Public investment in waterway management in Victoria, Australia

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Abstract

River restoration activities in Victoria can be traced back to the very beginning of European settlement. In their formal capacity, such activities can be traced back to the 1950s and beyond. This paper presents a review of restoration activities that have been undertaken between 1950 and 1987 in an attempt to bring some perspective on the distribution of investment. The investigations focused primarily on the distribution of investment and the key drivers of that investment: socio-political and geo-physical. The paper reviews a range of drivers for investment in waterway management throughout Victoria and provides some further discussion into what may be some of the future drivers for investment.

Keywords

Waterway management, GIS, population, geo-physical drivers, socio-political drivers

Introduction

To the experienced waterway manager, a review of the spatial distribution of waterway management activities throughout Victoria between 1950 and 1987 would be considered to be relatively straightforward. The density of activities would appear to correlate to a combination of both occurrence of issue and population density. However, what is the variation in these two drivers? When do works shift from being dominated by population to physical geographical drivers? And can such a methodology be utilised to justify some of the extreme expenditure placed on "icon rivers" such as the Yarra running through Melbourne, Victoria or the Snowy River in East Gippsland? The concept indicates that as the physical drivers become less important the population becomes the dominant driver. Conversely, where there is reduced population, the physical drivers are the dominant factors that cause issues to be funded. The concept has been illustrated in Figure 1.

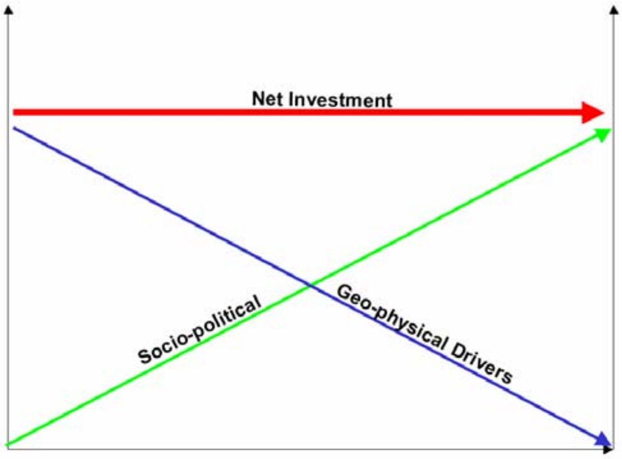

Figure 1. Conceptual relationship between investment, socio-political drivers and geo-physical drivers

In areas such as health and telecommunication, the question of whether to fund a small community exchange or clinic must be weighed up against other competing agendas. Not only do the decision makers have to consider the complex mesh of factors within the actual project, but consideration must also be given to the other projects and the range of complexities that they bring to the decision making process. These decisions are not dissimilar to those of the waterway management authorities who are regularly faced with a range of issues to address with limited data or processes to assist with the decision making process. Furthermore, under some circumstances there are community advocates who will support "pet" issues to the agencies and in the presence of no better data or processes, it is often more obvious to "grease the squeaky wheel", than attempt to gather the data and then to process that data into a transparent and scientifically defensible range of projects. The primary objective of the research presented in this paper was to determine if the pattern of waterway management activities aligns with existing theories regarding public investment.

Hypothesis - Waterway management activities are consistent with conventional public investment theory in that socio-political and geo-physical characteristics are the dominant drivers to investment in waterway management in Victoria.

Methods

In order to test the hypothesis, over 1600 historic waterway management works were identified from a single resource relating to waterway management in regional Victoria (Department of Water Resources 1989). No activities undertaken by the Melbourne Metropolitan Board of Works were considered as part of this investigation. It is worthy to note that the data collected by the Rural Water Corporation (RWC) states that: *"Deficiencies in the data are largely due to omissions and inconsistencies in recording information, particularly in the case of early works. Management works locations, property name, stream name, or worse still the name of the landholder at the time. In these cases, works were not recorded on the maps presented here. Similarly, illegal works have not been recorded. These works rarely appear on file and are generally only reported to those persons downstream who are adversely affected. Illegal installation of poorly designed stream crossings are particularly significant as they can dam flows, alter flow patterns and cause bank erosion. This can have repercussions for downstream users and in-stream flora and fauna."*

Each site of waterway restoration activities was attributed with the information represented in the maps in the aforementioned document. The attributed data included the number of bed and bank stabilisation works pre-1975 and post-1975, and the number of stream clearing works pre-1975 and post-1975. The following definitions for the two classifications of works are quoted in Table 1.

Table 1. Classification of activities

Type of Activity	Definition
Bed and bank stabilisation works	Works aimed at stabilising erosion through structured bank protection works and revegetation
Stream clearing works	Removal of obstructions, snags and sediment dredging

The geographical drivers were also attributed to each of the sites where works had been recorded. The two geographical drivers considered to be critical to the prominence of a waterway issue are flow rate and gradient. Valley gradient was determined by extending a linear feature upstream and downstream along the valley with upstream and downstream elevation determined. The linear features ranged from between 1.6km and 7.7km, with a mean length of 3.5km. The gradient was determined by attributing the linear feature with the elevation at the extents of the line based on the nine second digital elevation model (DEM) for Victoria. The gradient was calculated by subtracting the upstream elevation from the downstream elevation and dividing the difference in elevation by the length of the linear feature. Valley gradient was selected in preference over channel gradient as this was considered to be a more appropriate scale given the waterway plan-form alignments and the elevation data. Flow rate was not able to be determined for each works site within the timeframes of the project. As such a suitable surrogate was assessed. Two options were considered: catchment area and elevation. Elevation data based on the nine-second digital elevation model for Victoria was utilised.

Human population was obtained from Census data for the two timeframes relevant to this investigation. The timeframes were from 1950 to 1975 and 1975 to 1987. The start date for the analysis correlates to the beginning of the analysis in the Department of Water Resources Handbook, which is understood to relate to the time when records began to be kept with regard to waterway management activities. The Census data from 1961 was utilised to represent the first stage and the 1981 Census data used to represent the second phase of the investigation.

The 1961 data were manually entered for 2170 localities throughout Victoria. To ensure that the population data were relevant to the river activities data, the metropolitan area was excluded from these data sets.

Furthermore, population data were aggregated where there was a primary locality and a separate population figure for the surrounding area. The 1981 data were utilised to represent the second timeframe. These data were provided by the Department of Sustainability and Environment and contained 453 locality references.

The Census data for the two timeframes were geocoded within the GIS to spatially project the population data. The geocoding process involved an automated process for the majority of the localities. However, under circumstances whereby there was variation in the spelling, or an absence of a locality, manual matching and spatial projection of a population was required. The geocoding process for the 1961 dataset resulted in the production of 1483 spatially projected data points from 2170 data items extracted from the Census data. The 1981 data set resulted in 340 spatially projected data points from an original data set of 457, of which 57 did not have populations recorded in the 1981 data set and 55 relation to non-specific areas such as local government areas. Ten buffer polygons were established from factors of the population for each population centre. The radius of each of the buffer polygons related to the population (Table 2). Scores were attributed to each of the buffer polygons. The scoring was utilised to attribute works sites with a score that reflects the influence of local population centres.

Table 2. Population centre buffers

Buffer Number	Buffer Radius in metres	Buffer Score	Buffer Number	Buffer Radius in metres	Buffer Score
1	0.2x population	10	6	2.3x population	5
2	0.5x population	9	7	2.6x population	4
3	1x population	8	8	3x population	3
4	1.5x population	7	9	3.5x population	2
5	2x population	6	10	4x population	1

Some of the population centres were excluded from this process as they did not have any population records for the timeframes of interest to the analysis. Some of the reasons why there are more population centres in the 1961 data set as opposed to the 1981 data set may be explained by the method of collection and storage of this information, or may be due to decline in regional population bases (Department of Infrastructure 2002a & 2002b). This aspect of the data was not thoroughly investigated due to complications with the original data and lack of guiding information provided, particularly for the 1981 data set. In order to assess the correlation between stream management works and population, each of the stream management works sites was attributed with a population score. The population score was utilised to develop a graph between population and number of stream management works and geo-physical drivers.

Results and discussion

Attributed with the population scores from each of the buffer population centres and drawing upon the physical drivers including gradient and elevation, Figure 2 and Figure 3 represent the data obtained. An initial review of the data processed did not provide any clear relationships. Of particular note is a lack of any significant correlation between activity and geo-physical drivers for either of the two timeframes that were reviewed.

Population data

The information attained to analyse population distribution, although sourced from the same original source, indicate variation between the two population distributions. The variation is to be expected given the 20 years that had transpired between the two data collection activities. However, it is interesting to note that there is significant contraction in the number of remote settlements that have population records in the 1981 Census by comparison with the 1961 Census. This may be in response to the general rural contraction and decline that has been reported (www.infovic.gov.au) or may be due to collection and processing procedures.

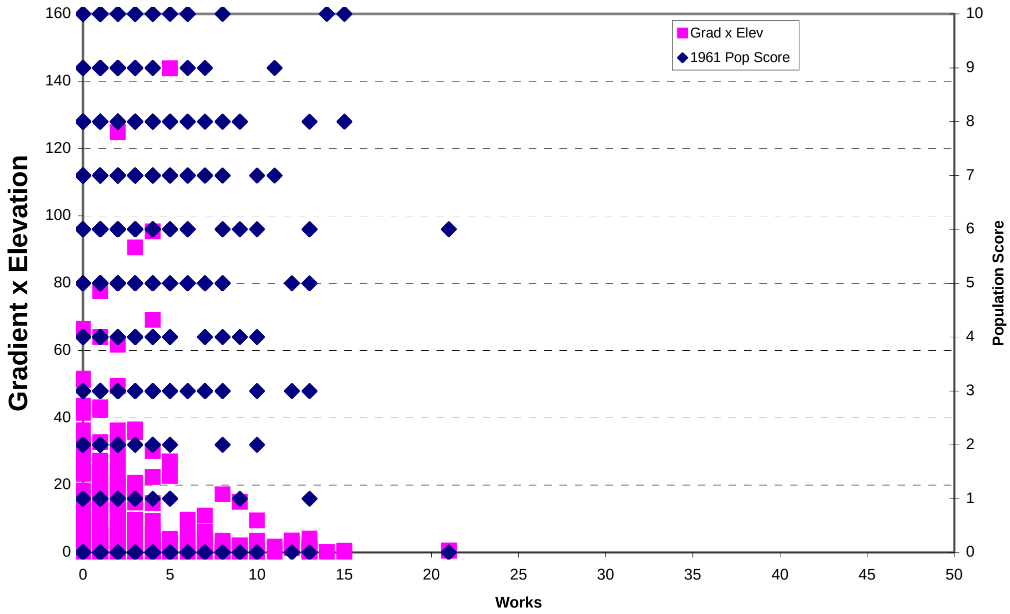

Figure 2. 1961 Public investment graph

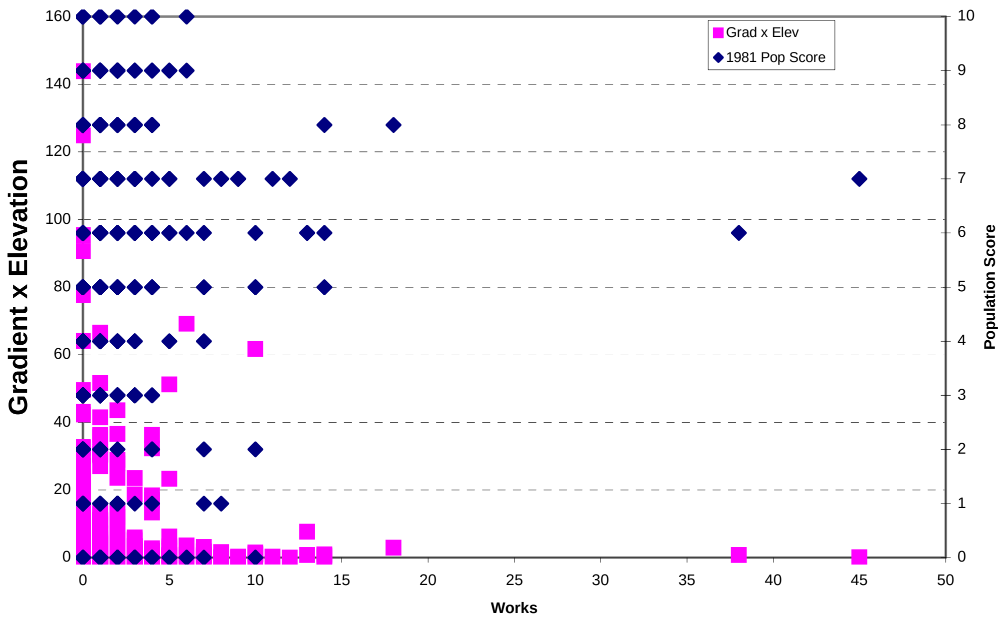

Figure 3. 1981 Public investment graph

Gradient versus project number

In an attempt to resolve the relationship between project occurrence and one of the two physical drivers utilised in the analysis, both valley gradient and elevation were plotted against the number of projects. The results of the analysis are presented in Figure 4. The analysis indicated that there was no clear gradient or gradient range that dominated the occurrence of investment in waterway management, which according to the hypothesis would occur. As such, this partially demonstrates that the hypothesis is not supported.

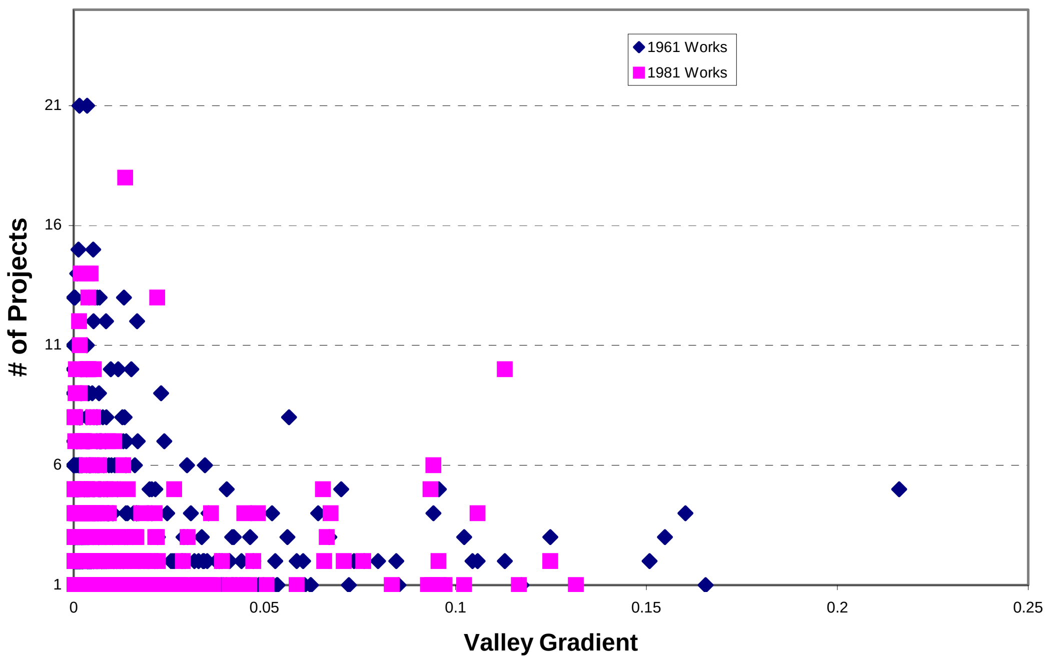

Figure 4. Valley gradient versus investment (# of Projects)

Elevation versus number of projects

Further investigations were undertaken with regard to the correlation between elevation and waterway management investment. There appears to be an increase in the number of projects below 450m AHD (Figure 5). This is confirmed through a plot of the cumulative number of projects versus elevation (Figure 6). Ninety six percent of the investment sites occur below 450m AHD. Above 450m, the land mass is 35,030km^2. Approximately 30% of this land mass (10682km^2) is under the control of Parks Victoria.

It is not expected that activities undertaken by Parks Victoria in the area of waterway management have been recorded within the DWR database. Despite the influence of Parks Victoria's responsibility within the land mass above 450m AHD, it is expected that population distribution will also be a factor, with only 2.8% and 2.0% of the regional population being above this elevation for the 1961 and 1981 data sets respectively. The lack of population in this area may also be a factor influencing the lack of waterway management investment.

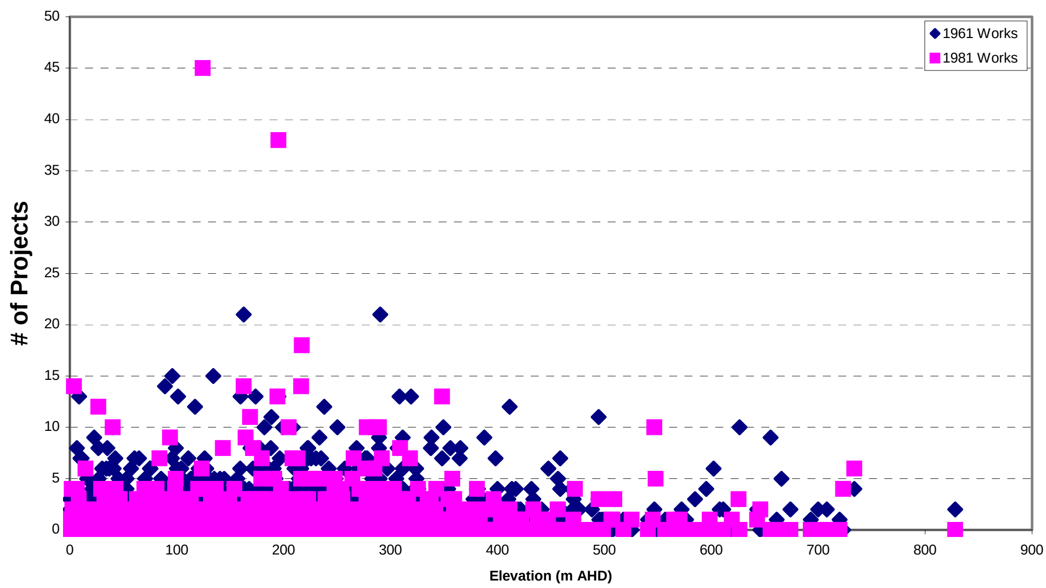

Figure 5. Elevation versus investment (# of projects).

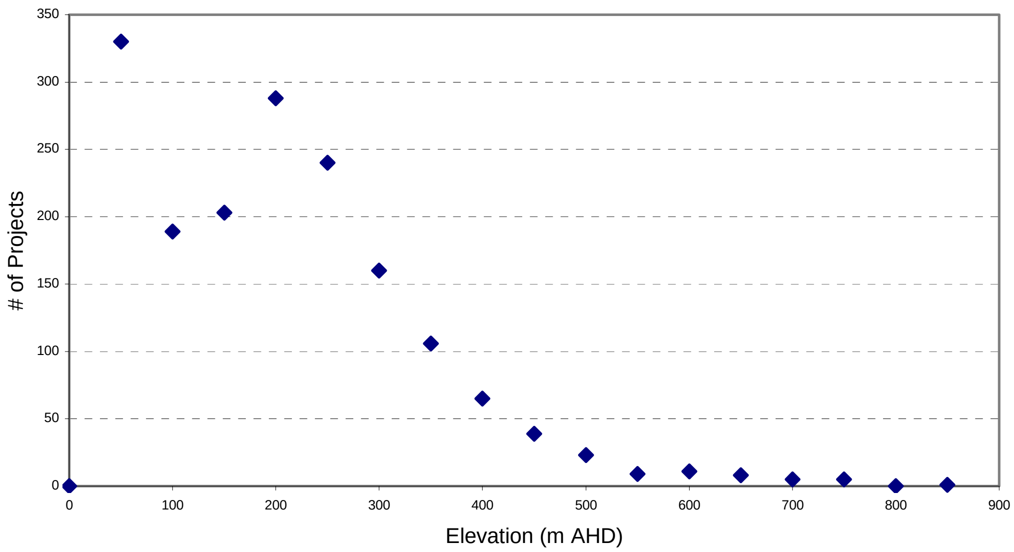

Figure 6. Cumulative number of projects versus elevation.

Conclusion

There is no clear relationship between the physical drivers of elevation or gradient, the population distribution and the investment in waterway restoration undertaken throughout the State. Furthermore, there is no clear distinction between the two time periods utilised in the analysis. Despite the lack of clear relationships, it was determined that at a particular elevation, there is an increase in both activity in waterway management and population.

It is anticipated that with further improvements in data collection and storage associated with waterway management activities, such as Catchment Activity Management System (CAMS), improved tracing and analysis can be undertaken. Furthermore, it is expected that there will be improvements in topographic data utilised in this analysis. With such improvements in data, it is expected that corresponding improvements in the relationship between activity and physical drivers can be determined leading to improved understanding of where other investment should be made. Other potential areas for future enquiry includes the utilisation of elevation as a surrogate for catchment area, and it relevance to stream power.

In the introduction, the question of expenditure on rivers such as the Snowy River in East Gippsland or the Yarra in the Melbourne metropolitan areas was posed. The information and analysis undertaken during this investigation is not strong enough to support the hypothesis, nor provide guidance as to whether the expenditure on these two rivers is justified.

Acknowledgements

The author wished to thank the Environment Protection Authority Victoria (EPA), various staff within EPA Victoria, Dr Steve Wealands and Ass. Prof. Ian D. Rutherfurd.

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