Abstract

The alpine areas of Australia contain ski resorts which are mini-urban areas nestled within sensitive National Park ecosystems. There are numerous examples of WSUD to manage surface runoff impacts in Australia’s ski resorts. To date, however, none of these WSUD projects has intervened in the water cycle to decrease demand on potable water supplies. In the Perisher Range Resorts of NSW, the situation is markedly different where potable water supplies are not sustainable in their current form to meet future growth without action being taken. WSUD has the potential to meet this additional demand while at the same time reducing peak flow and water quality impacts of stormwater runoff on alpine ecosystems. The Department of Environment & Climate Change will expand a trial of roof water harvesting in this cold climate to an active pilot site retrofitting an existing ski lodge where it will be plumbed in for all uses. Modelling shows the system will save 60-98% of mains water over a snow season. With so many environmental, economic and social constraints to manage in the delivery of secure potable water supplies in the Perisher Range resorts, WSUD – specifically roof water harvesting - offers an opportunity to facilitate truly sustainable development.

Introduction

While alpine areas make up only a minute fraction of Australia’s mainland, they contain ski resorts which are mini urban areas nestled within sensitive National Park protected ecosystems. Victoria has five ski resorts, while New South Wales has four.

Even before the advent of Stormwater Management Plans in NSW and Victoria in the late 1990s and early 2000s, the principles of Water Sensitive Urban Design (WSUD) were espoused and implemented in several subdivision developments in Thredbo Alpine Village, Kosciuszko National Park.

Since then, the planning and design of WSUD in Australia’s ski resorts has been formalised in an Alpine Environments WSUD Guideline (WBM and STORM_CONSULTING, 2005) and many new examples of WSUD have been implemented. While the Alpine WSUD Guidelines were being developed for Victoria’s skifields, the Victorian Government also funded demonstration WSUD projects in each of Victoria’s five ski resorts. Over the border in New South Wales, Kosciuszko Thredbo continues to implement excellent examples of WSUD in car parks and new developments across Thredbo Alpine Village.

However, to date none of these WSUD projects has intervened in the water cycle to decrease the demand on potable water supplies.

In Perisher Valley the situation is markedly different. Somewhat paradoxically in an area of high rainfall and abundant wetland ecosystems, Perisher Valley has limited access to low cost water supplies for domestic consumption. Newly approved developments in the valley will potentially increase the demand on potable water by up to 20%. There is a high economic cost and some environmental cost to access existing water storages, part of the Snowy Mountains Hydro Electric Scheme, in order to provide sufficient water for long term domestic
consumption. DECC is searching for alternative solutions to both minimise demand and capture water from sources other than the mountain streams in order to defer or negate the expensive capital works options.

WSUD has the potential to meet this additional demand while at the same time reducing peak demand and water quality impacts of stormwater runoff on stream and wetland ecosystems.

**The context of water supplies in the ski resorts**

The resorts have atypical patterns of water use. With the exception of Thredbo Alpine Village, they remain nearly empty of people for much of the year and their populations swell into the thousands in the snow season. Nearly all mains water consumption is for internal domestic and commercial (food preparation) uses. There is virtually no garden watering or car washing, and there are no water hungry uses such as commercial laundries, etc.

Modelling of the water supplies for Perisher Valley, Smiggin Holes and Guthega (also known as the Perisher Range Resorts and which together with Mt Blue Cow comprise the resort of Perisher Blue) has shown that early to mid-winter and late summer are times of potential water shortage in each of these resort villages (Gippel and Doeg, 2002).

The water supplies for the Perisher Range Resorts are all similar with a weir offtake located upstream of the ski resort on a small mountain stream. The weirs feed reservoirs by gravity or pumping. Perisher Valley has the largest storage reservoirs totalling approximately 8 ML only. The provision of significant additional water storage (i.e. a dam) in the Perisher Range Resorts to better meet demand would not be palatable given the politically and socially charged notion of destroying pristine alpine ecosystems in the Kosciuszko National Park to accommodate such infrastructure development.

The only treatment provided to the high water quality mountain stream water is ultraviolet disinfection. Water supplied to ski lodges is metered and each lodge maintains a place-based Environmental Management System where water conservation targets are set and reported on.

The NSW Independent Pricing and Regulatory Tribunal has set water supply costs in the Perisher Range Resorts at $3.50/KL from 1 July 2006 (CPI adjusted annually) which is substantially higher than in most parts of Australia, and which provides a considerable incentive to avert mains water demand. The Department of Environment & Climate Change has established considerable demand reduction strategies including:

- Leakage reduction program (monitoring, mains replacement)
- Demand Management including installation of water saving devices on all new development (Development Control Policies), installation of water metering, and water pricing policy based on a user pays system
- Education Programs – ‘Waterwise Resorts’ Campaign
- Environmental Management System for the Perisher Range Resorts
- Roof Water Harvesting Trials
- Effluent Reuse at STP
- Drought Management Strategy
- Operations review e.g. mains flushing program modification
WSUD to reduce mains water demand in ski resorts

Previous roof water harvesting trial

The Department of Environment & Climate Change has trialled roof water harvesting in a ski resort cold climate over a three year period 2005-2007. The trial was conducted on the Department of Environment & Climate Change’s operations building in Perisher Valley. Water was harvested from both a modified roof gutter to accommodate snow loadings, and a ground trench collection system (Brown et al 2005). Water from both collection systems entered a sump pit where it was pumped out and metered (Figure 1).

![Diagram of roof water harvesting trial](image)

**Figure 1.** Location and configuration of the roof water harvesting trial on the DECC operations building at Perisher Valley - 1,720m ASL (Brown et al, 2005).

It is important to note that a north-northwest facing roof section was chosen. In the southern hemisphere, northerly aspects receive the greatest solar exposure and thus the greatest snowmelt. This becomes important when extrapolating the results to entire buildings which will only have partial exposure to the north.

The roof gutter component of the trial incorporated a proprietary gutter developed for cold climates with the trade name of Priority Alpine (Figures 2 and 3). The gutter is able to collect water and convey it in a downpipe to a collection sump (Figure 4). One design feature of this gutter is that when larger masses of snow/ice slide down the roof, the gutter flips over to allow this material to fall to the ground, thus protecting the structural integrity of the roof and
gutter. Only the precipitation that enters the downpipe was collected and measured in this component of the trial.

Figure 2. Roof gutter collection system

Figure 3. Priority Alpine roof gutter fitted to existing roof

Figure 4. Downpipe conveying flow into collection sump

The ground collection system was located under a 'bullnose' roof where precipitation deposited directly into a stone-filled collection trench and was then transferred into the collection sump (Figures 5, 6 and 7).

Figure 5. Ground collection component of trial showing dual collection sump on LHS

Figure 6. View inside one of the collection sumps showing pumping arrangement

Figure 7. The trial in operation during winter 2005

The results were encouraging with both collection systems in the trial averaging water harvesting rates of about 4.7 L/m²/d in winter, and 2.7 L/m²/d in summer. Analysis of water quality also indicated that with no treatment, the collected water complied with Australian Drinking Water Guideline requirements (Brown et al 2005).

Extrapolation of the volumes showed that this harvested water had the potential to supply up to 20% of the demand of a ski lodge – sufficient to supply water for toilet flushing, and sufficient to avert the amount of mains water needed to accommodate the approved resort expansion.

Ski lodge retrofit pilot project

Satisfied that the initial trial provided a feasible and plausible alternative to water storage augmentation, the Department of Environment & Climate Change has commissioned a new trial, this time a pilot project on a ski lodge.
An exhaustive analysis of ski lodges identified the CSIRO lodge (Figures 8 & 9) in Perisher Valley as having an ideal set of conditions that would facilitate the trial, e.g. northerly aspect, gently sloping land with few constraints for tank placement, level site access, enthusiastic lodge managers and members. One member is a plumber who knows the hydraulics of the lodge intimately (STORM CONSULTING 2006), is keen and knowledgeable on reuse systems.

The trial will be configured with a roof gutter collection system feeding an underground tank (designed to withstand snow loadings). A pump will supply water for all internal uses into the lodge and a solenoid operated by a float switch in the tank will switch the water supply over to mains water when the tank is nearly empty.

A water balance model for the CSIRO lodge trial was created with the following assumptions:

- maximum population of lodge: 18
- roof area feeding tank (northerly aspect only): 110m²
- potential maximum demand during winter season = 2,500L/day
- occupancy rate of the lodge is:
  - June to mid July - 20%  
  - Mid July to mid September – 100%  
  - Mid September to end September – 25%  
- all precipitation between 1 October to 31 May is collected in a tank  
- no demand from October to June  
- initial loss: 1mm.

Local precipitation data from Perisher Valley BOM station #71072 was used in this analysis. Long term climatic averages from Perisher Valley indicated average annual precipitation for the following:

- 10th percentile (dry) – 1249mm/yr  
- Median – 1770mm/yr  
- 90th percentile (wet) – 2435mm/yr

The demand from the ski lodge during the winter season was calculated to be 188kL over 122 days.
Table 1 shows the volume of water harvested for the CSIRO roof trial for the non-winter seasons based in dry, median and wet years in Perisher Valley. These volumes are available for use at the commencement of the snow season.

Table 1: Modelled maximum volume of water harvested for the CSIRO roof trial for the non-winter seasons (Oct-May) based on selected dry, median and wet years in Perisher Valley.

<table>
<thead>
<tr>
<th>Model Run (Year)</th>
<th>10&lt;sup&gt;th&lt;/sup&gt; percentile (dry year)</th>
<th>Median</th>
<th>90&lt;sup&gt;th&lt;/sup&gt; percentile (wet year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984 – 1985</td>
<td>1300mm</td>
<td>1812mm</td>
<td>2595mm</td>
</tr>
<tr>
<td>1985 – 1986</td>
<td>568mm</td>
<td>887mm</td>
<td>1288mm</td>
</tr>
<tr>
<td>1995 – 1996</td>
<td>49kL</td>
<td>81kL</td>
<td>121kL</td>
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Based on the initial roof trial at the DECC operations building, water collected during the snow season (June to September) was calculated to be 4.7L/m²/day. Therefore additional water harvested during the snow season is calculated to be 63kL. Assuming that the tank is full (total rainfall volume collected during non-winter seasons) at the beginning of the snow season, the following yields can be achieved for the snow season only (Table 2).

Table 2: Modelled snow season water yields from the CSIRO roof trial with varying tanks sizes.

<table>
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<tr>
<th>Tank volume</th>
<th>10&lt;sup&gt;th&lt;/sup&gt; percentile (dry year)</th>
<th>Median</th>
<th>90&lt;sup&gt;th&lt;/sup&gt; percentile (wet year)</th>
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</thead>
<tbody>
<tr>
<td>49kL</td>
<td>60%</td>
<td>77%</td>
<td>98%</td>
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Therefore, with the installation of a 50kL tank, the roof water collection system will save almost 60% of mains water demand from the lodge. If the size of the tank is increased, the yield is also likely to increase dependent on rainfall during the non-snow season. In a wet year with a 120kL tank in place, approximately 98% of mains water demand that would otherwise be supplied by mains water, will be saved. The reason that such high yields are achieved is because the tanks are full at the commencement of the snow season when demand occurs.

**Conclusions**

Monitoring of the CSIRO ski lodge pilot trial will be undertaken to validate the water balance modeling. If the assumptions are correct, the roof water harvesting system will supply between 60-98% of the ski lodge’s water demand over the snow season when the lodge is populated.

Because there is no one lodge like another in size, bed numbers and aspect, it is difficult to extrapolate the results to the broader ski resort. However, given only 20% additional water supply needs to be found in Perisher Valley to accommodate new development, the analysis undertaken provides strong encouragement that WSUD - specifically roof harvesting - has the potential to solve the security of supply issues in the Perisher Range Ski Resorts.
At a minimum, new developments should be mandated to incorporate roof water harvesting. Existing ski lodges could be prioritised for retrofit according to their ease of installation and suitability of aspect, etc.

With so many environmental, economic and social constraints to manage in the delivery of secure water supplies in the Perisher Range ski resorts, WSUD offers a real opportunity to facilitate truly sustainable development.

References


