Maintenance changes
Likely ability to abstract water	Intake blockage Intake damage Altered river morphology Fish screen utilisation	Increase in maintenance or automation of screen cleaning Increase in repairs or alternative intake technologies Additional river training Additional maintenance

To maintain future productivity farmer focus should be on farm practices and better utilisation of local water and soil resources.

On farm adaptations and considerations include:

- Increased on farm storage – small or large scale
- Implementation of practices that improve water use efficiency and reduce wastage
- Improved soil management – topsoil retention, organic matter content, cultivation and fallowing practices that increase soil moisture retention and slow run-off

- Implementing farm system changes – pasture species e.g. lucerne for dryland, stock policy, type and number
- Development of wetlands for storage and retention of water. This will also impact on water quality
- Adjust irrigation application rates to take into account climate change effects on rainfall and evapotranspiration.

At scheme level, considerations include:

- Assess and review current scheme performance and integrity against future climate conditions, including codes of practice and operational documents;
- Develop a "plan of action" to future proof the schemes against the potential physical changes likely to be caused by climate change impacts and effects. Build in resilience at scheme level by upgrading, if required, as part of on-going management;
- Review condition of all off-farm assets to ensure fitness for purpose for future conditions

Further Information

The full technical report, *Impacts of climate change on rural water infrastructure* MAF Technical Paper No: 2011/20 can be downloaded from www.climatecloud.co.nz/CloudLibrary/2011-20-cc-impacts-rural-water-infrastructure.pdf

In addition, readers may also be interested in *Projected Effects of Climate Change on Water Supply Reliability in Mid-Canterbury*. MAF Technical Paper No: 2011/12. Prepared for the Ministry of Agriculture and Forestry. March 2011which can be downloaded from http://www.mpi.govt.nz/news-resources/publications.aspx .