EMERGENCY PLANNING FOR THE HAWKEBURY NEPEAN VALLEY

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Abstract

This paper examines the interaction between the emergency management planning process and a major road works program recommended in the Hawkesbury-Nepean Floodplain Management Strategy. The primary aim of the works is to upgrade the regional roads needed to carry out the evacuation operation which is the main strategy of the Hawkesbury-Nepean Flood Emergency State Plan. The road works were originally estimated to cost in the vicinity of $47million. As the project has progressed and detailed design work for the roads has been undertaken, there is the very real prospect that the emergency management requirements, and by implication public safety standards, will have to be reassessed because of the high cost of compliance. In implementing the emergency management recommendations of the Strategy, each additional hour required to carry out emergency management actions may have a price tag of several million dollars. What is revealed by this case study is the fact that emergency management requirements are difficult to quantify and are not a low cost alternative to appropriate urban planning and development.

Key Words: Hawkesbury-Nepean, Flood Plans, Warning, Evacuation

The Planning Basis

The Hawkesbury-Nepean Flood Emergency State Plan (HNFESP) (SES,1993) is an emergency management framework document prepared under the authority of the State Emergency and Rescue Management Act 1989 and is a Special Sub-Plan of the NSW Disaster Plan (DISPLAN). The purpose of the HNFESP is to enable control and coordination of the preparations for, response to, and recovery after severe to extreme floods in the Hawkesbury-Nepean valley (floods exceeding a threshold height of 14m at Windsor). The Plan establishes a control structure, describes the emergency management strategies, and documents the agreed responsibilities of all participants including the planning required to be done by other agencies.

The NSW SES is the Combat Agency for floods and the HNFESP is directly supported by a series of SES Division and Local Flood Plans which deal with the functions of the SES units and their relationship with other agencies at the relevant Division (regional) and Local level. These SES plans operate in a dual mode by: one, dealing with floods that do not require activation of the HNFESP ie. those not defined as severe to extreme, and two, by operating in support of the HNFESP when it is active.

Further planning and preparation for dealing with severe to extreme floods in the Hawkesbury-Nepean valley has yet to be undertaken. This additional planning work will involve a number of government agencies in the preparation of the more detailed state level supporting plans required by the HNFESP. These supporting plans will deal with specific issues, for example: traffic network management, evacuation centre management, area security, transport services, and post flood recovery. To assist other agencies in their own planning process, the SES will provide the flood intelligence and information about aspects of the Services' intended operations during a flood.

The Planning Parameters

The main strategy of the HNFESP is a road based evacuation of up to 50,000 people, and major influence on effectiveness of this strategy is the capacity of the main evacuation route out of each of these population centres. This issue was studied in detail in the Hawkesbury-Nepean Emergency Response Planning and Traffic Infrastructure (ERP&TI) report (Danielson et al 1997). That report highlighted the most critical issue for evacuation as being the traffic capacity and flood durability of these main evacuation routes. Of particular concern is the fact that all evacuation routes cross low points which are flooded before the area being evacuated is flooded. Put simply, people can be trapped on shrinking islands of land with no escape route.

The ERP&TI report reviewed the methodology for determining evacuation route capacity and concluded that the planning figure of 600 vehicles/lane/hour used by the SES was valid for flood evacuation conditions. This figure **does not allow for major stoppages**. With the maximum evacuation traffic flow out of population centres being restricted at the entry point onto these main routes, it is valid to consider each population centre as a black box with an output of 600 vehicles/lane/hour for analysis.

To facilitate the control of flood operations, the HNFESP establishes 18 sectors and 36 associated sub-sectors covering the flood affected population centres and the surrounding rural areas. There is no need to attempt a detailed analysis of traffic dynamics within each sector unless there is evidence to suggest that the capacity of the main route is being under utilised because of low exit numbers of vehicles from the sectors within each population centre.

Apart from the time required to move people out of the area to be flooded there are other important evacuation planning parameters not related to traffic flow. These are the time required to make flood height predictions, the time required to mobilise the response, the time required to warn the population, and the time elapsed before people respond appropriately. There are no known numerical models dealing with the performance of warning systems, especially in relation to the critical link between warnings and the response of recipients. It is therefore considered unlikely in the short term, that it will be possible to quantify the spatial and temporal outcomes of various warning options, in a way that could provide useful numerical input into a dynamic traffic flow analysis.

A Tool for Conceptual Analysis of Planning Parameters

The parameters identified above are represented diagrammatically in Appendix A (EMA,1999a). This tool was developed by the author of this paper in 1997 in attempt to assist those involved in the Hawkesbury-Nepean planning process to conceptualise the relationship between the various actions and their timings during a flood evacuation. Subsequently, other users of the concept have shown that a flood hydrograph can be added to the diagram to show true flood timings and heights. The concept can be applied to the total response or to any sub-component of it and could be used for analysis of any time dependent operation.

Using this methodology it is easier to estimate how much time is needed to evacuate people from within an area before an evacuation route will be cut by flood water. The parameters that need to be determined are shown below.

Maximum time available <u>for all actions</u> (tm) = (Flood height of lowest point on route **minus** present river level) **/** rate of rise per hour.

Evacuation time needed (En) = Number of vehicles **/** 600 Note 1.

Total time to completion (tc) = Prediction time (P) **+** Response time (R) **+** Warning time (W) **+** Evacuation time (En) Note 2.

Note 1: Assumes one lane out, and one lane in for buses etc. Two separate, 2-lane routes will double this and so on. The number of vehicles must include an allowance for buses etc for people without cars.

Note 2: It is possible to obtain a negative result. This means that there is insufficient time to evacuate and one or more of the actions has to be modified to occupy less time. Alternatively the maximum available time has to be increased by raising the route level.

For the purpose of emergency management planning, it is essential to be conservative when estimating the time needed to carry out important tasks, especially where the consequences of underestimation could result in a large number of fatalities. To illustrate this, consider the following two contrasting situations. If the design of a road for normal commuter use turns out to have underestimated traffic demand, people will probably spend time sitting in their cars in a traffic cue. On the other hand, if the design of a road needed as a critical evacuation route turns out to have been based on an underestimate of the time required to predict the flood, or to mobilise the response, or to warn the community, or to move evacuation traffic, people will probably lose their lives.

This paper does not attempt to analyse the issue of traffic flow parameters. This will be a task for those preparing Traffic Network Supporting Plan referred to earlier.

The Time Required for Non-Traffic Flow Parameters

A detailed study of emergency response planning for the Hawkesbury-Nepean was conducted by Danielson & Associates, Paterson Britton & Partners, and Masson Wilson Pty Ltd. The results were published in the Emergency Response Planning and Traffic Infrastructure report (ERP&TI) (Danielson et al,1997). In that report the emergency management consultant concluded that full scale evacuation would be unlikely to commence earlier than 10 hours after the decision point (Hawkesbury-Nepean River reaches a height of about 6.5m at Windsor) because of the time needed to predict, mobilise, and warn.

The ERP&TI report considered the following factors were critical for evacuation planning because total available time was short due to loss of the evacuation route due to flooding:

A) Adoption of a trigger point

Adoption of a starting point based on the lowest possible river level to trigger a response is essential for planning. The ERP&TI report suggested that 60% bankfull (about 6m at Windsor) may be suitable if comprehensively linked to predictive rainfall. The intention is to make a decision as early as possible but at least have enough water in the river to suggest to the community that flooding is likely (a psychological trigger).

The ERP&TI report emphasised that from an operational viewpoint, adopting a trigger point based on a low river level eg a height of 6m at Windsor **"contains large uncertainties and introduces a high probability of false evacuations".** This uncertainty stems from the need to base such early flood height predictions on forecast rainfall.

Even if measured rain is used for the predictions, there may be large uncertainties and this can be demonstrated by considering a possible flood scenario. The Bureau of Meteorology (BoM) has modelled a flood on the Hawkesbury-Nepean River based on the August 1990 flood, with extra rainfall added in to create a 17metre flood at Windsor. All predictions in this scenario assume the input to be **measured rainfall** not forecast rainfall. Although other population centres along the Hawkesbury-Nepean River would be affected in the scenario, only Windsor is discussed. In Windsor it is estimated that there will be 3350 vehicles to get out. This equates to 6 hours of traffic flow **assuming no major stoppages**.

The first flood warning is issued at 1000hrs for minor flooding. More rain and further river rises are expected.

By 0200hrs in the morning on day 2, the river at Windsor exceeds 6m but there is no rainfall data to suggest serious flooding is likely. It is possible if more heavy rain falls.

At 0300hrs there is a prediction that flooding may exceed 13.7m by 1800hrs, which could cut the first of several important evacuation routes in 15hrs time. There is no possibility of predicting the likely flood peak at this time. The river at Windsor has exceeded 7m already (remember the suggested trigger point is 6m!).

At 0430hrs there is a prediction that flooding may exceed 15m (by 1800hrs) which could flood lower urban areas in Windsor and cut the main evacuation route for Windsor in 13 hrs time. The river at Windsor has already reached 9metres. Despite not knowing how much of Windsor is likely to be flooded, the decision to conduct a total evacuation would have to be made at this point to have any chance of evacuation being completed in 13 hours.

At 0710hrs there is a prediction that the height may exceed 15m by 1500hrs! and 18m by day 3 if rain continues. There is now only 8 hours to complete evacuation. Evacuation will have to commence by 0900hrs. A height of 18m will mean severe urban flooding in Windsor (the majority of development is below 18m).

At 1330hrs a prediction of a peak near 17m (by 0900hrs on Day 3) is given. The river at Windsor is at a height of 14metres.

At 1500hrs the river exceeds 15m cutting the main Windsor evacuation route, 3 hours earlier than first predicted.

It is important to emphasise the high level of inherent uncertainty demonstrated by this scenario. This uncertainty is exacerbated by the fact that critical evacuation routes can be cut by floodwater before all people have reached safety. Total evacuation time has to be extended somehow. Unless the low points on evacuation routes are raised to extend the total available evacuation time, the only choice is to force decision making and warning back into a period where too little reliable information is available to make informed decisions about evacuation.

B) Mobilisation and warning time

Estimating the time required to mobilise field resources and initiate the warning process and deliver warnings is very important. The ERP&TI report stated that a period of "7-8 hours is regarded as optimistic".

It should not be concluded that in an actual flood, warning will not commence until the end of the 7-8 hours considered by Danielson et al. The SES recognises that in a flood, warnings will be delivered as soon as possible and that some people may decide to evacuate using road evacuation routes within this period. With existing knowledge however, the number of people that will be warned or the number of people that will decide to evacuate early cannot be determined using any reliable quantitative method.

Warning methods and the Time to Warn

Determining warning methods and the time required to warn a community is a critical issue. Warning will involve a multi-layered approach (EMA,1999b). The SES has already investigated the use of telephone as a warning technology. A feasibility study was done in 1999 and presented a system design based on the need to warn the estimated 20,000 subscribers that will have to be evacuated from the Hawkesbury-Nepean valley in a severe to extreme flood. This system will cost at least $500,000 to build and will cost $150,000 a year to maintain. There is **no existing capability** to drive such a telephone warning system. The system will take an estimated **7 hours** to make just one telephone call to each subscriber in the affected area, assuming no systems failure and no network congestion. This represents probably the fastest method of delivering specific messages to individual locations.

The Internet is not considered to a viable warning method because there is no alarm component to attract the attention of the person to be warned. The recipient has to be at the Web site to receive the warning. On the other hand the Internet is a useful tool for making information available to people who are actively looking for it, once they are aware of a situation via some other warning method.

The use of load speakers on vehicles and other audible systems such as public address and sirens is not considered good warning practice. These methods are likely to create panic and cannot convey important detail to recipients about what they need to do. A detailed investigation of siren and public address technology is being undertaken for the SES. An investigation into the effectiveness of these systems in the United States is also being undertaken for the SES in an attempt to better understand their potential contribution to the warning task. Some of these methods will inevitably form other layers of the total flood warning system along with broadcast radio and TV.

Doorknocking is not considered likely to make a significant contribution to the large scale, short time frame warning problem in the Hawkesbury-Nepean valley. This assumption will be tested in a series of field exercises planned for mid year 2000. Military experience gained during the wartime use of warden systems, suggests that it takes 6 minutes on average to doorknock each house. Using two person teams, which must be done for safety, 10 teams (20 personnel) plus control personnel will be required to doorknock 100 homes in 1 hour. To doorknock 20,000 homes in 12 hours will require 167 teams (334 personnel) in the field at any time plus control personnel.

Conclusion

In consideration of the uncertainties discussed above the SES has indicated that for the Hawkesbury-Nepean, the use of a planning figure of a ½ day (12hours) for mobilisation and warning provides a more realistic safety factor against the uncertainties describe above, none of which have been resolved. For the purpose of planning this means allowing 12 hours before the theoretical start of evacuation traffic movement out of the area. This interval is measured from the time of an adopted trigger after which the decision to evacuate must be made. For the Hawkesbury-Nepean River this is currently assumed to be a height of a 6m river at Windsor. The fact that the flood scenario described above fails this assumption is an indication of why the safety factor has to be applied when considering the design of evacuation routes.

The time period used as the basis for evacuation planning is a decision for the legislated Combat Agency for flood which will have to control the evacuation operation when it is required to be implemented. If the requirement to adopt a 12 hour planning figure cannot be met because of technical limitations or budgetary constraints, then a lower standard of community safety will have to be accepted and the SES will adapt to the environment that exists, as it does now for floods wherever and whenever they occur.

The emergency management arrangements needed to deal with floods have a monetary cost and in the case of severe to extreme floods this cost can be significant. Quantification of the parameters used to design the support systems needed to implement emergency management is conceptually difficult. The SES asks that there be a recognition of the fact that emergency management is not a precise engineering science. It may not possible, or desirable, to try and plan everything down to the smallest detail. This is a recognition that there has always been and always will be, a high level of uncertainty in the environment in which emergency managers have to function. There is a place for “gut feeling” in the management of complex response operations for disasters. The SES is prepared to argue this case in support of the need for funds to build the necessary emergency management infrastructure.

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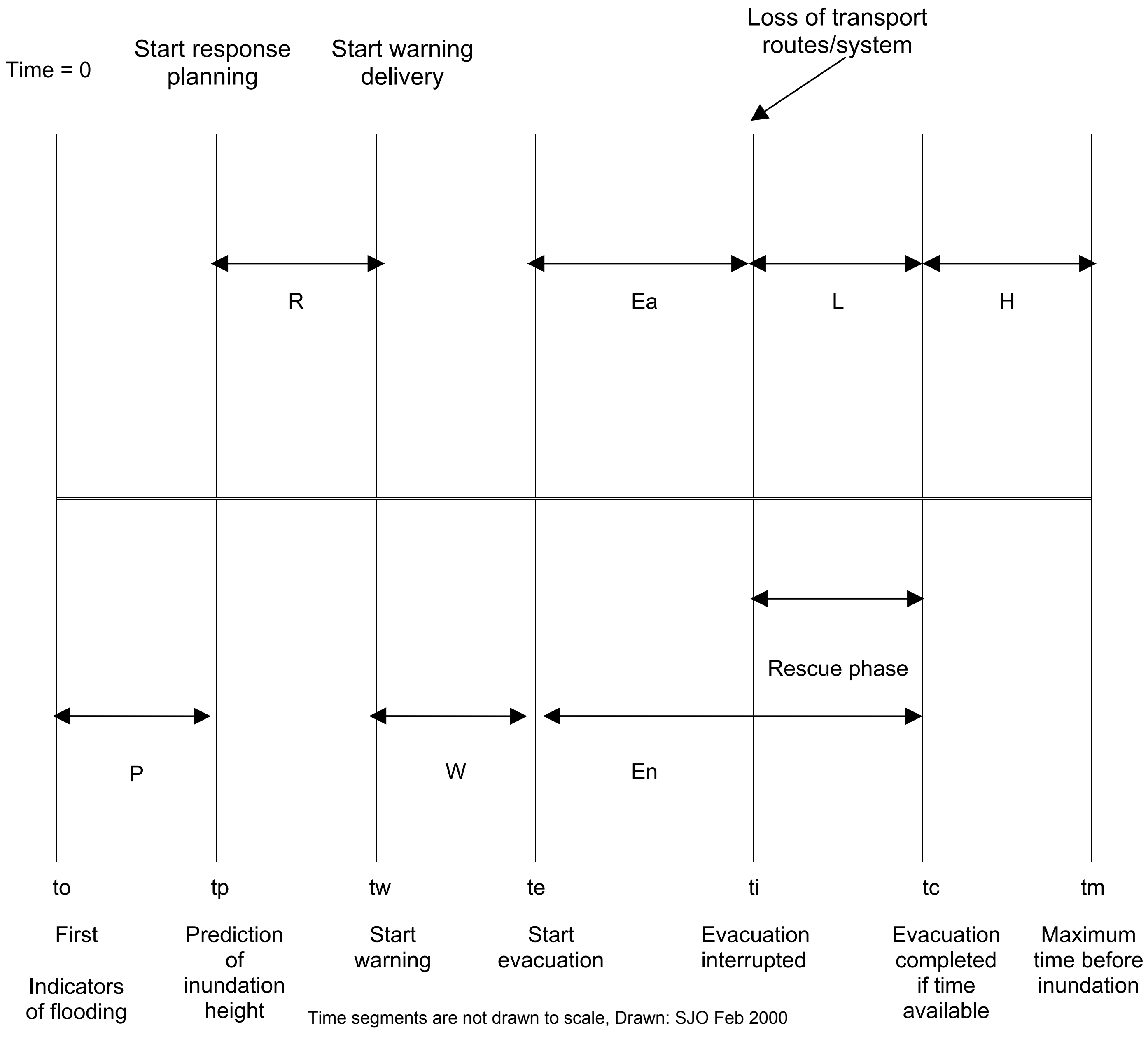
Appendix A

TIME-LINE OF EMERGENCY RESPONSE TO FLOOD EVACUATION



P = prediction calculation, R = response initiation, W = warning delivery, En = time needed to evacuate, Ea = time available to evacuate, L = time lost due to failure of route/system, H = headroom for error. Note: H can be negative if tm is earlier than tc.

Author Biography

Steve Opper has been involved in emergency management since 1974 when he joined the ACT Emergency Service as a volunteer. He was also a volunteer in the NSW Rural Fire Service for 9 years. As a volunteer Steve was trained in flood operations, search and rescue and remote area fire fighting. Steve took up a full time position with the NSW SES in 1985 and has since worked as an Executive Officer for the Southern Highlands and Lachlan Divisions, as the State Equipment Manager, and as the Planning and Research Officer. He is currently the State Planning Coordinator and in that position functions as SES's Project Manager for the Hawkesbury-Nepean Strategy. Steve is trained in telecommunications and surveying, and holds a Disaster Services Administration Certificate. In his spare time Steve enjoys bushwalking, canyoning, caving, and cave SCUBA diving.

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