

# The Application of GIS in Analysing Human Risk to Shipwrecks. Port Phillip Bay, Victoria, Australia.

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This paper summarises research conducted to investigate potential risk to shipwrecks in and around Port Phillip Bay, Victoria, Australia. Geographical Information Systems (GIS) were used to aid in this analysis. The aim of the research was to determine risk to shipwrecks from human activities using a simple method that could be duplicated for similar research conducted elsewhere. Methods of combining data using GIS was also tested to determine how results can alter depending on the approach selected.

## Background

Port Phillip Bay was chosen as the study area because it has a large number of shipwrecks currently protected by Australian legislation, there is a high level of shipping, coastal and water activities and research previously conducted has been inadequate (Duncan 2002). It was also selected because its size allowed an assortment of human related activities that occur in the region to be incorporated (*Figure 1*).

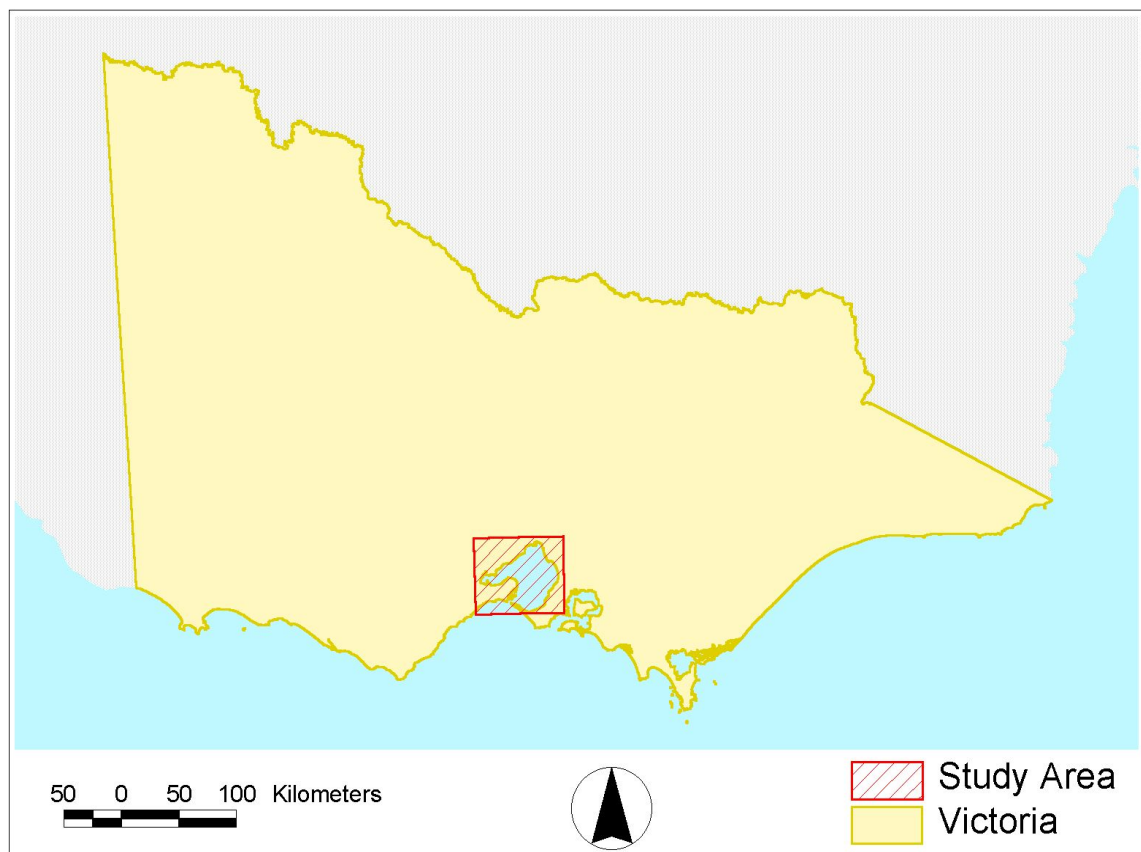


Figure 1 – Location of the study area within the state of Victoria, Australia.

Vessels go through four stages of destruction after being wrecked, but only one of these was relevant to the research. A vessel is initially destroyed and sunk. It is then damaged by natural biological disintegration processes which are then followed by natural chemical disintegration. Finally, a vessel is further destroyed by human activities after its rediscovery (Muckelroy 1978, Ward et al. 1998). As the final stage of the destruction process focuses on the human impact, it was the only section of the destruction process investigated. Risk from human activities was investigated through three groups:

1. *Scuba Diving*
2. *Fishing and Shipping*
3. *General Population, Tourism and Development.*

## Analysis

Scuba divers have played an important role in Maritime Archaeology through discovering shipwrecks and participating in research, however they are also extremely destructive (Bascom 1976). Divers cause damage by creating new entrances to shipwrecks, removing materials that provide natural protection, collecting souvenirs, dropping heavy equipment such as weights and tanks, and colliding with shipwrecks because of buoyancy control problems (Gibbins 1995, Green 1990, Harvey 1996). Scuba divers can access shipwrecks in a number of ways, such as by private boat, charter operators and accessing shipwrecks from the shoreline. They also use a variety of sources to locate them, such as the media and word-of-mouth. To incorporate these into the analysis and get a general idea of the risk scuba divers and scuba diving poses, the proximity of a shipwreck to major beaches and piers, the number of divers visiting shipwrecks, shipwrecks accessed by charter operators and shipwrecks promoted in various media sources were analysed as well as the number of shipwrecks previously looted and what type of shipwrecks looters favour.

Fishing and shipping activities are a large part of the human related activities that occur within the study area and have the potential to cause a great deal of damage. Damage is caused by equipment being caught on shipwrecks, removing natural protection, altering the surrounding marine environment, dropping anchors on or near shipwrecks, and producing waves which cause damage to the shipwrecks and the surrounding marine environment (Tomkin 1998, NSW Heritage Office 2000). To get a general idea of the potential damage caused through fishing and shipping activities, locations used for commercial and recreational fishing, the types of boats and ships using the study area and the proximity of both to shipwrecks was incorporated into the study.

The area surrounding Port Phillip Bay is popular for residential housing and popular to tourists. This has led to a large amount of development in the area. The general population and tourists cause damage through water sports and other water activities in the

vicinity of shipwrecks. Development causes damage differently depending on the type being analysed – foreshore or underwater. Foreshore developments have the potential to alter the coastal environment. This has been shown to cause damage to the underwater marine environment (Bird 1993). Underwater developments can have a direct impact on shipwrecks or the underwater marine environment (Joint Nautical Archaeology Policy Committee 1990, Breen and Forsythe 2001, Heritage Victoria 2001). The impact of the general population and tourism was incorporated into the analysis by determining the amount of people using the area and the activities they are involved in. The impact of developments was analysed by looking at the number and location of foreshore and underwater developments and the land and property values for local government areas. Proposed developments were also taken into consideration to incorporate future risk. Again, this analysis was not designed to produce an accurate risk result, but rather a result that would be simple, but easy to recreate in other analyses.

For each of the three groups analysed, ratings were produced showing the degree of risk from human activities. The ratings given were between 0 and 3 representing no, low, moderate and high risk. While only one result was created to show risk from *Scuba Diving* and *Fishing and Shipping*, two results were produced for the risk from *General Population, Tourism and Development*. This was done so one result would overlook potential developments and the other would incorporate it.

The three ratings produced showing the risk from human activities needed to be combined to produce a final result and determine an overall level of risk to shipwrecks within the study area. This was also an opportunity to test how results can differ depending on the combination method used. Three combination methods were chosen for analysis: *Manual Combination, Rating and Weighting* and *Adding*. For each of these, two results were produced. One overlooked potential developments while the other incorporated them. The final rating system used for each gave values between 0 to 5 rather than the 0 to 3 used previously. This was chosen to allow the extreme high and low values to be distinguished better. For this new rating the values represent no, very low, low, moderate, high and very high risk.

## Results

*Manual Combination* looked at all possible values achieved by combining the three risk ratings and reclassified them with an appropriate value. It allowed for certain risks to be given priority over others and selected combinations to be given higher or lower overall risk ratings if it was considered necessary (*Figure 2*).

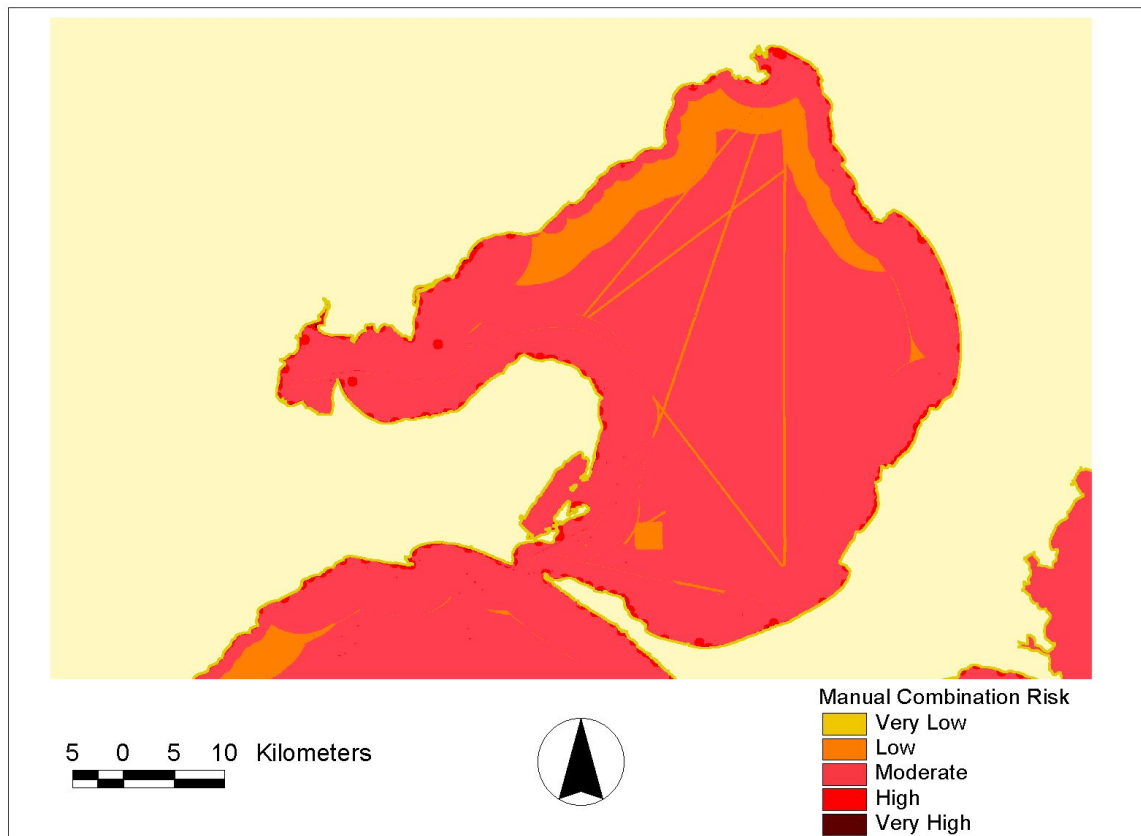


Figure 2 – Risk to the study area produced by the manual combination method.

*Rating and Weighting* involves placing categories in order of importance and multiplying them by values that will increase or reduce their significance before combining. Combining the three risk categories using a rating and weighting method was impossible for this analysis. All three categories were equally important in terms of the risk they posed. They were instead subdivided into nine groups and these were placed in order of importance and given appropriate weightings (*Figure 3*).

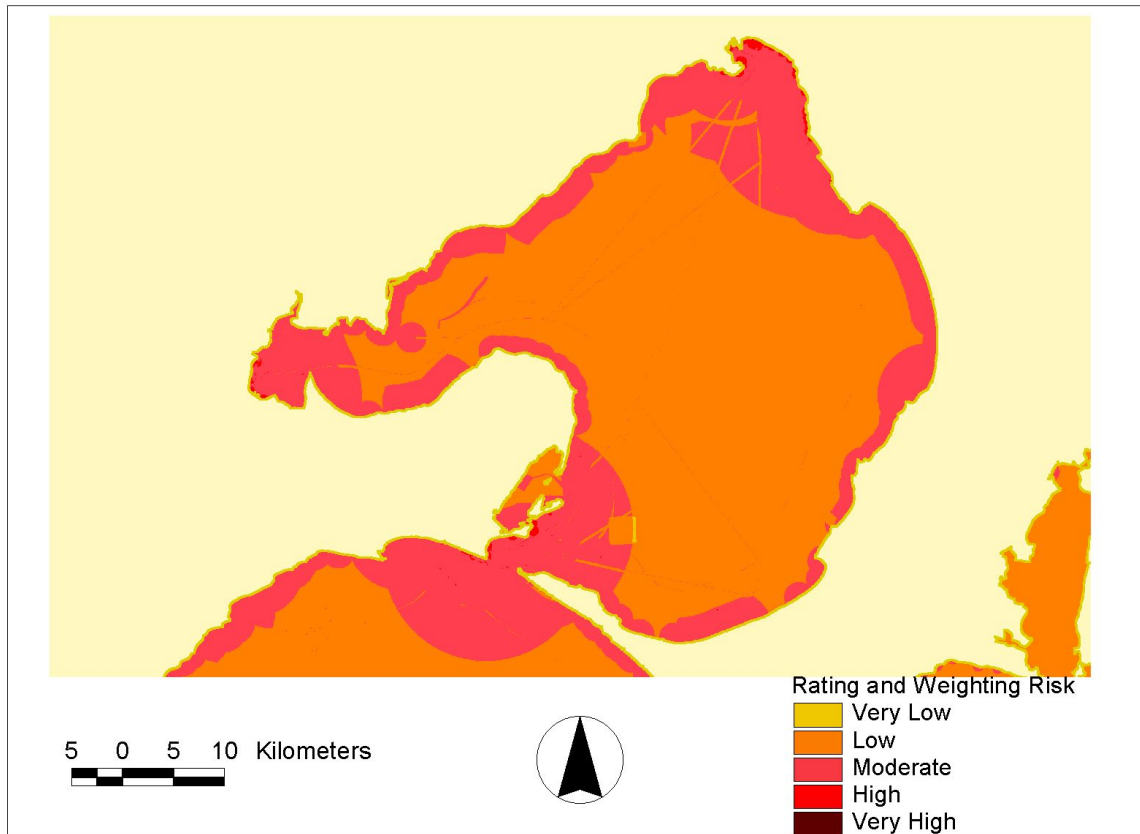


Figure 3 – Risk to the study area produced by the rating and weighting combination method.

*Adding* simply involves adding the three risk categories together and reclassifying them into values from 0 to 5. This method was used to test the accuracy of the combination methods used above (Figure 4). Both *Manual Combination* and *Rating and Weighting* can be influenced by personal biases on what the results should be.

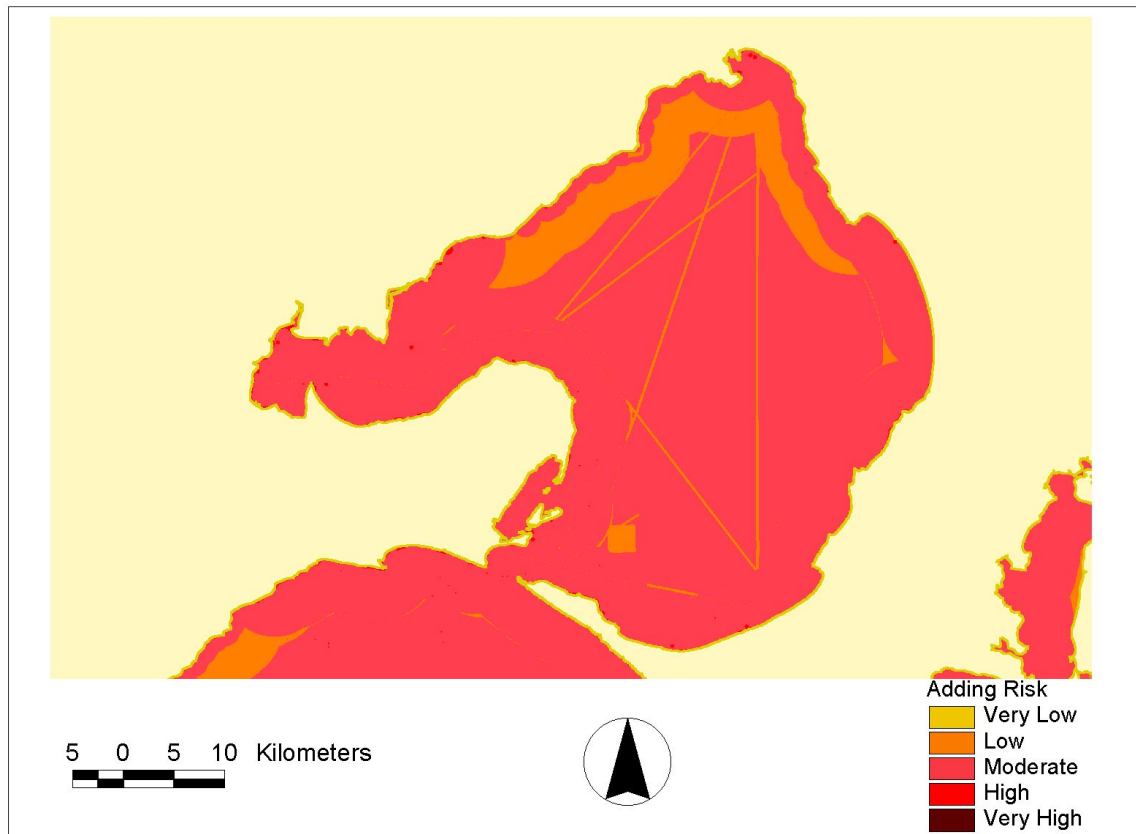
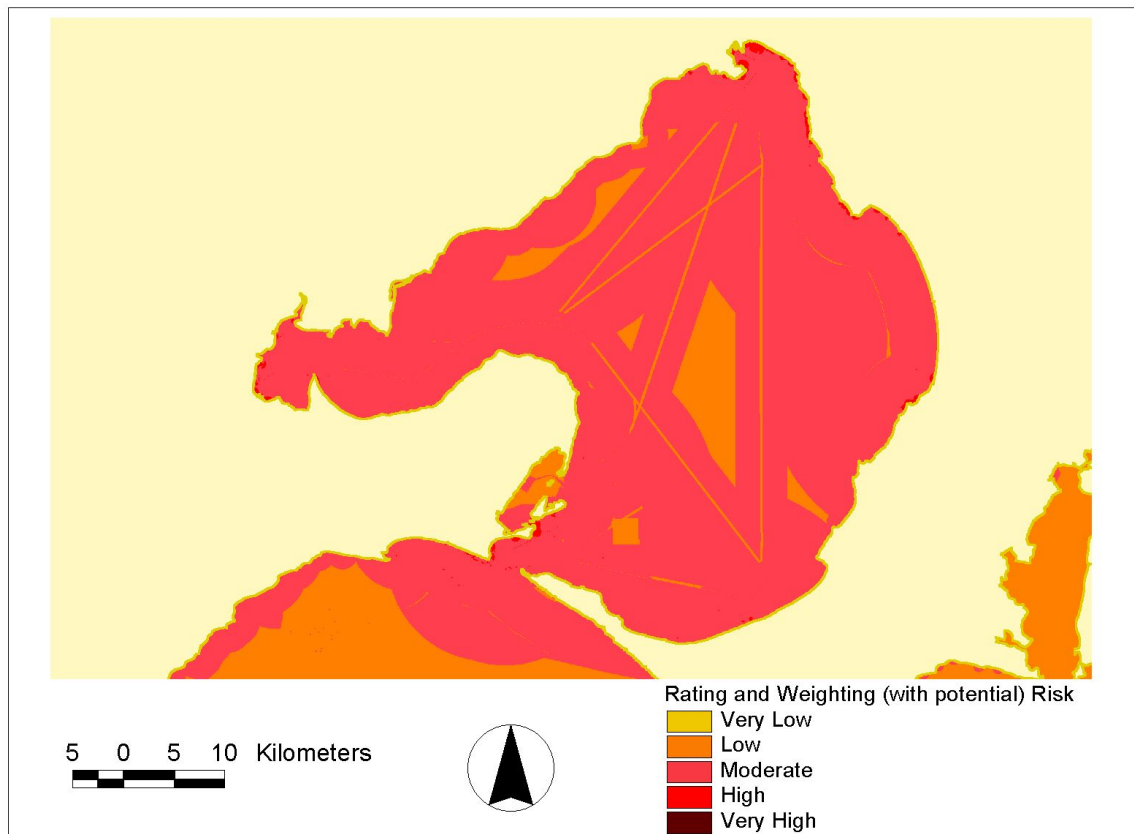


Figure 4 – Risk to the study area produced by the adding combination method.

*Manual Combination* exaggerated the level of risk within the study area. When using this method, ratings can be increased or decreased depending on the desired result. *Adding* allowed results to be given quickly, but they were inaccurate. Any results obtained using this method should only be considered a guide for a basic analysis. *Rating and Weighting* was the preferred method of combining risks. Important categories could be emphasised and changes in the level of risk could be updated or incorporated by simply changing the ratings and weightings assigned to the categories being combined.

In the results of the analysis conducted, moderate and high risk dominated the results. This is because most shipwrecks lie in or near Port Phillip Heads or along the coast where the greatest amount of human related activities occur in the study area. Potential developments were most evident with the results of the *Rating and Weighting* combination method (Figure 5). *Rating and Weighting* allowed foreshore developments and underwater construction to play a more significant role in the overall results. Other combination methods masked their impact when they were merged with general population and tourism risk.



*Figure 5* – Risk to the study area produced by the rating and weighting combination method, incorporating potential developments.

## Conclusion

The results of this analysis give a simple and basic understanding of risk to shipwrecks within the study area. To keep the analysis updated, the study needs to be adjusted, revised and conducted regularly to test the impact of changing risk. When using the risk model to determine the protective needs of shipwrecks, it is recommended that shipwrecks with a high or very high level of risk be concentrated on first. However it is necessary to conduct more research to determine the accuracy of ratings and what may need to be done to protect shipwrecks before the risk rating is used for conservation within this study area or other areas.

The complexity in combining and reclassifying data using GIS was downgraded in this study in favour to providing a method of analysing risk that could easily be recreated. Care was taken to use data that could easily be found and replaced by data relevant to the new study area. It was not intended to produce an accurate risk result, but rather a general understanding that could be used as the basis for further research.

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