SFPE Europe Magazine

1st Quarter - 2026

A word from the Editor

All,

Finally, it's time for our first issue, the first opportunity of the year for us to share knowledge and information with you all. This is our twelfth year of delivering high quality articles to all of you.

The editorial team are preparing a steady flow of high-quality articles for you, these ones are the first to go, and we have also added an "old" article from an earlier FPE issue.

We have just celebrated the very successful SFPE PBD Conference in Singapore. It was a great event, full of very good presentations and a lot of networking activities. It was good to meet new faces and old colleagues. In my mind the presentations on the case studies were great, different approaches to the same problems and in every presentation there was something new, I took a lot of good ideas back with me. All presentations are available from SFPE (including live recordings).

I will not go into any details about the articles, but I would like to mention the one about "A Risk-Informed Approach to Regulatory Changes for Fire Requirements" which I did find very interesting and also something that we as a profession must try to get our grip on, and it was also a subject that was discussed a lot in Singapore.

If there are readers out there that feel that you have an important subject that you would like to share with the industry do not hesitate to contact us, we can make that happen.

As always, a great thanks to the people who have put in a lot of time and effort to make this issue a reality.

The next issue will come in June/July.

Yours sincerely,

Jimmy Jönsson, Managing Editor

SFPE Europe Q1 2026 Issue 41

A Message from the SFPE Europe Chair

Dear Members of the SFPE Europe,

It goes without saying that providing fire safety for all has become more complex over the years. When I embraced this career two decades ago, I thought designing buildings was all of it. I never imagined we would be dealing with battery fires in vehicles and storage, photovoltaics, or living walls. I had no idea why I would need to know anything about wildfires or wind engineering. Back then, I trained for the role of a Fire Safety Engineer dealing with building design fires, compartmentation, fire resistance and automation. Yet, the needs for my role have changed so much.

I write this from a privileged position. In the end, I did receive a full formal education as a Fire Safety Engineer. Even if not complete in all caveats of fire science (is any education ever complete?), it was sufficient to embark on the journey I am still enjoying so much. During those years, I learned that this is a profession of continuous learning. How would I cope today without the foundation I received at university?

With the challenges around us, we seem to be too few. Nearly every engineering company I speak to stresses how difficult it is to recruit people—those with formal FSE education, but also those pivoting into our profession from other worlds. We need more of them, from both groups. At the same time, we must ensure that their **competencies and credentials** are robust and reliable.

I have been looking for a theme to guide my presidency at SFPE Europe. I now believe this should be a time to strengthen professional recognition, embrace the scientific foundations of fire engineering, and ensure that fire safety professionals are equipped with a rigorous basis for design. I will work hard on this together with my colleagues on the SFPE Europe Board, as well as Chapter Leaders and members across our Chapters.

I hope this is something you also resonate with, and that you will lend me your support. Only together can we ensure our profession thrives—it is our shared responsibility.

Wojciech Węgrzyński

SFPE Europe Chair

A Risk-Informed Approach to Regulatory Changes for Fire Requirements

By: Brian Meacham, Lund University, Sweden

Kyle Christiansen, SenezCo Fire Science & Engineering, USA

Nicholas Ozog and Carl Baldassarra, Wiss, Janney, Elstner Associates, USA

Greg Metz, Minnesota Department of Labor and Industry, USA

Building regulatory changes for fire safety can be difficult. Fire safety provisions of building regulations in many countries are steeped in history, with many of the most recent changes reacting to the last fire that yielded unwanted consequences. Some criticize function- or performance-based building regulations for not having enough guidance or 'guardrails' to control for emerging fire hazards and risk, leaving too many decisions to designers and engineers. Likewise, some prescriptive building regulations (or compliance documents) layer on new provisions, with little or no assessment of the interaction with historical provisions. There are further critiques that prescriptive building regulations do not address emerging hazards in a timely manner. At the same time, building regulations try to address changing societal and policy objectives and provide flexibility for innovation, all while delivering buildings that meet a level of societally tolerable risk. In some cases, risk in general, and fire risk specifically, are not expressly considered in any of the regulatory change evaluations.

Risk-informed decision-making (RIDM) can provide the basis for assessing regulatory change for fire that uses available hazard and risk data, along with a breadth of stakeholder perspectives, to understand, benchmark and evaluate options, and to facilitate discussion, agreement and change. It can be used to consider the impact of policy changes that are deemed important for society, innovation that comes from the market, and concerns from the public and other stakeholders.

As the name implies, RIDM is an approach that uses risk data to inform decisions, and which features stakeholder deliberations to help assure common understanding. Numerous definitions for RIDM exist, with variation depending on the use context. The U.S. Federal Energy Regulatory Commission (FERC),

for example, defines RIDM as “the process of making safety decisions by evaluating if existing risks are tolerable and present risk measures are adequate, and if not, whether alternative risk reduction measures are justified” [1]. RIDM has broad application within the structural engineering community [e.g., 2-5], and while slow to catch on, this has also been suggested for fire safety engineering [e.g., 6] and building regulation [e.g., 7-9]. A critical attribute of RIDM is that the focus is not specifically on how one quantifies risk, but how one uses risk information in a decision. This makes RIDM different than risk-based design, which is often based on achieving a specific risk or reliability value.

In North America, there is currently significant discussion and debate regarding potential regulatory changes to allow for a single exit stair for residential buildings in the range of 4-6 stories above grade with limited floor plate areas [e.g., 10-12]. Several proponents cite the need for more mid-level housing, and have raised questions concerning the need for two exit stairs, which could place limits on siting such buildings. For those outside of North America, this concern may seem disproportionate for rather small buildings, since single-stair residential buildings are permitted to much higher levels in Europe and elsewhere around the world [e.g., see 10, Appendix A.2.] However, North America has a long history of requiring at least two means of egress in buildings, dating to historical fires such as the Triangle Waistcoat Fire in 1911 and development of the NFPA 101, The Life Safety Code, which originated in the NFPA Committee on Safety to Life which was formed in 1931 [13].

In 2025, the U.S. State of Minnesota (MN) Department of Labor and Industry (DLI) authorized a RIDM approach to compare the risk in single stair multi-family dwelling (MFD) configurations to code-compliant single-exit stair and two-exit stair MFDs [14]. In this study, the RIDM approach that was applied consisted of the steps as outlined in Fig 1:

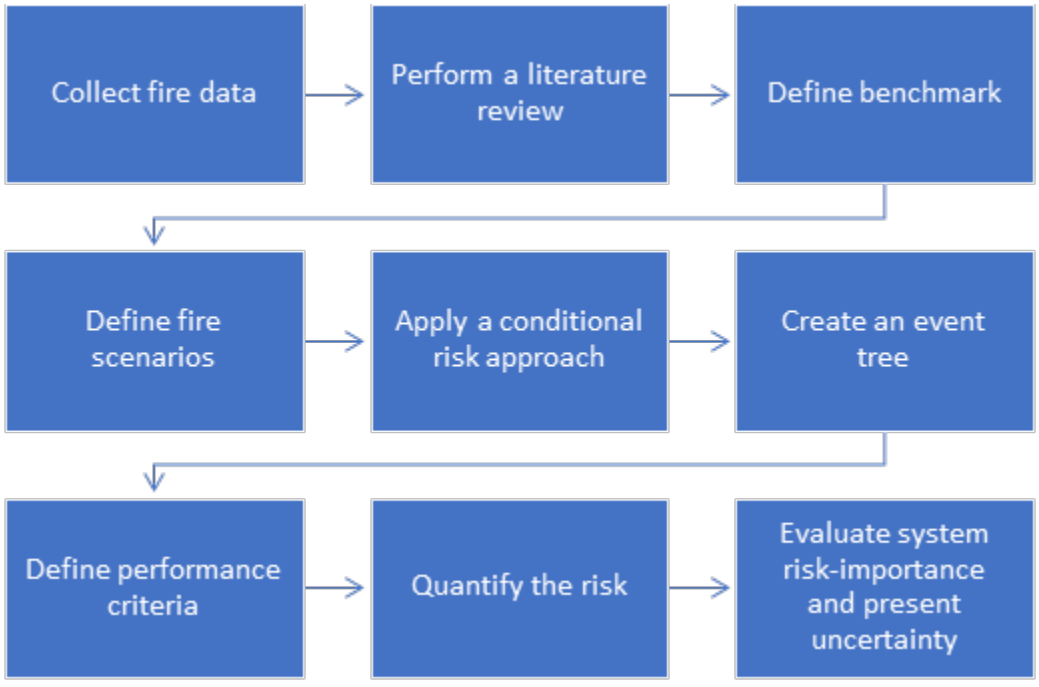

Fig 1. RIDM approach to single-exit stair MFD risk comparison [authors]

Fire loss data and system performance data were collected from U.S. national and MN data sources. This included data on civilian and firefighter injuries and fatalities and fire protection system reliability in

MFD fires, as well as baseline data regarding fire sources, fire locations, and location of fatalities in MFD fires. The literature search was used to obtain data and information on performance of systems for which U.S. national and Minnesota datasets did not include, such as fire door reliability. The literature search was also used to acquire additional information regarding fire sources and locations, typical fuels and size of fire that could be reasonably expected in MFD in sprinklered and non-sprinklered scenarios, MFD unit size information, tenability criteria, and occupant characteristics.

Input was also collected from a wide range of stakeholders via surveys, interviews, and the Technical Advisory Group (TAG) set up by the MN DLI. Furthermore, a series of decisions on factors to consider, including how to benchmark risk for this analysis, building configurations to consider, occupant loads, fire safety systems and features of MFD buildings, were made in conjunction with the MN DLI. In particular, use of this type of analytic-deliberative risk characterization process [15,16] helped to assure a variety of inputs were heard and considered, appropriate boundary conditions could be set, and limitations on data and subsequent analysis could be fully vetted.

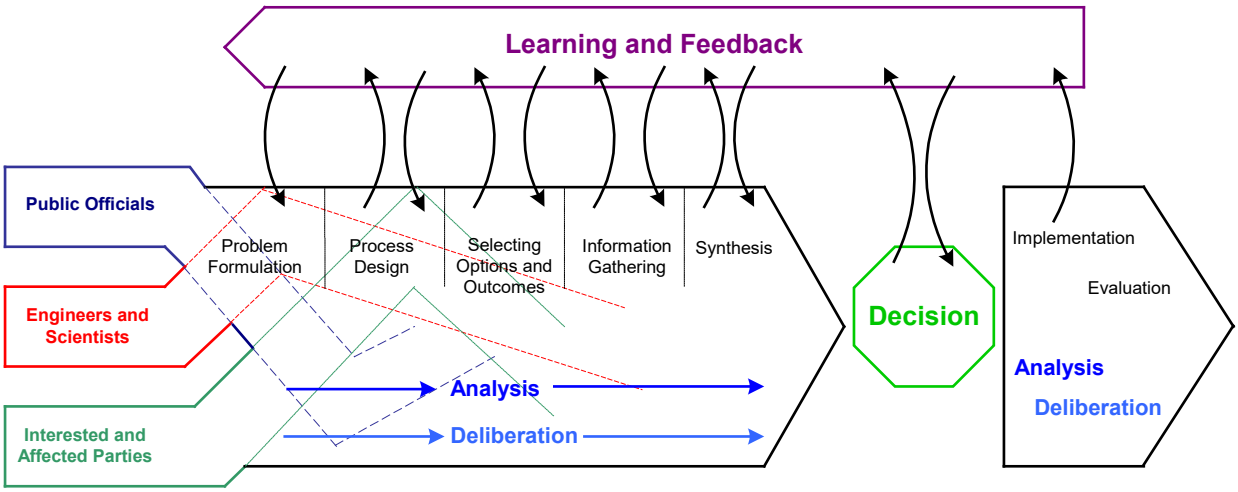

Fig 2. Exemplar analytic-deliberative risk characterization process [15,16]

Outcomes of discussions with the TAG included agreement on taking a comparative risk approach, in which the risk associated with a benchmark building would be used to compare different prototype options. It also included agreement on using a conditional risk approach, which assumes probability of fire ignition of 1.0. This helped to mitigate the lack of publicly available ignition probability data and significant uncertainty that would be associated with ignition probability estimates. Building configurations for benchmark and comparison were also agreed to. Initial mitigating systems were identified as those required by MN building regulation. The TAG also agreed with the event tree approach, as well as defining the consequence as the number of occupants likely to remain in the MFD after tenability limits in the egress pathway had been reached. Finally, it was agreed that although fire service response can play an important role in rescue operations, data describing the fire response are lacking, and thus like ignition probability, this factor was not considered.

Next steps involved creating the event tree using the code-required mitigating systems to estimate the probability of different end states occurring based on mitigating system success or failure. The event tree can be modified as needed to quantify the risk benefit of incorporating optional mitigating systems. Fire

modeling was used to estimate tenability conditions when the unit or origin door to the corridor was open. Risk to occupants in the unit of origin was not considered, as the code assumed that protection could not be guaranteed. Response time of occupants to cues and bases of movement time were taken from the literature. With consequence being a function of the number of occupants remaining in the building when tenability limits in the exit pathway are reached, the alerting of occupants plays a key role. The event tree is shown in Fig. 3.

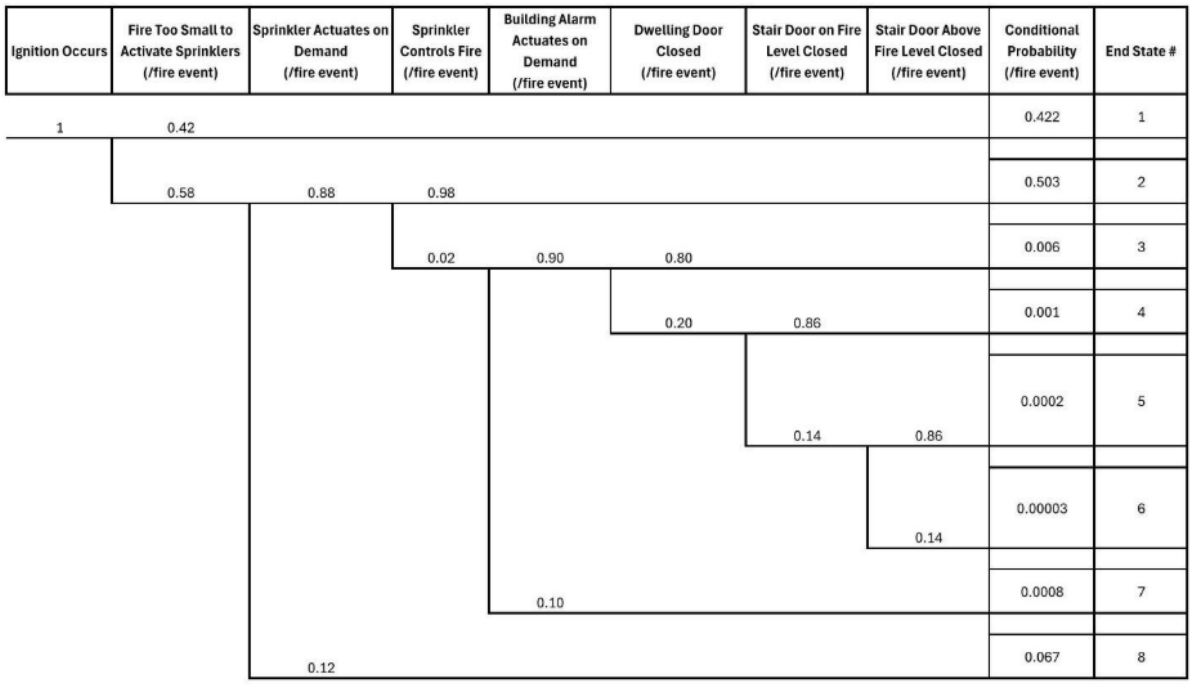

Fig 3. Event tree for comparative risk assessment [14]

The risk from fires originating in the dwelling unit's living room and the building corridor are calculated using the event tree probability and consequences for each end state. The most risk-significant mitigating system is the automatic sprinkler system which provides three key functions: applies water to the fire, activates the building-wide fire alarm system to cue occupant evacuation, and to dispatch the fire department. The results also show that the risk of the prototype single-exit stair MFD can be reduced to comparable risk levels of code compliant single-stair MFD by introducing a common area smoke detection system interlocked with the MFD's building-wide fire alarm notification system (not currently required by the MN code). The analysis indicates that a second exit stair is not significant in lowering risk further for the configurations considered. An in-depth discussion of the approach, data and analysis is available for those who are interested [14].

In the end, the RIDM approach was shown to be highly effective in bringing together a wide range of data and stakeholder perspectives, facilitating agreement on how to characterize risk, consequence, and use of probability concepts, and achieving a robust analysis that met the need of the MN DLI and policy makers. Aside from the successful application in MN, the findings illustrate how a well-structured and managed RIDM approach can be used to help inform revisions to building and fire codes and provide actionable strategies for policymakers evaluating fire safety issues.

Acknowledgements

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References

[1] FERC Risk-Informed Decision Making Guidelines, Version 4.1, Federal Energy Regulatory Commission, Washington, DC, March 2016, https://www.ferc.gov/sites/default/files/2020-04/Introduction-to-Risk-Informed-Decision-Making.pdf

[2] Joern Birkmann, Holger Sauter, Ali Jamshed, Linda Sorg, Mark Fleischhauer, Simone Sandholz, Mia Wannewitz, Stefan Greiving, Bjoern Bueter, Melanie Schneider, Matthias Garschagen; Strengthening risk-informed decision-making: scenarios for human vulnerability and exposure to extreme events. Disaster Prevention and Management: An International Journal 27 November 2020; 29 (5): 663–679. https://doi-org.ludwig.lub.lu.se/10.1108/DPM-05-2020-0147

[3] Ersdal, G. (2024). Risk-Informed Decision-Making for Assessment of Existing Structures. In: Pavlou, D., et al. Analytical and Experimental Methods in Mechanical and Civil Engineering. OES 2023. Structural Integrity, vol 28. Springer, Cham. https://doi-org.ludwig.lub.lu.se/10.1007/978-3-031-49723-0_11

[4] Jianxu Su, Junping Zhang, Colin C. Caprani, Junyong Zhou, A practical framework for determining target reliability indices for the assessment of existing structures based on risk-informed decision-making, Structural Safety, Volume 114, 2025, 102583, ISSN 0167-4730, https://doi.org/10.1016/j.strusafe.2025.102583.

[5] Ellingwood, B.R. (2022). Risk-Informed Approaches for Mitigating Impacts of Extreme and Abnormal Events in the Built Environment. In: Stewart, M.G., Rosowsky, D.V. (eds) Engineering for Extremes. Springer Tracts in Civil Engineering . Springer, Cham. https://doi-org.ludwig.lub.lu.se/10.1007/978-3-030-85018-0_3

[6] Alvarez, A., Meacham, B.J., Dembsey, N.A. and Thomas, J.R., "A Framework For Risk-Informed Performance-Based Fire Protection Design For The Built Environment," Fire Technology, DOI 10.1007/s10694-013-0366-1, Vol. 50, pp161-181, 2014.

[7] Meacham, B.J. "A Risk-Informed Performance-Based Approach to Building Regulation," Journal of Risk Research, Vol.13, Issue 7, 2010

[8] Meacham, B.J., Stromgren, M. and van Hees, P. "A Holistic Framework for Development and Assessment of Risk-Informed Performance-Based Building Regulation," Fire and Materials, DOI:10.1002/fam.2930, 2020.

[9] Meacham, B.J., van Straalen, IJ.J. and Ashe, B. "Roadmap for incorporating risk as a basis of performance objectives in building regulation," Safety Science, 141 (2021) 105337, https://doi.org/10.1016/j.ssci.2021.105337, 2021.

[10] Pew Foundation, Small Single-Stairway Apartment Buildings Have Strong Safety Record, https://www.pew.org/en/research-and-analysis/reports/2025/02/small-single-stairway-apartment-buildings-have-strong-safety-record

[11] Len Garis, Evaluating Stakeholder Concerns About Proposed Single Egress Stairs - Residential Buildings in Canada, and What the Data Tells Us, University of the Fraser Valley,

https://cdn.ymaws.com/cafc.ca/resource/resmgr/single_egress_resources/Single_Stair_Egress_Report-v.pdf

[12] NFPA, One Stair, Two Perspectives: Single Exit Stair Symposium, NFPA, Quincy, MA, https://www.nfpa.org/en/education-and-research/building-and-life-safety/the-single-exit-stair-debate

[13] NFPA 101, The Life Safety Code, National Fire Protection Association, Quincy, MA, USA.

[14] WJE & Crux (2025). Minnesota Single-Exit Stairway Apartment Building Study. https://dli.mn.gov/sites/default/files/pdf/Minnesota_Single-Exit_Stairway_Apartment_report.pdf

[15] Stern, P.C. and Fineburg, H.V., eds., Understanding Risk: Informing Decisions in a Democratic Society, National Academy Press, Washington, DC, 1996.

[16] Meacham, B.J., "Understanding Risk: Quantification, Perception and Characterization," Journal of Fire Protection Engineering, Vol. 14, No. 3, pp.199-228, 2004

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Fire Retardant Impregnated Wood Products and the Question of Long-Term Fire Performance When Exposed To Outdoor Environments

By: Carolina Arvidsson and Konrad Wilkens, Lund University, Sweden.

Introduction

Wood is no longer just for cabins in the woods. It is climbing skywards in tall buildings like the 20-story *Sara Kulturhus* in Skellefteå Sweden [1] and planned to be entire neighborhoods like *Stockholm Wood City* [2]. The appeal is clear: wood is renewable, stores carbon, feels warm and promotes wellbeing more than concrete and steel [3,4]. However, wood and fire have a complex relationship. In modern cities, external parts of building i.e. façades, are potential fire highways, allowing flames to race from one apartment to the next, as seen in many recent façade fire events, Grenfell [5]and more recently at the Turkish ski resort Kartalkaya hotel fire 2025[6]. To keep wood façades both beautiful and compliant with fire codes and safety, many turn to treating them with fire-retardant chemicals. The idea is admirable: preserve the natural look, while reducing its susceptibility to fire. That has been, and still is, the concept. But does it hold up after two months, years or decades of real-world exposure to harsh climates and weathering?

Fire (or Flame) retarded (FR) wood, represent a group of materials/products that becoming more widely used in modern construction to reduce the fire risks associated with untreated wood, limiting potential flame spread and heat release, and contributing to compliance with countries building code requirements, e.g. via reaction-to-fire classifications under EN 13501[7]. Such treatments have expanded the use of wood in the built environment where regulatory frameworks have historically restricted its use due to its potential to burn.

However, what happens when you add some fire-retardant chemicals to your wood and then put them outside, exposed to the earth's unpredictable weather and the onslaught of time? Well… *we aren't sure if we are being honest*. Changes in the chemicals used, and the processing methods, make it very hard to generalize, but it has long been known, though maybe less widely acknowledged, that the fire performance of these materials is not necessarily stable over time, particularly when these materials are used in areas that are exposed to the external environment. Aging, moisture ingress, ultraviolet (UV) light exposure, cyclic wetting (rain)/drying and temperature changes, can all lead to the movement and partial or complete loss of the fire-retarding chemicals, through mechanisms like leaching and UV degradation. As a result, these materials and products that may have initially met fire performance requirements, after some time no longer behave as assumed in the fire safety design or regulatory approval. What then?

There are many technical and regulatory challenges associated with the long-term fire performance of these materials, here we are mainly focusing on external applications as these have the highest risks of exposure. What are the potential implications for fire risk, building code compliance and professional practice?

Fire Retardant Treatments for Wood: Principles, Problems, Testing and its Limitations

Fire retardant treatments for wood typically take one of two approaches: surface protection – using a coating with fire retarding performance – e.g. a paint or varnish, or via impregnation - using pressure and vacuum to embed the chemical agents into the wood product itself, leaving the end-product looking similar to how it was before treatment i.e. like natural wood. Within this article we focus on the latter method, which is desirable due to its natural wood finish. The chemical agents impregnated are intended to alter the thermal decomposition and combustion behaviour of the wood they are added too. How they work varies with the chemicals used – commonly for wood, the mechanisms include *char promotion* – converting more of the wood to char, rather than it becoming gaseous volatiles – that feed a flaming fire [8] and diluting combustible gases by producing more non-combustible gases [9]. These treatments can significantly improve important fire performance parameters, such as ignition time, heat release rate and flame spread propensity.

From a regulatory perspective, the performance of FR wood is usually demonstrated through *reaction-to-fire* testing, which in Europe is governed by the Euroclass system through EN 13501-1 [7], and for FR wood products generally this requires Single Burning Item (SBI) testing via EN 13823 [10] as a minimum (some countries may require further testing in specific use cases). Importantly, these tests are conducted on new or recently manufactured specimens, under controlled laboratory conditions. The implicit assumption here is that the tested performance is representative of the material or product throughout its service life. In the case of FR wood materials – for internal applications in dry, controlled environments, this assumption may be reasonable. For external applications, however, the validity of this assumption becomes far less certain.

Weathering, Aging and Loss of Fire-Retardant Chemicals

When FR wood is used outdoors, it is subject to a range of environmental stressors that can significantly affect its composition and performance, not only for fire. Moisture is one of the critical factors. Many of today's commercially available fire-retardants use, in their base, hydroscopic chemicals (some add fixatives as a method to better hold these chemicals in the wood), and repeated exposure to rain, condensation or even high humidity can lead to migration and leaching of these chemicals from the wood matrix [11]. In addition, cyclic exposure, to wetting, drying, can cause microstructural changes in the wood, cracking and increased permeability [12]. UV radiation exposure degrades surface layers [13], while temperature fluctuations further drive diffusion processes within the material. Over time, the combination of these mechanisms can result in further chemical losses, particularly near the exposed surfaces, which will affect phenomena like ignition and surface flame spread more significantly.

Laboratory and field studies have exhibited that weathered FR wood can have markedly different fire behaviour compared to un-weathered specimens e.g.[14–23]. The late, Dr. Birgit Östman especially, had been repeatedly raising these issues surrounding FR wood products for decades, and have authored (with others) some of the only long-term studies available in the literature [24,25] on this topic. Recently activities at Lund University, including a number of master's thesis projects (past and ongoing) [21,26–29] are continuing Birgit's work investigating this problem using *real-world samples,* something that is severely lacking in the literature. All these studies, and other quality work from research institutes such as; Göttingen University [15,22,23], Luleå University of Technology[30], University of Tokyo [18–20] and others. All show similar outcomes to an extent – increasing heat release rates, changed ignition times, and more rapid flame spread have all been observed, after both natural and artificial weathering/aging, in some cases the performance of weathered FR wood approaches something more like untreated wood behaviour.

Implications for Facades and External Fire Spread

The issue of long-term fire performance is particularly critical for facades and external wall systems. In these applications, fire safety strategies, expect that materials/products chosen should contribute to limiting external fire spread, preventing vertical flame propagation, and limit fire growth that can compromise occupant and building safety, and firefighting operations. If FR wood loses its effectiveness over time, these assumptions may no longer be valid, meaning fire safety strategies and building compliance with regulations, which are built on these assumptions may also no longer be valid.

Building Codes, Compliance, Documentation and the Question of Service Life

From a regulatory perspective, the challenges associated with FR wood products are closely linked to how compliance is defined and demonstrated within existing regulatory frameworks. In Europe, reaction-to-fire performance is primarily regulated under the Construction Products Regulation (CPR) through harmonised standards and classification systems such as EN 13501-1 [7]. These frameworks are largely based on initial performance testing of products in a defined controlled condition at the time of placing on the market. Under the CPR, manufacturers are required to declare the performance of their products through a Declaration of Performance (DoP), supported by type testing and factory production control. However, the CPR does not explicitly require that declared fire performance be maintained for a defined service life. As a result, long-term degradation of fire performance due to weathering or aging is often outside the formal scope of regulatory assessment. The issue of durability is partially addressed in EN 16755[31], which introduced durability classes for FR wood products based on some leaching and weathering testing. While EN 16755 represents an important step forward, its application is currently not mandatory, and its results are more qualitative, as they provide limited insight into how performance evolves over time, just that a sample passes or fails a set criterion after a set amount of natural or artificial aging, and it cannot be used to say anything about a material or products service life or maintenance requirements.

Information on service life, expected durability of FR treatments, and required maintenance is frequently hard to find, completely absent or expressed in vague, non-committal terms such as “does not affect the service life of the wood”, “ages the same as untreated wood”, or “does not need any additional maintenance” and thus provides little practical guidance to designers, building owners or regulators and is counter to much of the evidence provided by the scientific literature. From a fire safety engineering perspective, this is problematic as this conflicting information hinders informed decision making – making it difficult to assess whether a proposed solution is robust over the intended life of the building, and places reliance on assumptions that do not seem to be supported by much quantitative evidence. Further, unlike active fire protection systems, FR wood products are rarely subject to routine inspection or maintenance regimes. Once installed, that’s it. Even if we wanted too, in practice, there is no straight forward way to verify the FR content, or fire performance of products once installed*. (*there are some projects that are looking at this issue e.g. [32,33].

Implications for Fire Safety Engineering Practice

For fire safety engineers, the challenges associated with FR wood materials and products highlight the importance of critically evaluating performance claims and being properly informed. Reliance on classification alone may be insufficient, particularly for external applications and long service lives. Where FR wood is proposed, engineers could consider questions such as:

- Has the material been tested after representative weathering or aging?
- Is there clear, creditable guidance and limitations with regards to maintenance and service life of the material or product?
- How sensitive is the overall fire safety strategy to the potential degradation of the material or products fire performance? (i.e. what if untreated wood were used?)

Based on our current understanding, it is likely that the engineering team may conclude that the answers to the first two questions are "No". Consequently, the design team should consider investigating the sensitivity of the facade material to the presence (or absence) of fire retardant (question 3). In many countries, this will demonstrate the clear need for a performance-based design approach. Addressing the first two questions better will require action between multiple stakeholders. Manufacturers/producers need to provide clear documentation, will explicit statements on durability, service life and maintenance requirements, and evidence as to how they were determined. Regulators should strengthen requirements for weathering and aging assessment, particularly for exposed or external applications. Within the fire safety engineering community, there is a need for diligence and critical assessment of materials, and for continued research into the long-term fire behaviour of materials such as FR wood, that are exposed to fluctuating environments, as improving our understanding of degradation mechanisms can support better products, guidance and more reliable design practices.

References

[1] https://www.sarakulturhus.se/sv/ett-klimatklokt-hus/, Sara Kulturhus, Ett Klimatklokt Hus (A Climate Smart-House) (2025).

[2] Atrium Ljungberg. (n.d.), Stockholm Wood City, Https://Www.al.Se/Sickla/Stockholmwoodcity/ (2025).

[3] H. Ikei, C. Song, Y. Miyazaki, Physiological effects of wood on humans: a review, Journal of Wood Science 63 (2017) 1–23. https://doi.org/10.1007/s10086-016-1597-9.

[4] A.Q. Nyrud, T. Bringslimark, Is interior wood use psychologically beneficial? A review of psychological responses toward wood, Wood and Fiber Science (2010).

[5] S.T. McKenna, N. Jones, G. Peck, K. Dickens, W. Pawelec, S. Oradei, S. Harris, A.A. Stec, T.R. Hull, Fire behaviour of modern façade materials – Understanding the Grenfell Tower fire, J. Hazard. Mater. 368 (2019) 115–123. https://doi.org/10.1016/j.jhazmat.2018.12.077.

[6] Wikipedia contributors, 2025 Kartalkaya hotel fire, Wikimedia Foundation Inc. Https://En.Wikipedia.Org/Wiki/2025_Kartalkaya_hotel_fire (2026).

[7] European Committee for Standardization, EN 13501-1 Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests, 2009.

[8] J.L. Torero, Flaming ignition of Solid Fuels, in: SFPE Handbook of Fire Protection Engineering, 4th ed., 2016: pp. 2–260; 2–277.

[9] I. Hansen-Bruhn, T.R. Hull, Flammability and burning behaviour of fire protected timber, Fire Saf. J. 140 (2023). https://doi.org/10.1016/j.firesaf.2023.103918.

[10] C.C. Secretariat, EN 13823 - European Standard - Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item (SBI), Brussels, 2022.

[11] C.F. Lin, O. Karlsson, I. Kim, O. Myronycheva, R.A. Mensah, M. Försth, O. Das, G.I. Mantanis, D. Jones, D. Sandberg, Fire Retardancy and Leaching Resistance of Furfurylated Pine Wood (Pinus sylvestris L.) Treated with Guanyl-Urea Phosphate, Polymers (Basel). 14 (2022). https://doi.org/10.3390/polym14091829.

[12] L. Yermán, L.-M. Ottenhaus, C. Montoya, J.J. Morrell, Effect of repeated wetting and drying on withdrawal capacity and corrosion of nails in treated and untreated timber, Constr. Build. Mater. 284 (2021) 122878. https://doi.org/10.1016/j.conbuildmat.2021.122878.

[13] V. Jirous-Rajkovic, H. Turkulin, E.R. Miller, Depth profile of UV-induced wood surface degradation, Surface Coatings International Part B: Coatings Transactions 87 (2004) 241–247. https://doi.org/10.1007/BF02699671.

[14] L. Mesquita, L. Ferle, G. Santos, Durability of reaction to fire performance of wood based panels through accelerated aging cycles, in: Lecture Notes in Civil Engineering, Springer, 2020: pp. 31–47. https://doi.org/10.1007/978-3-030-36240-9_3.

[15] M. Wu, L. Emmerich, K. Kurkowiak, H. Militz, Fire resistance of pine wood treated with phenol-formaldehyde resin and phosphate-based flame retardant, Wood Mater. Sci. Eng. (2023). https://doi.org/10.1080/17480272.2023.2205379.
[16] T. Harada, H. Matsunaga, Y. Kataoka, M. Kiguchi, J. Matsumura, Weatherability and combustibility of fire-retardant-impregnated wood after accelerated weathering tests, Journal of Wood Science 55 (2009) 359 – 366. https://doi.org/10.1007/s10086-009-1039-z.
[17] R.H. White, Accelerated weathering of fire-retardant-treated wood for fire testing, in: 20th Annual Conference on Recent Advances in Flame Retardancy of Polymeric Materials 2009, 2009: pp. 264 – 276. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893298538&partnerID=40&md5=a693d94b25b5b3f661a2e7c86fdda15b.
[18] M. Nakamura, H. Yoshioka, M. Kanematsu, T. Noguchi, S. Hagihara, A. Yamaguchi, K. Shimizu, T. Sugita, Y. Matsumoto, Y. Nishio, T. Hayakawa, Reaction-to-fire performance of fire-retardant treated wooden facades in Japan with respect to accelerated weathering, in: MATEC Web of Conferences, 2016. https://doi.org/10.1051/matecconf/20164605011.
[19] H. Yoshioka, Y. Nishio, M. Kanematsu, T. Noguchi, T. Hayakawa, X. Zhao, FIRE BEHAVIOR OF FIRE-RETARDANT TREATED WOODEN FACADES: COMPARISON OF DETERIORATION CAUSED BY ACCELERATED WEATHERING AND NATURAL EXPOSURE IN JAPAN, 2021. https://doi.org/XXX.
[20] M. Nakamura, Y. Nishio, S. Hagihara, K. Shimizu, M. Kanematsu, H. Yoshioka, T. Sugita, T. Noguchi, Evaluation of durability of reaction-to-fire performance of fire-retardant treated wooden facades by accelerated weathering test; [外装用難燃処理木材の経年劣化を考慮した防火性能評価に関する研究], AIJ Journal of Technology and Design 25 (2019) 709 – 714. https://doi.org/10.3130/aijt.25.709.
[21] F. Engström, H. Psajd, Beständigheten hos brandimpregnerat trä, Thesis, Lund University , 2024.
[22] M. Wu, J. Karthäuser, L. Martin, L. Emmerich, K.W. Flecknoe-Brown, L. Hesse, C. Hötte, H. Militz, Long-term durability and flame retardancy for outdoor wood: Multifunctional enhancement using phenol-formaldehyde resin and monoguanidine phosphate salt, Ind. Crops Prod. 235 (2025) 121825. https://doi.org/10.1016/j.indcrop.2025.121825.
[23] M. Wu, L. Emmerich, H. Militz, Studies on the Durability of the Reaction to Fire Performance of Melamine Formaldehyde Resin and Phosphorus Polyol Treated Wood, in: 2025: pp. 151–157. https://doi.org/10.1007/978-3-031-99418-0_19.
[24] B.A.L. Östman, L.D. Tsantaridis, Durability of the reaction to fire performance of fire-retardant-treated wood products in exterior applications–a 10-year report, International Wood Products Journal 8 (2017) 94–100. https://doi.org/10.1080/20426445.2017.1330229.
[25] Östman B, Tsantaridis L, Erratum to: Durability of the reaction to fire performance of fire-retardant-treated wood products in exterior applications – a 10-year report, International Wood Products Journal 8 (2017) 190. https://doi.org/10.1080/20426445.2017.1352217.
[26] C. Arvidsson, Does timber burn? A field study of naturally weathered fire-retardant-impregnated timber façade, LTH, 2025. www.brand.lth.se.
[27] K. Wilkens Flecknoe-Brown, N. Johansson, H. Psajd, F. Engström, Fire Performance of Impregnated Wood Subjected to Natural Aging in the Swedish Climate, in: FSF 2024 : The 4th International Symposium on Fire Safety of Facades - The 4th International Symposium on Fire Safety of Facades, RISE, Research Institute of Sweden, Lund, 2024.
[28] K. Wilkens Flecknoe-Brown, R. Hosseinpourpia, S.A. Ahmed, E.E. Thybring, N. Johansson, M. Fredriksson, Can bio-chemicals improve the fire performance of wood?, in: 21st Annual Meeting of the Northern European Network for Wood Science and Engineering, Växjö, 2025: pp. 25–27.
[29] E. Arinaitwe, J. Rex, K. Wilkens, V. Malmborg, J. Pagels, M. McNamee, Characterisation of fire smoke emissions from fire retardant wood, J. Phys. Conf. Ser. 2885 (2024) 012033. https://doi.org/10.1088/1742-6596/2885/1/012033.
[30] Chia-feng Lin, Olov Karlsson, Oisik Das, Rhoda Afriyie Mensah, George I. Mantanis, Dennis Jones, Oleg N. Antzutkin, Michael Försth, Dick Sandberg, High Leach-Resistant Fire-

Retardant Modified Pine Wood (Pinus sylvestris L.) by In Situ Phosphorylation and Carbamylation, ACS Omega (2023).
[31] CEN, EN 16755 - Durability of reaction to fire performance - Classes of fire-retardant treated wood products in interior and exterior end use applications., 2017.
[32] P. Stefansson, I. Burud, T. Thiis, L. Gobakken, E. Larnøy, Estimation of phosphorus-based flame retardant in wood by hyperspectral imaging—a new method, Journal of Spectral Imaging (2018). https://doi.org/10.1255/jsi.2018.a3.
[33] Brandforsk., B. Källander, K. Wilkens, N. Johansson, Cost-effective method to estimate fire protection treatment status on existing facades, 2026.

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Fostering the effective fire response and the risk reduction at the community level —A Case Study of Zihuatanejo, Mexico—

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1. Introduction

This study ethnographically documents the process through which a community-based disaster risk reduction organization, the Community Emergency Response Team (hereafter "CERT"), in Zihuatanejo de Azueta, Guerrero State, Mexico (hereafter "Zihuatanejo"), came to play a central role in initial fire response and evacuation support during a large-scale fire that occurred in December 2018. The study also suggests the potentials of the promotion for the fire prevention at the communities of the non-engineered housings.

Cases in which local residents voluntarily assume responsibilities for disaster risk reduction and response have been increasingly implemented in many countries. Examples include community-based disaster risk reduction organizations "*Jishubosai Soshiki*" in Japan (for example, Shiroshita et al, 2024), Community Emergency Response Teams in the United States (for example, FEMA, 2025) and volunteer brigades in New Zealand (for example, Fire and Emergency New Zealand, 2026). In general, these community-based groups collaborate with public disaster risk management and emergency response agencies to promote disaster preparedness at the local level and to support response during actual disaster events.
Research examining the outcomes of such community-based group has included questionnaire-based surveys targeting these organizations (for example, Tomeno et al, 2024; Nakai & Nakano, 2023). In addition, ethnographic studies have followed these groups over extended periods, describing how they are formed, what types of training they undergo, and how positive community engagement in disaster risk reduction emerges through these processes (for example, Sugiyama & Yamori, 2022).

The ethnography presented in this study is grounded in an action research approach. Action research, originally proposed by psychologist Kurt Lewin (1946), is a research orientation in which researchers stay in the study area and work collaboratively with local stakeholders—such as government officials and residents—to generate new value and address local challenges through collaborative practice.
Between 2016 and 2019, the author stayed in Zihuatanejo for approximately 300 days. This stay was conducted under the framework of the Japanese government–supported program *Science and Technology Research Partnership for Sustainable Development (SATREPS)*, entitled "Hazard Assessment of Large Earthquakes and Tsunamis in the Mexican Pacific Coast for Disaster Mitigation." Accordingly, the primary focus was on earthquake and tsunami risks, and evacuation

drills and educational programs related to these hazards were conducted in collaboration with the Zihuatanejo Civil Protection, reaching a cumulative total of more than 10,000 participants. The establishment of CERTs in Zihuatanejo was implemented as part of this program.
The next section describes the fire incident in detail, followed by a description of the process through which CERTs came to engage in disaster response.

2. Fire Incident and CERT Response

Zihuatanejo is a medium-sized coastal city facing the Pacific Ocean, with a population of approximately 120,000. It is well known as a beach resort, and its lowland areas contain a concentration of hotels, restaurants, supermarkets, and residential housing. Residential areas have expanded toward the surrounding hills, and poverty levels generally increase with elevation. As a result, while many buildings in the lowland areas are constructed of concrete blocks and fire-resistant materials, hillside communities are often composed of non-engineered housings assembled from wooden boards, thus fire risks were extremely high. Although these communities are electrified, they lack a piped water supply and instead rely on periodic water deliveries by water tank trucks.

The fire occurred in one such hillside community. At approximately 13:45 on December 23, 2018, the Zihuatanejo Fire Department received the first report of a fire. Because December falls within the dry season, building materials were likely dry, allowing the fire to spread rapidly. Ultimately, approximately 100 houses were completely destroyed (Figure 1).

Figure 1. Fire occurred on December 23, 2018
Courtesy: Zihuatanejo Civil Protection

Although the fire site was located only about 1.5 km in distance from the fire station, the narrow mountain roads significantly delayed access, and it took several tens of minutes for fire engines to arrive. As a result, the first responders on scene were CERT members from a nearby community. In a post-fire interview, the CERT leader explained: *"We received reports from residents that smoke was rising. I instructed CERT members to gather with their equipment and head to the site."* The equipment referred to basic protective gear provided upon completion of CERT training, such as fire-resistant gloves, goggles, helmets, flashlights, and masks. Upon arrival, CERT members observed residents remaining inside their homes to retrieve belongings and valuables despite the approaching fire, as well as crowds of onlookers standing by without taking action. CERT members therefore guided residents out of their homes, organized bucket relay among the crowd, and requested cooperation from a water tank truck that happened to be delivering water at the time (Figure 2). These efforts contributed to slowing the spread of the fire and protecting the lives of the local residents.

Figure 2. organized bucket relay among the residents
Courtesy: Zihuatanejo Civil Protection

Subsequently, the Zihuatanejo Fire Department, the State Civil Protection, and the Red Cross arrived at the scene, and CERT members supported firefighting operations in coordination with these public and non-governmental agencies. Because approximately 100 homes were destroyed, many residents lost their housing and evacuation shelters were opened. CERT members also volunteered to assist with shelter management.
The following section describes the process through which CERTs came to take on a proactive role in disaster response.

3. Establishment of CERTs

(1) Chile Training as the motivation for CERT Formation

When the author began visiting Zihuatanejo in July 2016, no community-based disaster risk reduction groups had yet been established in Zihuatanejo. The author therefore explained to Mr. A, an official in the Zihuatanejo Civil Protection, that in Japan, community-based disaster risk reduction organizations are formed in many communities and have demonstrated effectiveness in promoting disaster preparedness and response. The author also introduced a CERT training program organized by the Japan International Cooperation Agency (JICA), scheduled to be held in Chile between April and May 2017. Mr. A expressed interest, was recommended by the author, and subsequently participated in the training.
In Chile, Mr. A learned about CERT organizational structures and training components such as search and rescue and fire safety, and he returned to Mexico certified as a CERT instructor. Together with the author, Mr. A then began working toward the establishment of CERTs in Zihuatanejo.

(2) Preparations for CERT Establishment

Several challenges were encountered in establishing CERTs in Zihuatanejo. One major challenge was team building for training implementation. Because the Zihuatanejo CERT structure consisted of four brigades—first aid, firefighting, search and rescue, and incident command—it was necessary to secure trainers for each brigade. Members were selected from the Civil Protection and the Fire Department, and detailed coordination and information sharing were conducted regarding CERT objectives and training methods. Workshops were also held to strengthen team cohesion and coordination.
Another challenge involved explaining the importance of community-based disaster risk reduction groups to local communities. In Japan, neighborhood associations often serve as the foundation for community disaster risk reduction organizations. In contrast, such local governance structures were absent or weak in Zihuatanejo. As a result, identifying whom to approach and how to disseminate information within communities became key issues.
The initial approach involved visiting influential community leaders to explain the CERT concept. When these leaders expressed interest, they were asked to encourage potential participants within their communities. Even so, it was not possible to immediately recruit sufficient numbers. Repeated visits were made to the same communities, beginning with small groups of residents

and gradually expanding participation as interested individuals invited friends. Once approximately twenty potential CERT members were assembled, CERT training for that community was initiated.

(3) CERT Training

As noted above, CERTs were organized into four brigades— first aid, firefighting, search and rescue, and incident command—and training corresponding to each brigade was provided. In addition, training on psychological care during disasters was incorporated. The program consisted of several tens of hours combining classroom instruction and practical exercises.

The culmination of the training was a full-scale exercise simulating an actual disaster scene. In areas with many wooden structures, full-scale wooden houses were used to recreate scenarios involving earthquake damage, falling debris causing injuries, and subsequent fire outbreaks (Figure 3, left). CERT members practiced a sequence of actions including scene safety assessment, internal situation checks, victim search and assessment, transport and triage, identification of fire sources, and initial fire suppression using extinguishers.

Because Zihuatanejo also contains five-story apartment buildings, training was conducted in actual apartment units (Figure 3, right). Smoke generators were used to limit visibility, and CERT members practiced evacuation guidance, victim search, and rescue procedures under realistic conditions. Members who completed all training components were certified as CERT members. By the end of 2017, 45 CERT members had been trained across two community areas. It was after completing this training that the December 2018 fire occurred.

Figure 3. Training in the wooden structure (left), Training in the five-story building (right)

4. Expansion of CERT Activities

The CERT response during the December 2018 fire attracted significant attention from surrounding residents and the Zihuatanejo municipal government. As a result, CERTs were formally incorporated into the municipal disaster risk management plan. Furthermore, for the first time in Zihuatanejo, joint disaster drills were conducted involving four actors: the community-based CERTs, governmental organizations such as the State Civil Protection Agency and the Zihuatanejo Fire Department, and the NGO Red Cross. These drills simulated earthquake and fire scenarios and led to more active initiatives.

Two key insights emerge from this study: local capacity building and sustained researcher accompaniment. Typically, when external supporters such as NGOs or researchers engage in community disaster risk reduction, they often deliver training directly. In contrast, this study adopted a model in which training was first provided to a local civil protection officer, Mr. A, who then served as the central instructor for CERT training. The researcher acted as a companion to Mr. A, providing expert input—such as training scenarios—across all phases from program design to exercise implementation, while consistently emphasizing that implementation authority resided with locality.

This mode of engagement helped sustain the proactive commitment of civil protection and fire

department personnel to CERT establishment. This approach also suggests the potentials of taking fire safety measures at the communities with non-engineered housing throughout the capacity building and reduce the impact once the fire occur as communities themselves can attend immediately to the fire incident.

References

[1] FEMA: Federal Emergency Management Agency, 2025, Community Emergency Response Team (CERT). Effective February 10, 2026. https://www.fema.gov/emergency-managers/individuals-communities/preparedness-activities-webinars/community-emergency-response-team.

[2] Fire Emergency New Zealand, 2026, Different ways to volunteer. Effective February 10, 2026. https://www.fireandemergency.nz/work-or-volunteer-for-us/volunteering/different-ways-to-volunteer/.

[3] Lewin, K. 1946. "Action research and minority problems." Journal of Social Issues 2 (4). 34–46.

[4] Nakai, F. & Nakano, G., 2023. "Community-mediated individual disaster preparedness practices: A case study in Kochi, Japan." *International Journal of Disaster Risk Reduction* Vol 86. 103532. https://doi.org/10.1016/j.ijdrr.2023.103532.

[5] Shiroshita, H., Jayaratne, R. & Kitagawa, K. 2024. "Integrating communities' perspectives in understanding disaster risk." *Natural Hazards* 120, 8263–8282. https://doi.org/10.1007/s11069-024-06452-0.

[6] Sugiyama, T. & Yamori, K. 2022. "Analysis of regional response and development of disaster prevention teaching materials for "Nankai Trough Earthquake Extra Information". *IDRiM Journal* 12.1. 24-38.

[7] Tomeno, R., Toyoda, Y., & Kanegae, H,. 2024. "A study on promoting proactive activities of Voluntary Disaster Management Organization through Evacuation Shelter Operations Gaming in Fukakusa elementary school district, Fushimi ward, Kyoto city." *Journal of Social Safety Science* Vol. 44, 207-216.

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