A review of evacuation modelling software for emergency management in Australia

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We acknowledge the Traditional Custodians across all the lands on which we live and work, and we pay our respects to Elders both past, present and emerging. We recognise that these lands and waters have always been places of teaching, research and learning.

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List of Acronyms and Terms

Acronym / Term	Description
ACT	Australian Capital Territory
AEP	Annual Exceedance Probability
BDI	Belief-Desire Intention
BFMC	Bush Fire Management Committee
CERM	Community Emergency Response Model
CFA	Country Fire Authority
CPG	Conflict-based Path-generation Model
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEECA	Department of Energy, Environment and Climate Action, Victoria
DFES	Department of Fire and Emergency Services, Western Australia
DSS	Decision Support System
EES	Emergency Evacuation Simulator
EM	Emergency Management
EMV	Emergency Management Victoria
ESDST	Evacuation Simulation Decision Support Tool
ETIS	Evacuation Traffic Information Systems
FEM	Flood Evacuation Model
FETM	Flood Evacuation Timeline Model
GIS	Geographic Information System
HURREVAC	Hurricane Evacuation
IEP	IBM Evacuation Planner
IMT	Incident Management Team
LCD	Least-Cost Distance
LSM	Life Safety Model
MATSim	Multi-Agent Transport Simulation
NHRA	Natural Hazards Research Australia
NICTA	National ICT Australia
NSW	New South Wales
NSW RFS	NSW Rural Fire Service
SES	State Emergency Service

NT	Northern Territory
PRG	Project Reference Group
PTHA	Probabilistic Tsunami Hazard Assessment
PTVA	Papathoma Tsunami Vulnerability Assessment
QLD	Queensland
RMIT	RMIT University
RMP	Risk Modelling Platform
SA	South Australia
SAFER	Statewide Analysis of Fire Evacuation Risk
SEEKER	Simulations of Emergency Evacuations for Knowledge, Education and Response
Tas	Tasmania
TfNSW	Transport for New South Wales
USA	United States of America
USACE	U.S. Army Corps of Engineers
VIC	Victoria
WA	Western Australia
WUI-NITY	Wildland-Urban Interface Evacuation Simulation Tool

1 Executive summary

Use of community evacuations in Australia as a life-saving strategy for populations threatened by natural hazards such as bushfires, floods and cyclones, has increased in the last 15 years. This increase has followed recommendations for States and emergency agencies to improve evacuation planning and processes from several major inquiries following natural disasters including 2009 Victorian Bushfires Royal Commission [1], 2017 Cyclone Debbie Review [2], Inspector General for Emergency Management (IGEM) Inquiry into the 2019–20 Victorian Fire Season [3], 2020 NSW Bushfire Inquiry [4], and 2020 Royal Commission into National Natural Disaster Arrangements [5]. This period has seen an associated increase in the use of software technology to assist in evacuation decisions. For the purpose of this report, software tools intended for supporting evacuation-related decision-making from planning to response and across different hazards are referred to as Evacuation Simulation Decision Support Tools (ESDSTs).

This research was conducted under a project funded and supported by Natural Hazards Research Australia (NHRA) and sponsored by Department of Energy, Environment and Climate Action (DEECA). The project will operate between 2025-27 with research being conducted by a team from Collaborative Consulting Co and CSIRO. The project seeks to establish a comprehensive, cross-jurisdictional understanding of ESDST use for emergency management in Australia and develop a nationally agreed and prioritised roadmap for ESDST capability development.

The purpose of this review is to document the evacuation modelling approaches currently in use or previously applied within the emergency sector in Australia, providing practitioners with a clear and consolidated picture of existing capability and work to date. This review also serves to align understanding of these tools among stakeholders, given the varying degree of maturity in use of evacuation modelling software across jurisdictions, use cases and hazards. Establishing this shared baseline will support discussions in workshops planned for this project, for identifying user needs and research gaps for improving ESDSTs, and producing a nationally agreed and prioritised roadmap for further development of such technology.

The scope of this report is limited to ESDSTs used by emergency services in Australia for decision support in relation to large-scale community evacuations. Coverage of academic research was restricted to work showing evidence of collaboration with the emergency services. The review does not extend to building evacuations. This review also does not cover data requirements for ESDSTs.

This report primarily focuses on technical reports, government archives, and internal emergency management documentation, and cites peer-reviewed scientific literature only where relevant, such as when readers may seek additional information on specific scientific models or case studies. The analysis also draws on approved information from media releases, public product and project websites, internal reports from emergency agencies, and unpublished work identified through a targeted survey and direct consultation with CSIRO experts.

This research identified 11 ESDSTs that have been used by emergency services in Australia. Five of those (Flood Evacuation Model (FEM), HEC-LifeSim, Probabilistic Tsunami Hazard Assessment (PTHA), Simulations of Emergency Evacuations for Knowledge, Education and Response (SEEKER), and Statewide Analysis of Fire Evacuation Risk (SAFER)) were classed as actively used, given evidence of use in the past five years. Use among jurisdictions varies significantly, with the most use in New South Wales (NSW) and Victoria (VIC), and no identified use in Australian Capital Territory (ACT), Northern Territory (NT), South Australia (SA), and Tasmania (TAS). All 11 models have been used for evacuation planning. In contrast, none of the identified models have been used for response during live emergencies, hindered among other things by a lack of current and accurate real-time data on populations.

2 Literature review methodology

This review covers ESDSTs used by Australian emergency agencies. Academic works are included where collaboration with emergency services is evident. Data requirements for ESDSTs are out of scope of this review, as are tools related to building evacuations. To cover relevant material including technical reports and internal documents within emergency agencies, a tailored approach was used as summarised in Figure 1.

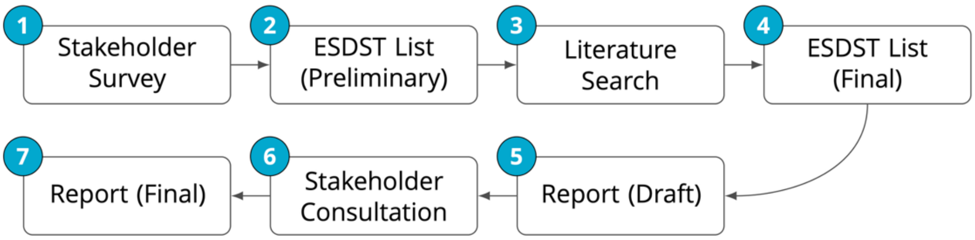

FIGURE 1: METHODOLOGY USED FOR THE REVIEW OF EVACUATION SIMULATION DECISION SUPPORT TOOL (ESDST) CAPABILITY IN AUSTRALIA

A short online survey was prepared (Step 1) to identify ESDSTs used within or in collaboration with emergency services in Australia. Respondents were asked to provide information on projects utilising such software, including when the work was done, a short description of the work conducted, and contact details of a person who could be contacted in relation to the reported work. The survey was open for one month and was promoted internally through the Project Reference Group (PRG) and publicly through the NHRA monthly newsletter (3,000+ subscribers) and NHRA LinkedIn posts (2,000+ views).

A total of eight responses were received to the survey, identifying: Emergency Evacuation Simulator (EES), SAFER, SEEKER, Compass IoT, FEM, improved flood intelligence for Western Australia (WA), WA Tsunami Inundation Modelling Project and Gender and Disaster Australia project. This list was further expanded through the knowledge of the CSIRO project researchers to include Community Emergency Response Model (CERM), HEC-LifeSim, IBM Evacuation Planner (IEP), and Decision Support System (DSS) — a precursor to SEEKER. As well, Wildland-Urban Interface Evacuation Simulation Tool (WUI-NITY) was added as a complimentary model available though not yet used in Australia. To gather details of models involving CSIRO, publication archives and repositories of historically delivered projects in CSIRO were reviewed for relevant reports. Publications openly released in conference proceedings, journals or as open-source outputs for related projects were also examined. This process created the preliminary list of ESDSTs (Step 2).

The reference list was expanded using Google Scholar searches with combinations of the following keywords: “evacuation”, “model”, “modelling”, “natural disaster”, “fire”, “bushfire”, “flood”, “tsunami”, “Australia”, “application”, and “case study”, as well as the names of the already identified models. This search identified the following models: Flood Evacuation Timeline Model (FETM), Life Safety Model (LSM), PTHA, Conflict-based Path-generation Model (CPG), and Papathoma Tsunami Vulnerability Assessment (PTVA).

A total of 11 evacuation models used by Australian emergency agencies were identified. Collected information was reviewed and documented in this report (Step 5). Draft content was circulated to the PRG for review (Step 6) and feedback incorporated (Step 7) to produce the final version of this report.

3 Summary of findings

This review identified five ESDSTs that have been used in the last five years for emergency management in Australia. These models were classified as active, and are listed below (in alphabetical order).

FEM (Section 4.1)

HEC-LifeSim (Section 4.2)

PTHA (Section 4.3)

SEEKER (Section 4.4)

SAFER (Section 4.5)

A further six ESDSTs have been used in the past, but no evidence was found of their use in the last five years. These models were labelled inactive, and are listed below.

CERM (Section 5.1)

CPG (Section 5.2)

FETM (Section 5.3)

IEP (Section 5.4)

LSM (Section 5.5)

PTVA (Section 5.6)

Figure 2 shows a categorisation of all models against criteria of interest. Details of the comparison are included in Appendix A.

With respect to natural hazards, there is evidence of the use of active models, to a varying degree, across bushfires (SEEKER, SAFER, CERM, IEP), floods (FEM, HEC-LifeSim, SEEKER, CPG, FETM, LSM), tsunamis (PTHA, SEEKER, PTVA), and tropical cyclones (SEEKER). The majority of models were used for bushfire and flood scenarios. Flood evacuation was found to be the most prominent capability across all models.

Considering the jurisdictions where ESDSTs have or are being used, New South Wales has the longest history and greatest diversity of ESDST use dating back to the early 2000s (FEM, HEC-LifeSim, SAFER, CPG, FETM, LSM, PTVA). Active models are presently being employed in New South Wales (FEM, HEC-LifeSim, SAFER), VIC (SEEKER, SAFER), WA (PTHA, SAFER), and Queensland (QLD) (SEEKER), with the majority of citable activity situated in New South Wales and Victoria. No evacuation modelling activity was found within emergency services in other jurisdictions in Australia. For clarity, this claim is restricted to the use of ESDSTs, or lack thereof and does not pertain to evacuation planning and response capability more broadly.

A notable finding is that every model, active or inactive, has been tried in the context of evacuation planning. For the purpose of this report, the planning use case is defined as any ESDST use by emergency agencies against hypothetical hazard events for the purpose of improving evacuation outcomes in a real event.

In contrast, no ESDST has to date been used for evacuation decisions during live emergencies. This fact does not point to a lack of need, as much as it highlights the limitations of existing models. Primary among them is the need for current and accurate real-time data on populations, which is a vital input when considering the use of evacuation modelling in live events.

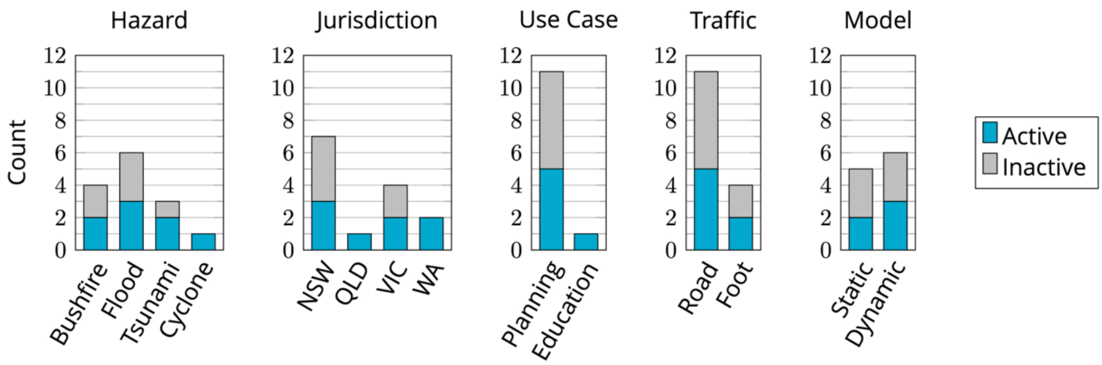

FIGURE 2: CATEGORISATION OF THE 11 EVACUATION SIMULATION DECISION SUPPORT TOOLS (ESDSTS) IDENTIFIED IN THIS REVIEW AS EITHER CURRENTLY IN USE (ACTIVE) OR PREVIOUSLY USED (INACTIVE) IN AUSTRALIA

Outside of planning, the only other recorded category of use was for emergency training and community education purposes (SEEKER). While town planning is also often listed as another important use case for such tools by stakeholders, no clear evidence exists that ESDSTs are being used in this context.

The modes of transport represented in the models reviewed is limited to road and foot traffic. All models capture evacuation by road in some way, though only a subset account explicitly for foot traffic (HEC-LifeSim, PTHA, LSM and PTVA). Public transport is not included in any of the models covered. Evacuation by aircraft or boats was also not accounted for in any model.

It is also interesting to note the modelling methods employed in the models. Broadly, the models can be grouped into two categories. Static models are those that follow a sequential workflow from hazard modelling to evacuation analyses and do not explicitly model the interaction between hazard progression and the population's mobility and its effect on egress. While this may at first appear to be a significant limitation, static models are in fact simpler to understand and use, and can be effective tools for evacuation planning. Roughly half of the models reviewed fall in this category (PTHA, SAFER, CPG, FETM, PTVA).

Dynamic models, on the other hand, simulate the response of the population to a developing hazard. They try to accurately capture the dynamic interaction between the hazard and the population, for example when a chosen evacuation route must be reconsidered because access is blocked by a progressing hazard front. This accuracy typically comes at a higher cost, in terms of model complexity, model run times and technical skills required to operate the model. Six of the 11 reviewed models fall in this category (FEM, HEC-LifeSim, SEEKER, CERM, IEP, LSM). All of these models are based on the agent-based modelling and simulation methodology that aims to represent a complex system from the bottom-up through its entities (the agents, for example, vehicles) and their interactions with the environment and each other (e.g., on the roads), leading to system level phenomena of interest (e.g., congestion).

In their ability to incorporate hazard timing, model community response and simulate induced traffic, significant commonality exists between the reviewed ESDSTs. Where these models differ is in the level of sophistication to which some of these aspects are represented, and in the specific types of outputs they generate. More often than not, particularly for tools in the agent-based tradition, these models generate sufficient detail in their raw outputs to allow similar evacuation risk metrics to be computed through post-processing workflows.

The following Sections 4 and 5 present the covered models in individual detail.

4 Models in current use in Australia

4.1 Flood Evacuation Model (FEM)

FEM [6] is an agent-based simulation tool developed to support strategic flood risk assessment and evacuation planning in the Hawkesbury-Nepean Valley, New South Wales. Built on the open-source MATSim traffic simulation platform [7] through collaboration between Urban Research and Planning (URaP), CSIRO, RMIT University (RMIT), and MATSim contributors, FEM superseded the earlier spreadsheet-based FETM model (Section 5.3) used by the NSW State Emergency Service (NSW SES) to address increasing evacuation complexity driven by population growth and climate change. The model simulates the movement of individual vehicles through the road network, incorporating route choices and closures caused by rising floodwaters. MATSim outputs constitute vehicle related events, that can be processed to compute road link volumes at any given time or aggregated over desired time periods (for example, 15-minute intervals), to calculate congestion levels, vehicle speeds and network throughput at key links. To account for stochasticity in the model, FEM runs MATSim several times and produces a distribution of results for each input flood scenario.

FEM evaluates flood risk and evacuation outcomes through two main metrics: (i) the average annual number of people at risk, calculated as a weighted average over all flood probabilities; and (ii) event-specific evacuation outcomes, quantifying the number of vehicles (people) able or unable to evacuate due to congestion or being cut off by floodwaters. These metrics provide insights into relative Risk to Life, evacuation success, and the effectiveness of flood mitigation strategies. Risk to Life is defined as the proportion of people unable to evacuate by road - either trapped by floodwaters or on the network for more than 12 hours. Evacuation within 12 hours is considered low risk.

In the Hawkesbury-Nepean Valley case study, FEM was applied to model large-scale evacuations under current and projected conditions, assessing Risk to Life across flood events with Annual Exceedance Probability (AEP) ranging from 1-in-50 to 1-in-5000, with particular emphasis on 1- in-500 and 1-in-1000 year events. Scenarios were simulated for three time horizons (2018, 2026, and 2041) incorporating projected population growth, future land-use development and evolving road network. In 2018, approximately 43,100 properties in the Hawkesbury-Nepean Valley were considered for evacuation: 36,700 dwellings, 1,900 caravans/manufactured homes, and 4,500 isolated dwellings. Future scenarios for 2026 and 2041, based on Department of Planning and Environment advice, were developed considering committed development and potential development requiring rezoning. Road network inputs, provided by Transport for New South Wales (TfNSW), included existing roads for 2018 and projected upgrades for 2026/2041 to reflect evacuation and daily capacity. Other inputs included evacuation road design, topography, car ownership, employment, and operational assumptions [6]. FEM used these inputs to simulate vehicle movement, determine when routes became impassable, and identify areas of isolation. Results showed that early warnings and timely mobilisation reduced flood exposure and improved evacuation outcomes across the valley's complex floodplain.

Scenario-based modelling, as provided by FEM, allows agencies to identify high-risk areas, prioritise interventions and develop evacuation strategies that are robust across a range of flood magnitudes and AEPs. The model provides actionable insights for multiple stakeholders, including Local Government Authority, NSW SES, TfNSW, the Department of Planning and Environment, Infrastructure NSW and NSW Reconstruction Authority, supporting evidence-based decisions on regional planning, infrastructure investment, and community resilience [6].

Informed by FEM, in 2023 the NSW Government announced a $200 million, two-year investment to upgrade key flood evacuation routes in the Hawkesbury-Nepean Valley, as part of a broader $550 million ten-year Western Sydney Flood Roads Resilience Program. Early works include the Pitt Town Bypass, Garfield Road East at Riverstone, and Richmond Road (M7–Townson Road), with additional upgrades at The Driftway Roundabout,

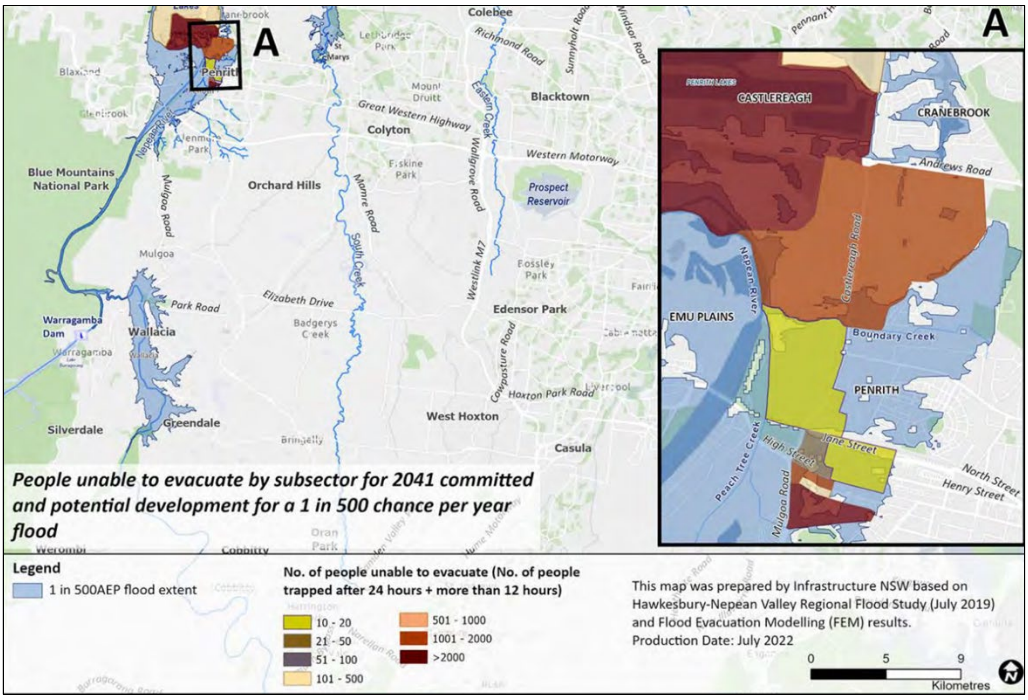

FIGURE 3: EXAMPLE FEM OUTPUT SHOWING THE NUMBER OF PEOPLE UNABLE TO EVACUATE BY SUBSECTOR FOR 2041 COMMITTED AND POTENTIAL DEVELOPMENT FOR A 1 IN 500 CHANCE PER YEAR FLOOD AS REPORTED IN [6]

Hill Road and sections of The Northern Road. Improvements include road widening, shoulder upgrades, drainage and bridge works, pinch-point remediation and road raising to enhance evacuation safety and network resilience, supporting population growth and emergency response capacity [8].

4.2 HEC-LifeSim

HEC-LifeSim is a spatial, dynamic, agent-based system for life loss estimation developed by the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Centre. It was originally designed for dam and levee safety evaluations in the United States. HEC-LifeSim takes as input hydraulic and hydrologic data (flood magnitude, timing, levee/dam performance, and inundation), temporal context (time of day, day type), and warning issuance parameters. Although developed for flood and dam-break analysis, the software can be applied to any hazard represented as a time-varying gridded dataset, including coastal storms, wildfire spread, toxic gas releases and hurricanes [9, 10].

The model estimates life loss as follows. Water height over time is first estimated at each building and road segment then used to decide the timing of warning issuance to each Emergency Planning Zones and estimate the time that the population in each building receives the first alert. The population is separated into groups based on occupancy type and each group decides its protective action such as to evacuate to a destination or shelter in place and move to higher ground within the building. Groups deciding to evacuate can leave even if flood waters have reached the building based on their willingness to enter flooded waters. On the road, a vehicle may become stranded if flood waters increase beyond a height deemed safe for driving, or if roads are congested and a new destination cannot be found when rerouting. At the end of the simulation, groups are assigned a hazard zone rating (none, low, high) depending on how safe their final location is deemed. Life loss is then calculated for each group using a fatality rate for the assigned hazard zone rating, and aggregated for all structures and evacuating vehicles. Additionally, HEC-LifeSim can calculate direct and indirect economic impacts via Economic Consequences Assessment Model, including property damage (structure, content, vehicle, etc.), capital and labour loss ratios, and agricultural and sectoral losses (e.g., damage to crops).

FIGURE 4: EXAMPLE HEC-LIFESIM OUTPUT SHOWING PEOPLE AT RISK IN A REGIONAL NSW TOWN AS REPORTED IN [16]

The model explicitly represents natural variability (aleatory uncertainty) in warning and evacuation processes, such as variability in the timing of warnings, individual decision-making and willingness to enter flooded roads. It also captures knowledge uncertainty (epistemic uncertainty) associated with parameters such as flood magnitude, hydraulic coefficients, building characteristics and warning dissemination efficiency. Many parameters exhibit a combination of both types of uncertainty. For example, vehicle stability thresholds (vehicle stability defines whether a vehicle can safely remain upright and controllable while moving through floodwaters) are influenced by both structural properties (epistemic uncertainty) and environmental conditions or human behaviour (aleatory uncertainty). HEC-LifeSim uses Monte Carlo sampling, iteratively drawing from probability distributions and curve functions (e.g., depth-damage, building stability and population-at-risk functions) to generate a range of potential consequences, including life loss, economic damage and evacuation outcomes, rather than a single deterministic estimate. This approach allows for robust quantification of variability and uncertainty in dam-safety and flood evacuation risk assessments, making HEC-LifeSim one of the most comprehensive consequence assessment tools currently available.

HEC-LifeSim has been applied in Australia for flood risk assessment. It was calibrated to the 2011 Grantham flood (Queensland) that resulted in 13 fatalities [11]. Using hydraulic modelling, forensic evidence, and eyewitness accounts [12], key parameters were adjusted for Australian conditions, including structure-stability thresholds [11] and a vehicle-specific fatality-rate curve, enabling the model to estimate potential evacuation behaviour patterns and loss of life outcomes [13]. Subsequent applications include consequence assessments for the Jandowae Water Supply Dam (Queensland) [14], dam-safety and emergency planning in Victoria. [15], and evaluations of the Total Flood Warning System in New South Wales [16].

HEC-LifeSim makes key assumptions and has limitations that must be considered when interpreting results [13]. Evacuation behaviour is simplified, assuming individuals travel along the shortest estimated route without complex trip chaining or atypical behaviours. The network is assumed empty at the onset of evacuation. Flooded roads are assumed to remain passable rather than dynamically blocked by rising floodwaters (unlike FEM and SEEKER). This can overestimate evacuation potential or underestimate life loss in isolated areas. These constraints require careful scenario design, sensitivity testing and expert interpretation to ensure credible use in decision-making.

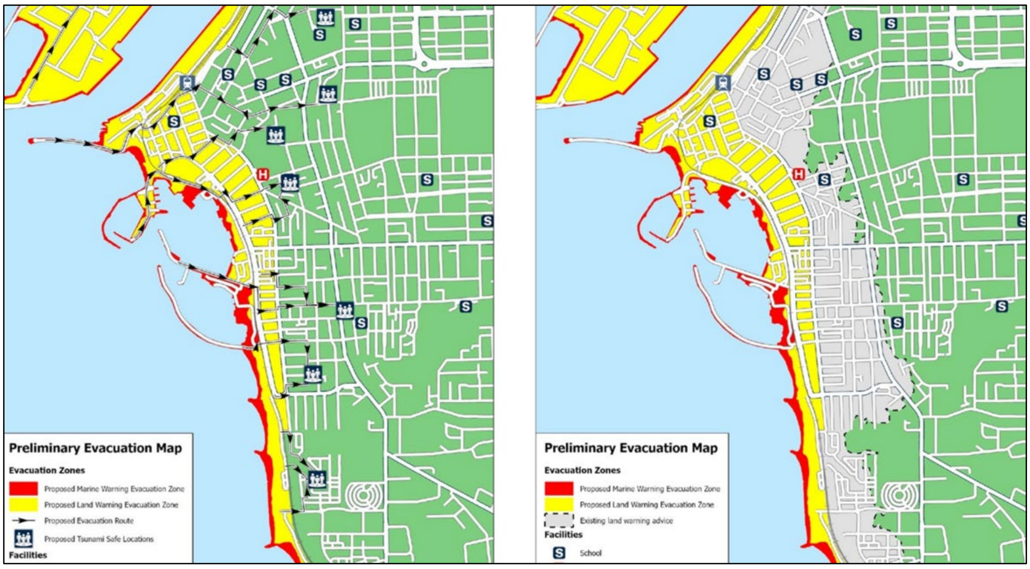

FIGURE 5: EXAMPLE OUTPUT SHOWING EVACUATION ZONES CALCULATION USING PTHA AS REPORTED IN [19]

4.3 Probabilistic Tsunami Hazard Assessment (PTHA)

PTHA estimates offshore wave heights, occurrence frequencies and associated uncertainties from large-plate boundary earthquakes. To include detailed onshore wave behaviour, high-resolution inundation modelling incorporating offshore bathymetry and onshore Light Detection and Ranging (LiDAR) topography was developed [17, 18] and validated against historic events, including the 2004 Indian Ocean and 2005 Sumatra tsunamis showing strong agreement with tide-gauge measurements along the Western Australian coast [18].

The updated PTHA enabled the translation of offshore scenarios into predicted onshore inundation patterns for evacuation planning [19]. WA Department of Fire and Emergency Services (DFES) applied operational expertise to interpret the inundation modelling, considering factors not included in the model, such as coastal erosion. This input informed the design of preliminary evacuation maps and the development of science-based evacuation zones for regions including Geraldton, Dunsborough and the Greater Perth area.

Evacuation routes were modelled using geospatial Least-Cost Distance (LCD) analysis [20] to identify the most efficient pedestrian routes between evacuation zones and designated tsunami-safe locations. LCD is a Geographic Information System (GIS)-based method that calculates the minimum cost of travel across a raster grid, where cost can be modelled as a function of distance, time or physical effort. By incorporating travel speeds, terrain and landscape features, the analysis generates time surfaces that allow visualisation of spatial variation in evacuation times. When combined with population exposure data, LCD analysis highlights areas where evacuees may be unable to reach safety before tsunami arrival. This analysis is analogous to that of time available versus time required to evacuate, as used in FETM (Section 5.3).

Evacuation routes initially generated via LCD were reviewed in workshops with DFES regional and local government staff. Revisions were made to reflect changes in tsunami muster and assembly point locations. The final evacuation maps incorporated these adjustments through manual digitisation, resulting in final routes partially derived from LCD analysis. The framework also identified gaps for future refinement, including high-risk areas, additional warning categories and atypical tsunami sources. Compared to the default guidance of evacuating one kilometre inland or 10 metres above sea level, the resulting model-informed zones were more targeted, reducing the population within evacuation zones from over 100,000 to under 20,000 in Greater Perth, and lowering the number of schools and hospitals requiring evacuation.

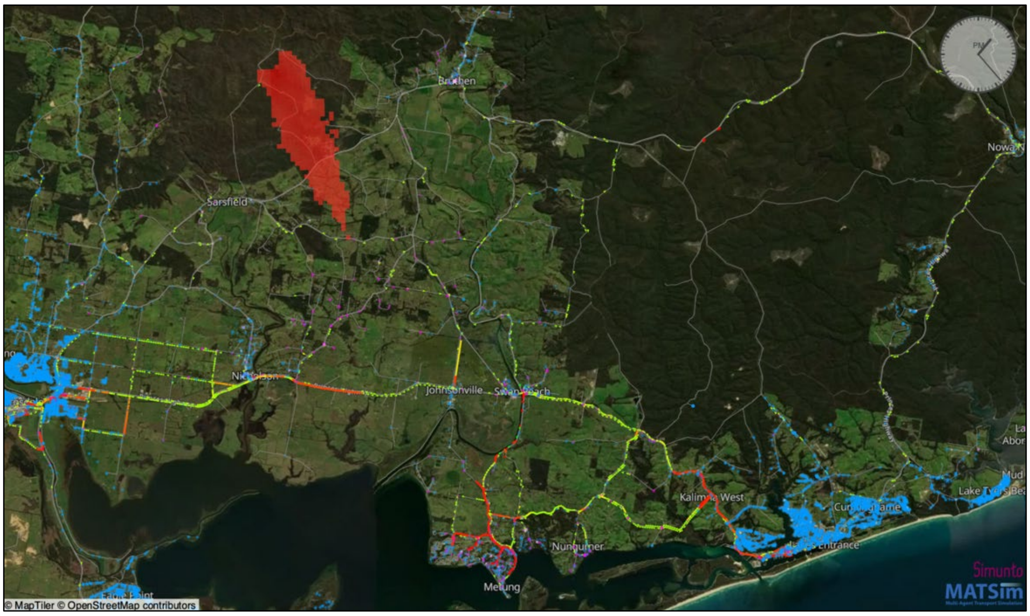

FIGURE 6: EXAMPLE SEEKER OUTPUT SHOWING EVACUATING VEHICLES WITH CONGESTED ROADS IN RED FOR A BUSHFIRE SCENARIO IN EAST GIPPSLAND AS REPORTED IN [34]

4.4 Simulations of Emergency Evacuations for Knowledge, Education and Response (SEEKER)

SEEKER has been developed by the CSIRO through a series of operational projects, during which it evolved under several working names, including BDI-MATSim [21], EES [22], and DSS [23, 24]. Key stages of this development were undertaken starting in 2015, in collaboration with Emergency Management Victoria (EMV) and Department of Premier and Cabinet Victoria. During these phases, the tool was applied to the Great Ocean Road and Otways region to support evacuation planning [23]. Development was guided by a detailed specification of functional, technical and user requirements.

SEEKER simulates the effect of human behaviour on traffic dynamics under specific hazard scenarios such as bushfires, floods, tropical cyclones, or tsunamis [25]. The tool requires three primary inputs, being a time-progressing shape of the hazard event, a representation of the threatened population, and a routable road network available for evacuation. Additional inputs include emergency warning and traffic management locations and timings. SEEKER simulates individuals' decisions – such as picking up dependants, delaying evacuation, returning home or leaving immediately – on the road network as induced traffic. It tracks the locations, activities and status of each simulated agent and produces vehicle movement visualisations and spatial analyses of evacuation effectiveness. The model can additionally simulate traffic disruptions from incidents such as accidents or fallen trees on specified road segments at defined times.

Its human behaviour model was initially developed at RMIT and integrates the Belief-Desire Intention (BDI) model of rational decision-making as the brains of the virtual agents within the Multi-Agent Transport Simulation (MATSim) agent-based traffic simulator (Section 6) to represent complex evacuation behaviours. Each BDI agent possesses beliefs about the environment upon which it operates, desires representing its goals (such as reaching safety), and intentions that represent commitment enacted as a hierarchical plan of action to achieve its goals. The model integrates demographic and behavioural data to assign agents different self-evacuation archetypes [26], or personas, that affect their beliefs and responses to risk stimuli, emergency warnings, and social influences [27, 28]. These behaviours can be adjusted for different hazards like bushfires and floods. More information on the human behaviour modelling in SEEKER can be found in [21, 29, 30, 31, 32, 33].

SEEKER has been used in Victoria for emergency training. During the 2024-25 fire season it was used with reconstructed historical bushfires to simulate community evacuations for emergency management (EM) training in collaboration with Country Fire Authority (CFA) and DEECA [35].

High-fidelity animations of the scenarios were produced for pre-season briefings and preparedness events, and the presentations were delivered to over 700 EM sector participants. In 2021, SEEKER was trialled for Incident Management Team (IMT) training in Surf Coast Shire Victoria [25]. The modelling incorporated an advanced synthetic population accounting for significant seasonal and daily population fluctuations [36]. During the training exercise, SEEKER outputs were used in the decision to evacuate or not, in a rapid-onset bushfire scenario. Participants found the visual animation of traffic particularly useful for informing discussion.

SEEKER was trialled for community information and education in Mount Alexander Shire, Victoria, in collaboration with CFA [37]. The modelling incorporated community expectations of attitudes from workshops to simulate expected evacuation behaviour in a bushfire. Scenario presentations were communicated back to the community to support resilience building and risk understanding. This high-risk area was affected by the 2026 Ravenswood bushfire [38].

In the planning context, SEEKER was used in collaboration with the East Gippsland Victoria Municipal Emergency Management Planning Committee to test evacuation assumptions around emergency response, messaging, and traffic management, and potential egress implications under the selected hazard conditions [34]. Another case study with CFA reconstructed the 2019 bushfire evacuation in Hepburn Springs, Victoria, using SPARK to model fire spread and SEEKER to simulate evacuation dynamics [39]. The objective was to evaluate the effectiveness of emergency response actions, including messaging, door-knocking, and traffic management and to explore counterfactual scenarios to understand potential consequences if the fire had breached containment lines.

SEEKER can be applied to a range of disaster scenarios beyond bushfire events. The evacuation modelling case studies in Queensland were part of a 13-month multi-hazard project led by CSIRO for the Queensland Fire and Emergency Services. The tsunami case study [40] assessed how evacuation centre placement and destination assignment influence evacuation efficiency and safety. The bushfire case study for South East Queensland [41] evaluated the timing of evacuation messages, showing that earlier or staggered messaging accelerated departures from risk areas and arrivals at evacuation centres. The tropical cyclone study [42] modelled the compounding effects of cascading hazards including tropical cyclone-related severe wind, coastal storm surge and cyclone-induced flooding.

SEEKER’s main strengths lie in its advanced human behaviour model and support for multiple hazard types. However, it does not explicitly represent pedestrian movements nor estimate life loss unlike a comparable agent-based model like HEC-LifeSim. Another limitation is that SEEKER does not perform simulation ensembles to account for input and model uncertainly to estimate evacuation outcomes with confidence levels, such as likely or worst-case outcomes.

4.5 Statewide Analysis of Fire Evacuation Risk (SAFER)

SAFER is a large-scale evacuation risk assessment tool developed by CSIRO to support Australian emergency services in strategic planning for bushfire-prone areas [43]. It is designed for automating assessment on high-performance compute infrastructure, across large sets of simulated fire ignitions at state and territory scales. SAFER uses mathematical optimisation, in contrast to agent-based models like HEC-LifeSim and SEEKER. It frames evacuation as a maximum flow problem to estimate the fastest theoretical rate at which populations

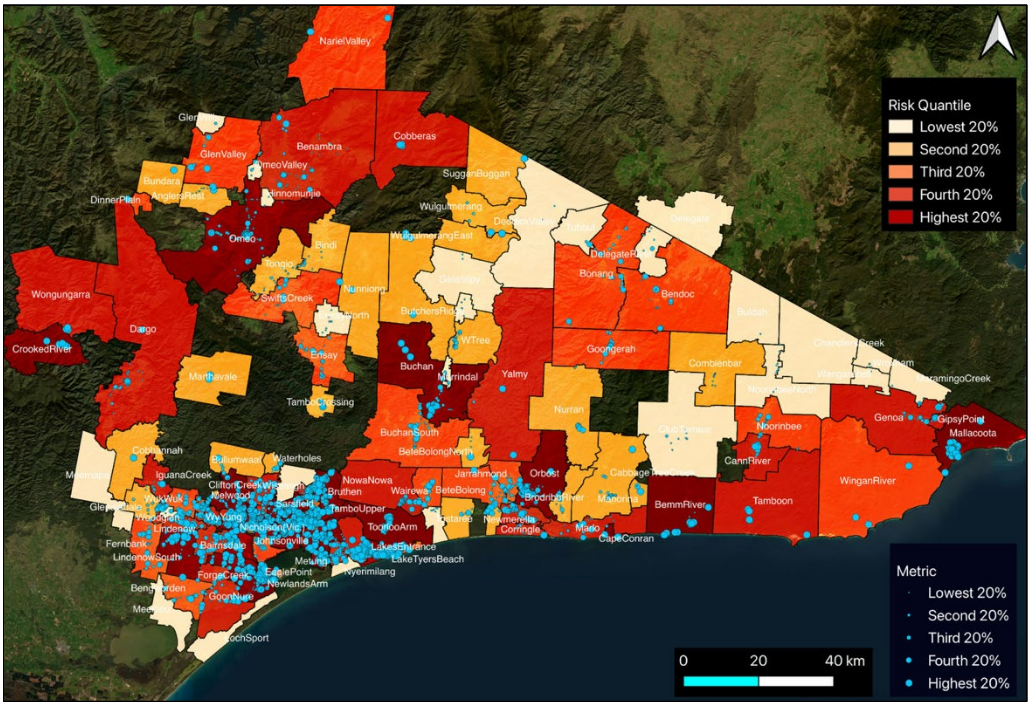

FIGURE 7: EXAMPLE SAFER OUTPUT SHOWING EVACUATION RISK IN EAST GIPPSLAND AS REPORTED IN [34]

can evacuate to assumed safety outside the fire perimeter given the available road network in the area. SAFER identifies best-case evacuation performance rather than detailed behavioural realism. The model deliberately adopts optimistic assumptions about human behaviour and traffic operations, enabling rapid screening of evacuation risk across very large spatial and bushfire scenario domains to identify risk hotspots.

The optimistic, best-case philosophy in SAFER means that areas flagged as high risk are likely to warrant concern and further investigation, making SAFER well suited as an early-warning and prioritisation tool. It complements more detailed behavioural and operational models by narrowing the focus to locations where deeper, scenario-specific evacuation modelling is most needed.

SAFER was used in collaboration with the East Gippsland Victoria Municipal Emergency Management Planning Committee to identify areas of elevated evacuation risk in the Shire using more than 6,000 simulated bushfire scenarios [34]. The modelling reinforced known high-risk areas while also identifying previously under-recognised evacuation hotspots.

In Western Australia, SAFER was applied across south-west Western Australia to assess large-scale bushfire evacuation risk using over 67,000 worst-case fire scenarios generated by the Australis bushfire simulation engine [44]. A CSIRO project is under way in 2025-26 to integrate SAFER within the NSW Rural Fire Service (NSW RFS) Risk Modelling Platform (RMP) to generate fire risk modelling outputs for bushfire risk management planning. Initial work includes preparing model outputs for trial with selected Bush Fire Management Committees (BFMCs) to assess the usefulness of SAFER outputs for bushfire planning.

SAFER is a static assessment tool, that is, it does not capture the dynamic interaction between the hazard timing and evacuation. It makes strong assumptions to simplify the evacuation problem in order to compute results quickly and at scale. For instance, it only considers the final extent of the fire and assumes roads are passable for the duration of the evacuation. It assumes roads are empty to begin with, and that any road node immediately outside the fire perimeter is a safe destination. It does not consider vehicular heterogeneity and deals only with traffic flows. Importantly, SAFER can produce false negatives, meaning that if areas are flagged as low risk, it does not necessarily mean that the risk in those areas is low. In contrast, if areas are deemed high risk, that is very likely the case in reality. Reported risk levels are relative, which is less informative than measures such as absolute estimates of loss of life.

5 Legacy models not in active use in Australia

5.1 Community Emergency Response Model (CERM)

CERM was an online tool to predict community responses to bushfires. It was developed in consultation with Bushfire Cooperative Research Centre researchers and emergency services, with state agencies including DFES, Tasmanian Fire Service, NSW RFS, and EMV as national project coordinator [45]. CERM applied a risk-based methodology accounting for threat, uncertainty and vulnerability, to estimate how people perceive risk and make decisions, including whether to evacuate and where to seek refuge. It predicted stay-or-evacuate decisions, as well as the type of destination for leavers, providing EM with support for planning, preparedness, and operational decision-making [45].

Specifically, CERM generated predictions of community response to bushfire events. Scenario inputs included bushfire severity, location, duration, progression, alert schedules, resource failures (e.g. loss of water and power), and the presence or absence of emergency services in the region. CERM takes into account each individual's day-to-day activities, including typical routines such as work and school attendance, travel periods and changes associated with public holiday conditions. Community profile inputs covered Census-based population characteristics, and levels of preparedness and stay-or-leave intentions derived from workshops with emergency agencies. Individuals became aware of the situation based on information about the location of the fire and from communication media. Action rules used pre-defined stay-leave thresholds and refuge selection logic to estimate the timing of responses.

The model produces behavioural predictions at half-hourly intervals, presented through interactive charts that visualise population responses under the configured scenario and alert schedule. The model predicts response categories such as stay-leave decisions and likely refuge type.

CERM was tested using data from five bushfire case studies: the Kelmscott/Roleystone Bushfire in Western Australia (2011), the Forcett Bushfire in Tasmania (2013), the Linksview Road Bushfire in New South Wales (2013), the Churchill Bushfire in Victoria (2009), and the Wangary Bushfire in South Australia (2005). The validation exercise tested the level of agreement between the recorded percentage of total households that stayed or left as determined from post-incident surveys, and the prediction of the model. It was reported to be greater than 90%.

Details of the prediction model within CERM are not published. It is worth clarifying that CERM did not model evacuations spatially through the simulation of traffic flow on roads, unlike currently used systems reported in Section 4.

5.2 Conflict-based Path-generation Model (CPG)

CPG was an evacuation planning and scheduling algorithm designed to generate actionable evacuation plans that integrate both route selection and traffic management. Its key concept was to iteratively generate evacuation paths for each population area to optimise overall evacuation performance. Each new path addressed conflicts in the existing plan and updated the master plan accordingly. The algorithm was developed by National ICT Australia (NICTA) 1 researchers. The authors stated that CPG had been developed in collaboration with Australian emergency services though did not provide specifics [46].

For validation, the CPG algorithm was applied to the Hawkesbury-Nepean floodplain in New South Wales, for a hypothetical 1-in-200-year flood requiring the evacuation of approximately 70,000 people. Results showed that the CPG approach could generate evacuation plans fast (in under 60 seconds), significantly outperforming traditional Mixed-Integer Programming approaches that are intractable at this scale. The study also explored the idea of allowing contraflow which increased the number of evacuees reaching safety and reduced lead time.

Behavioural variation was introduced through destination choice and departure timing and captured in two scenarios. In the "Quickest" scenario, each evacuee was assumed to travel to the nearest accessible safe node at their assigned departure time. The aggregate number of evacuees departing from each area was constrained so that it matched the evacuation demand volume generated by the optimisation model. In the "Random Quickest" scenario, behavioural variability was introduced by allowing probabilistic destination selection, where 50% of evacuees were assigned to the closest safe node, 40% were assigned to one of the five nearest safe nodes, and 10% were assigned to a randomly selected safe node. Departure times were also randomly generated within bounds defined by the earliest departure time of neighbouring areas and the latest departure time for the area under consideration. Validation through traffic simulations assessed plan performance under the two predefined behavioural scenarios, providing indicative insight into the robustness of the generated plans to variation in evacuee behaviour.

5.3 Flood Evacuation Timeline Model (FETM)

FETM was a spreadsheet-based tool developed by NSW SES to quantify local and regional flood evacuation requirements to support the planning of evacuation strategies [47]. The model compared the time required for evacuation against the time available, accounting for warning delays, flood travel rates and potential disruptions along evacuation routes. Designed primarily as a descriptive tool, FETM allowed stakeholders to interpret and communicate evacuation stages, providing a structured and transparent framework for assessing the feasibility of evacuations.

FETM was applied in the Hawkesbury-Nepean Valley as part of the 1997 Floodplain Management Strategy for planning in the towns of Richmond and Windsor. This analysis informed the design of critical infrastructure, including a $100 million evacuation bridge, and provided quantitative evidence to guide urban development planning. The application of FETM in this context demonstrated its usefulness for evaluating evacuation strategies at different scales - from small subdivisions to valley-wide areas involving up to 70,000 residents - and to identify circumstances where evacuation may fail, supporting risk mitigation and emergency preparedness [47, 48, 49].

FETM was also used together with outputs from dynamic two-dimensional flood models to incorporate GIS-based information to facilitate evaluation of route constraints under different flood conditions [50]. The combination enabled visualisation of affected areas, better estimation of evacuation times, and prioritisation of infrastructure investment or operational intervention.

Dynamic spatial models like FEM and HEC-LifeSim have largely superseded FETM by capturing detailed traffic interactions and scenario-specific variations in evacuation performance. Nevertheless, FETM was a simple and practical tool that was used successfully for operational and planning purposes by NSW SES for several years.

5.4 IBM Evacuation Planner (IEP)

Research into evacuation modelling and decision support was also undertaken by IBM Research in Melbourne, Australia, up until 2016. The proposed system, called IEP, was composed of multiple specialised components, including a wildfire simulator, warning generator, behaviour modeller, traffic simulator and analytics engine, linked through an explicitly defined workflow [51]. Evacuation scenarios specified configurable inputs such as fire ignition location, environmental conditions (e.g., wind velocity), warning system characteristics and evacuee behaviour categories. By coupling these components, the system enabled end-to-end simulation of wildfire evolution, warning dissemination, human decision-making and evacuation outcomes. The proposed delivery mechanism for IEP was Software-as-a-Service.

The system introduced a new performance metric, termed exposure count, which quantifies the number of vehicles that remain in close proximity to the fire during evacuation. The introduction of the exposure count metric provided a more direct measure of evacuation risk than traditional clearance time, which can mask dangerous levels of population exposure. This metric complements traditional measures such as clearance time and congestion, providing a more direct indicator of risk to evacuees during dynamic wildfire conditions.

The Australian case study was conducted in the Dandenong Ranges, a wildfire-prone region in Victoria. The system enabled spatial representation of population distribution, residential locations and the regional road network to support realistic evacuation and traffic simulation. The case study examined how dynamic wildfire progression and warning triggers influence evacuation behaviour across the region. The results showed that dynamic modelling captured spatial and temporal variability in departure times and exposure to risk that static models failed to represent. The case study demonstrated that dynamic evacuation modelling improves the realism, interpretability and operational value of wildfire evacuation simulations for emergency planning.

A novelty of the approach was that it proposed to simulate the hazard and evacuation within a single integrated workflow. Existing systems today, such as SEEKER and FEM take a decoupled approach of modelling the hazard first. This is more suitable and cost-effective for emergency planning workflows where hazard modelling is typically produced once for multiple downstream uses including, but not limited to, evacuation planning.

This modelling of the dynamic spatial and temporal interaction between the hazard and the affected population is standard practice in present day systems.

5.5 Life Safety Model (LSM)

LSM is a commercial, agent-based simulation tool developed by HR Wallingford [52] to support consequence analysis and emergency planning for fluvial floods, coastal inundation, and dam break scenarios [53, 54]. LSM takes as input representations of the natural environment (e.g., topography, water bodies), the socioeconomic environment (e.g., people, buildings, vehicles, roads), and temporal outputs of flood depth and velocity from two-dimensional flood wave models. LSM outputs are aggregated across multiple runs to derive probability-weighted loss of life estimates. The model also produces dynamic visualisations for comparing how emergency scenarios may unfold under different planning and mitigation conditions [55].

LSM simulates the dynamic interaction between people, vehicles, buildings, and the evolving flood [55]. It enables scenario testing of variables, including effectiveness of warnings, road capacity and time-varying population density. The model estimates fatalities and injuries as a function of flood depth, velocity and duration of exposure, accounting for thresholds beyond which individuals are swept away or drowned [56]. Vehicle movement is simulated using a simplified traffic model with road capacity governed by the Greenshields speed–density relationship [57] to represent congestion and bottlenecks. Building performance is modelled based on structural characteristics and flood loading, allowing for sudden collapse, progressive failure or survival.

Each individual is modelled as an agent, including grouped units such as families, with evacuation speed governed by the slowest member. Agents are assigned behavioural and physical attributes including warning reception, response time, evacuation decision, travel mode (vehicle or pedestrian), and resistance to flood forces. At each time step, the model updates agent location, awareness, movement and survival status based on flood depth and velocity. Warning dissemination is simulated through both official alerts and peer-to-peer communication. Evacuation routes and refuge locations are user-defined, including high ground, resilient multistorey buildings or designated shelters.

In 2011, Lumbroso et al. [55] compared (LSM) to other life loss assessment methods including HEC-LifeSim (Section 4.2) and HAZUS. The comparison indicated that at the time LSM provided the most scientifically robust and flexible approach for assessing flood risk, including dam break and other flood types. It explicitly accounted for dynamic interactions between individuals and the flood hazard, social vulnerability, population mobilisation and traffic movement. By contrast, other models produced only aggregated fatality estimates and lacked the detail needed for emergency response planning or scenario-specific loss assessment.

In 2013, NSW SES piloted LSM in Windsor, a population centre in the Hawkesbury-Nepean floodplain New South Wales, to assess evacuation performance under a night-time scenario. The study highlighted the ability of LSM to identify critical evacuation constraints to inform infrastructure planning, and evaluate urban development impacts. It was also compared to FETM, which was found to provide conservative estimates using simplified traffic assumptions. LSM offered a more dynamic representation of congestion, queuing, and individual household evacuation, enabling more precise assessment of evacuation performance and life safety outcomes [49].

In its feature set, LSM has significant overlap with HEC-LifeSim. While the latter is actively used in Australia in the present day, we found no evidence of LSM use in Australia since 2013.

5.6 Papathoma Tsunami Vulnerability Assessment (PTVA)

PTVA is a GIS model developed using empirical data from post-tsunami surveys and building damage assessments. Around 2009-10, the PTVA-3 model was applied to assess the tsunami vulnerability of more than 1,100 individual buildings within the anticipated inundation zone of a worst-case tsunami scenario affecting Manly, Sydney [58, 59]. PTVA-3 incorporated a multi-criterion, pairwise weighting framework to produce high-resolution, building-level vulnerability indices, enabling spatially explicit analysis across areas with contrasting urban characteristics. The case study considered a locally generated tsunami caused by an underwater sediment slide east of Sydney, with an assumed run-up of 5 m above sea level coinciding with high tide, and a very short lead time of 5-20 minutes – a particularly challenging scenario for evacuation. Model outputs were used to identify zones suitable for horizontal evacuation, as well as structurally resilient buildings appropriate for vertical evacuation where time constraints limited full evacuation.

The application of such tools to evacuation planning illustrates the traditional use of hazard modelling in conjunction with fixed assumptions around evacuation behaviour and timing. This use sits in contrast to dynamic models like SEEKER and FEM that simulate the interaction of hazard progression and evacuation behaviour. For use cases like shelter planning, such detailed and resource intensive model may not be warranted, since fixed estimates of available time for evacuation may be sufficient for selection of shelter options. This was also evident in the use of the spreadsheet-based FETM (Section 5.3) by NSW SES for several years for evacuation planning in NSW. However, since advanced data-driven dynamic models can produce such outputs with greater accuracy, and can cater for other use cases, these are starting to be preferred by agencies over traditional methods as reported here, as is evident in the application of such models in EM in recent years.

6 International models of significance

In the previous sections, the focus was on modelling tools used by emergency services in Australia, including both current and past initiatives. This section broadens the scope by examining several platforms developed and applied internationally. These have been selected not only for their prominence, but also for their potential relevance to the Australian context. In some cases they address capability gaps such as real-time evacuation modelling or demonstrate approaches that could potentially be adapted to Australian hazards and operational conditions.

Large-scale evacuations have been executed in the United States of America (USA) for more than two decades. Even as early as 2006, for hurricanes alone, 14 evacuations of greater than 100,000 people and two evacuations of more than 1 million people had been recorded [60]. As such, there has been a strong need for real-time evacuation support systems in the USA for some time.

HURRicane EVACuation (HURREVAC) [61] is a hurricane decision support tool developed through a partnership between Federal Emergency Management Agency, USACE and National Oceanic and Atmospheric Administration. While HURREVAC does not explicitly model evacuations, it integrates live tropical cyclone forecast feeds with evacuation clearance time matrices derived from hurricane evacuation studies to estimate the time required to move the threatened population to safety under different storm categories, population conditions and behavioural response assumptions.

Evacuation Traffic Information Systems (ETIS) is a live system that was originally developed in response to congestion issues during Hurricane Floyd (1999) [61]. It is a secure web-based GIS platform designed to support emergency management by facilitating information sharing and providing forecasts of evacuation traffic patterns. The system visualises evacuation-related data such as participation rates, expected congestion on primary routes, road closures, and interstate traffic flows [62].

The Genasys Protect system [63], previously known as Zonehaven, is a live online system that provides both an agency-focused evacuation management platform, and a community-facing interface for communication and preparedness [64]. The latter is akin to state-based emergency services apps in Australia. The former allows users to create and maintain zone-based evacuation pre-plan documents and maps, and view or run fire and flood models to understand local behaviour by incorporating weather conditions, geographic data and other regional knowledge. There is no indication it produces numeric evacuation timing predictions, vehicle flow modelling results, or detailed movement simulation outputs [63, 65].

It is worth noting that these systems support evacuation decisions through the provision of timely information during live events. They do not estimate evacuation outcomes in the way the ESDSTs in Sections 4 and Section 5 do.

WUI-NITY is a modular, multi-layer simulation platform developed to integrate fire spread, pedestrian movement, and traffic flow for bushfire evacuation scenarios [66] under active development by an international research team with contributions from Australian researchers. The platform has been introduced in Australian EM and disaster resilience literature as having strong potential to inform evacuation decision-making in wildland-urban interface contexts [67]. WUI-NITY integrates traffic simulation, behavioural modelling and hazard progression within a Unity3D-based framework for simulating evacuations at the wildland-urban interface. The pedestrian component represents initial response behaviour, including decisions to stay and time of departure. WUI-NITY also includes the Population Evacuation Trigger Algorithm (PERIL) [68] for defining spatial evacuation warning buffers.

UrbanEXODUS is a variant of the EXODUS [69] agent-based modelling framework that has been specifically developed to support large-scale, multi-modal, and multi-hazard evacuation simulations in both rural and urban environments [70]. The model accounts for people–people, people–hazard and people–environment interactions. Each individual is modelled as an autonomous agent whose trajectory is tracked from their initial location to a place of safety, unless they become trapped or incapacitated by a hazard. The software is stochastic in nature, meaning that multiple simulation runs may produce variation in outputs due to probabilistic behavioural and environmental parameters. It generates quantitative outputs including evacuation times to refuge or exit points, utilisation of assembly areas and exit routes, average distance travelled, time spent stationary due to congestion, and the number of agents trapped. In addition, urbanEXODUS can produce GIS outputs, such as shapefiles representing population movement, which can be visualised in web-based GIS platforms [71]. The model is primarily intended for pre-incident planning, enabling the exploration of multiple what-if evacuation scenarios including fire [72, 73], earthquakes [71] or HazMat leakage [74].

Large-scale outdoor evacuations are typically characterised by movements of vehicles on the road network. For this reason, dedicated traffic simulation models are frequently used for evacuation modelling [75, 76]. Examples of the use of popular traffic models in this context are provided below.

Vissim [77] is a microscopic multi-modal traffic simulation software that has been used to simulate hurricane evacuation traffic in New Orleans, validated against observed evacuation data from Hurricane Katrina [78]. Aimsun [79] was used to develop a traffic model to support evacuation planning for Auckland in New Zealand across multiple volcanic eruption scenarios. The results indicated that evacuation clearance times in the worst case could exceed the proposed warning time [80]. Simulation of Urban MObility (SUMO) is an open-source microscopic traffic simulation tool that has been applied in government-related or real-world evacuation applications to simulate traffic flows, evaluate traffic management strategies, and support transportation system analysis [81, 82, 83]).

MATSim is an open-source, activity-based multi-agent transport modelling framework designed for metropolitan-scale applications. It represents demand at the individual agent level through daily activity schedules and travel decisions. The framework uses a co-evolutionary algorithm to iteratively optimise agents' plans to reach an equilibrium state that represents the likely travel patterns of the input demand [84]. It is computationally efficient supporting large-scale simulations with millions of agents [85]. MATSim has been used in disaster evacuation research for tsunami evacuation in South Korea [86] and Indonesia [87], hurricane evacuation in Florida [88] and New Jersey [89] USA, flood evacuation in Belgium [90], and wildfire evacuation in California [91]. MATSim is also the underlying traffic simulator in FEM (Section 4.1) and SEEKER (Section 4.4) models.

7 Conclusion

This report covered ESDST use within emergency services in Australia. The space of actively used models (Section 4, five models) is found to be relatively small and niche. A similar number of models were deemed inactive (Section 5, six models) with no evidence of their use in the past five years. While this research did not investigate the reasons for the discontinuation of use of the latter set, some contributing factors seem evident. Two models are superseded by newer models (FETM by FEM, and LSM by HEC-LifeSim). The remaining four models are no longer maintained by their developers (CERM, IEP, CPG, PTVA).

This review revealed important findings about ESDST use in Australia. Notably, no ESDST to date has been employed during live emergencies in Australia pointing to a significant gap in capability. All models considered road travel in some way, but pedestrian modes and mixed modes with pedestrians and vehicles were under-represented. No models accounted for public transport, boat or aircraft use in evacuations. Models varied significantly in the level to which evacuee behaviour is captured, and this varied again by hazard. Comparison of models on this dimension is difficult given differences in explicit behaviours and implicit assumptions. Calibration and validation of models on human behaviour remains a challenge for tool developers.

Future efforts to standardise inputs and outputs, as well as functional and performance requirements, for ESDSTs, may be beneficial given significant overlap in features of existing models. There are several benefits to doing this.

- Improved inter-operability across tools: allowing tools to be swapped without impacting inputs and outputs and downstream decision-making.
- Improved inter-agency and inter-jurisdictional data sharing: reducing duplication of effort in preparing inputs or developing outputs that are conceptually similar.
- Simplification of tool selection for end users: by allowing direct comparison between tools against standardised inputs and outputs.
- Incremental improvement of tools: allowing developers to focus effort on and report progress against the agreed set of inputs and outputs.
- Independent testing and evaluation: enabling independent evaluation using tool-agnostic acceptance tests and workflows that quantitatively assess tool performance against set criteria.

A Comparison of Evacuation Simulation Decision Support Tools (ESDSTs)

TABLE 1: ACTIVE EVACUATION SIMULATION DECISION SUPPORT TOOLS (ESDSTS)

Attribute	FEM	HEC-LifeSim	PTHA	SEEKER	SAFER
Model Class	Dynamic	Dynamic	Static	Dynamic	Static
Hazards Covered					
Bushfire	-	-	-	✓	✓
Flood	✓	✓	-	✓	-
Tsunami	-	-	✓	✓	-
Cyclone	-	-	-	✓	-
Jurisdiction of Use					
ACT	-	-	-	-	-
NT	-	-	-	-	-
NSW	✓	✓	-	-	✓
QLD	-	-	-	✓	-
SA	-	-	-	-	-
TAS	-	-	-	-	-
VIC	-	-	-	✓	✓
WA	-	-	✓	-	✓
Use Case					
Planning	✓	✓	✓	✓	✓
Response	-	-	-	-	-
Education	-	-	-	✓	-
Travel Modes Covered					
Road	✓	✓	✓	✓	✓
Foot	-	✓	✓	-	-
Boat	-	-	-	-	-
Aircraft	-	-	-	-	-

TABLE 2: INACTIVE EVACUATION SIMULATION DECISION SUPPORT TOOLS (ESDSTS)

Attribute	CERM	CPG	FETM	IEP	LSM	PTVA
Model Class	Dynamic	Static	Static	Dynamic	Dynamic	Static
Hazards Covered						
Bushfire	✓	-	-	✓	-	-
Flood	-	✓	✓	-	✓	-
Tsunami	-	-	-	-	-	✓
Cyclone	-	-	-	-	-	-
Jurisdiction of Use						
ACT	-	-	-	-	-	-
NT	-	-	-	-	-	-
NSW	-	✓	✓	-	✓	✓
QLD	-	-	-	-	-	-
SA	-	-	-	-	-	-
TAS	-	-	-	-	-	-
VIC	✓	-	-	✓	-	-
WA	-	-	-	-	-	-
Use Case						
Planning	✓	✓	✓	✓	✓	✓
Response	-	-	-	-	-	-
Education	-	-	-	-	-	-
Travel Modes Covered						
Road	✓	✓	✓	✓	✓	✓
Foot	-	-	-	-	✓	✓
Boat	-	-	-	-	-	-
Aircraft	-	-	-	-	-	-

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