Highlighting the Danger of Water Storage Zones in Baixo Tâmega Valley

Jorge Pinto[1], Sandra Pereira[1(✉)], Cristina Reis[2], Paula Braga[3], and Isabel Bentes[1]

[1] UTAD/CMADE, Vila Real, 5000-801 Vila Real, Portugal
{tiago,spereira,ibentes}@utad.pt
[2] UTAD/CONSTRUCT/INEGI, 5000-801 Vila Real, Portugal
crisreis@utad.pt
[3] UTAD/INEGI, 5000-801 Vila Real, Portugal
plsilva@utad.pt

Abstract. This paper intends to highlight the problem of water-related accidents using Baixo Tâmega Valley, in Portugal, as a study case. Water storage zones can be a threat. There is no yet specific Portuguese standard to guide these infrastructures. In rural areas, this kind of risk also exists. It is very likely to find rivers, brooks, river beaches, swimming pools, washing tanks, fountains, watering holes, and wells, among others, in this type of low-density population site. Unfortunately, every summer, there are always victims of drowning and other water-related kinds of accidents. In this region, during the summer of 2020, there was a significant boom in swimming pool construction due to the COVID-19 pandemic that made it impossible to go abroad. Therefore, some examples of the above-identified existing water storage zones will be presented, some figures concerning water-related accidents will be delivered, and some technical aspects that may avoid this type of accident will also be introduced. The obtained conclusions may be extended to other rural regions.

Keywords: Water storage zones · rural areas · safety · Baixo Tâmega Valley

1 Introduction

Baixo Tâmega Valley is located in the Douro Litoral county and near the border between this county and the Trás-os-Montes e Alto Douro county, Portugal. It is a hilly area. The Tâmega river dictates the landscape, and, in this part, it almost reaches the Douro river. It is a very green scenario because it is a rainy region. Therefore, there are a lot of pine trees and green wine vineyards. Agriculture has been one of the main activities.

Considering these remarks makes sense that it is very likely to find water reservoirs such as rivers, brooks, river beaches, swimming pools, washing tanks, fountains, watering holes, and wells, among other water storage zones.

On the other hand, tourism is also an emerging activity in this region. Principally due to the wine industry and the beauty of the landscape.

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In this context, a boom of touristic accommodation has occurred and there has been a significant increase in building. Traditional dwellings have been reformulated to work as tourist accommodations.

In parallel, the COVID-19 pandemic has enormously changed daily life and resulted in considerable constraints in our way of living. Having holidayed in public places and abroad was banned, and people had to spend time at home or in private areas. These facts had unexpected results, such as selling off air conditioning and swimming pool accessories during the summer of 2020. There was a dramatic increase in interest in swimming pools and other water storage zones. Therefore, the risk of water accidents also increased.

Drowning has been a neglected health issue, largely absent from the global health and development discourse until the UN General Assembly (UNGA) adopted its first resolution on global drowning prevention in 2021 [1]. Some outlining issue characteristics are stated that interest for the present work: Over 2·5 million preventable deaths in the past decade; Drowning is largely unrecognised relative to its impact; Over 90% of drowning deaths occur in low-income and middle-income countries; Drowning takes place in rivers, lakes, domestic water storage, swimming pools, and coastal waters; Drowning affects children and adolescents in rural areas and presents as a social inequity issue; Drowning prevention could be a Sustainable Development Goal measure for child deaths, and could be framed as protecting investments in child development; Preventable and scalable, low-cost interventions exist.

There are several works published concerning this topic, such as Jonh Pearn et al., which analysed a consecutive series of 66 immersion accidents in swimming pool immersion accidents [2]. Joanna Chan et al. make some recommendations for swimming pools to avoid drowning [3], and Tracynda Davis encompasses new designs found in modern water parks and provides data for regulators to make better-informed judgements for the health and safety of pools [4]. Kyra Hamilton et al. explore the prediction of pool safety habits and intentions [5]. In addition, *Associação para a promoção das Segurança Infantil* (APSI) highlights the drowning tragedy worldwide [6]. American Academy of Pediatrics (AAP) also alerts to the need for measures to prevent drowning [7].

UNICEF states drowning, since 2001, when was the second cause of accidental death in children [8]. Many countries report drowning as the leading cause of childhood mortality, and drowning is among the ten leading causes of death globally for 5- to 14-year-olds [9]. Unfortunately, in Europe, about 5000 children (under 19 years old) drown stated to World Health Organization (WHO) [10]. In Portugal, this is also a tragedy. For instance, from 2002 to 2008, 144 children died by drowning reported by APSI [6] and European Child Safety Alliance (ECSA) [10].

Therefore, drowning is a priority, and there is much work to be done in this area.

Justin-Paul Scarr et al. identify three factors crucial to drowning prevention 1) methodological advancements in population-representative data and evidence for effective interventions; (2) reframing drowning prevention in health and sustainable development terms with an elevated focus on high burdens in low-income and middle-income contexts; and (3) political advocacy by a small coalition [11].

Thus, the main objective of this paper is precise to underling the danger related to water reservoir usage in the Baixo Tâmega region and as an example of the low population density territory of Portugal.

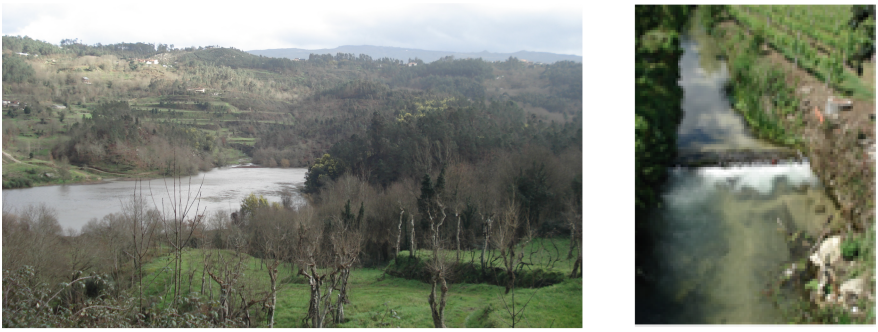
This paper is structured as follows. After this introduction, this region's existing traditional water reservoirs are identified. The next part reflects some technical aspects that may affect water accidents. Some mitigating measures to avoid water accidents are also considered. Finally, the main conclusions are delivered.

The danger of water storage zones in rural areas is highlighted, and some mitigating measures to reduce the risk of accidents are also presented.

2 Some Water Storage Zones in the Region

As stated above, this region is characterised by considerable rainfall. Therefore, it is expected to find different types of water storage zones. There are natural and artificial water storage zones.

In natural water storage zones, we can find rivers (Fig. 1.a) and brooks (Fig. 1.b).



a) River b) Brook

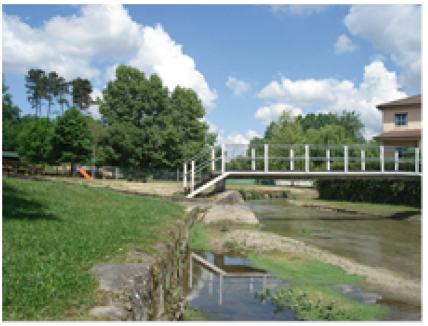
Fig. 1. Example of an existing river and a brook in the region of the Baixo Tâmega Valley.

In terms of artificial water storage zones, river beaches (Fig. 2.a), swimming pools (Fig. 2.b), washing tanks (Fig. 3.a), fountains (Fig. 3.b), watering holes (Fig. 4.a) and wells (Fig. 4.b) are some types that exist.

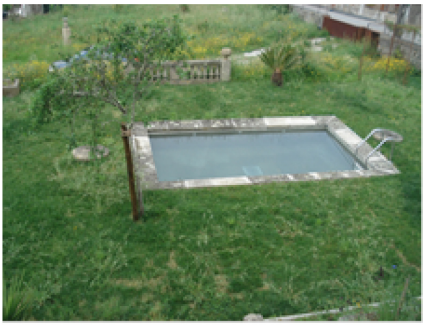
On the other hand, artificial water storage zones may be public or private. This fact is quite important because it defines the main entity responsible for the feature and influences the number of people who can access it.

In addition, the artificial water storage zones may have different purposes, such as agricultural (e.g. watering hole), domestic usage (e.g. washing tank and well), and leisure (e.g. river beach and swimming pool), among others.

It is worth adding that the wells in this region are still widely used in isolated houses, and rural areas, for domestic water supply and irrigation.



a) River beach



b) Swimming pool

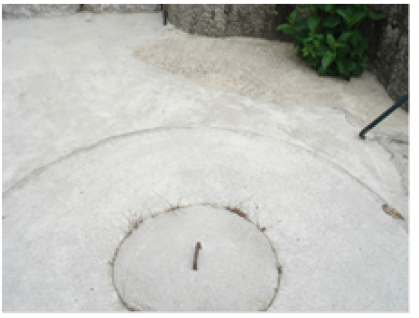
Fig. 2. Example of an existing river beach and a swimming pool in the region of the Baixo Tâmega Valley.

a) Washing tank

b) Fountain

Fig. 3. Example of an existing washing tank and a fountain in the region of the Baixo Tâmega Valley.

a) Watering hole



b) Well

Fig. 4. Example of an existing watering hole and a well in the region of the Baixo Tâmega Valley.

3 Some Technical Aspects that May Affect Water Accidents

UN General Assembly, in its first resolution on global drowning prevention, outlines some solutions that can be adopted in all countries: Appoint a national focal point for drowning prevention; Develop a national drowning prevention plan; Develop drowning prevention programming in line with WHO recommended interventions; Ensure the enactment and active enforcement of water safety laws across all relevant sectors; Include drowning within civil registration and vital statistics registers; Promote drowning prevention public awareness and behaviour change campaigns; Encourage the integration of drowning prevention within existing disaster risk reduction programmes; Support international cooperation by sharing lessons learned; Promote research and development of innovative drowning prevention tools and technology and Consider the introduction of water safety, swimming, and first-aid lessons as part of school curricula [1].

The above-identified water storage zones have a considerable amount of water and threaten people's safety.

The threat may increase if the purpose of the water storage zones is for leisure and if it is public because more activity may occur as more people use it.

Several kinds of accident consequences can occur in water storage zones, such as drowning, fracture of a human limb, contracting a disease by water contamination, stopping congestion, and falls.

Water flow, depth, accessibility, unpredictability, quality of water, the temperature of water and level of water surface are some technical aspects that can significantly influence the risk of an accident. Given their variability and extension, controlling the technical characteristics mentioned above in natural water storage zones is tough. In this case, displaying information concerning safety measures in critical points may be an excellent mitigating action to prevent accidents and also confining (when possible) access to hazardous areas.

On the other hand, in artificial water storage zones, it seems easier to control these technical aspects. For instance, on river beaches, the water flow and water depth can be controlled by building dams or floodgates. In the other type of water storage zones, such as swimming pools, the water depth can be controlled by considering floors with different levels. However, we must be aware that even very shallow water storage zones are enough to potentiate an accident if we think of an infant.

Accessibility is another important technical aspect that may avoid accidents. Automatic control of the access to the water reservoir by building a fence and having an intelligent control device, increasing the distance, using a rough pavement or using different levels may impede an infant's entrance to the water storage zones, as stated by the Consumer Product Safety Commission (CPSC) [12].

Avoiding unusual geometries and shapes of the reservoir and avoiding unexpected objects or devices below the water level may also reduce danger.

On the other hand, ensuring good water quality is also fundamental to reducing the risk of contracting a disease or accident. Therefore, the water should be tested often. The water treatment process also has to be considered to avoid threats because there may be certain health risks. The quality of the water can also be obtained using an intelligent control/action system.

The temperature of the water can also potentiate accidents. For instance, freezing water can cause a shock and result in a heart attack or digestion stops. The water surface level of the reservoir may also affect the risk of an accident.

The same pavement level and water surrounding the water storage zones may be hazardous. A high level of water surface may be difficult to reach. A deep level may potentiate falling.

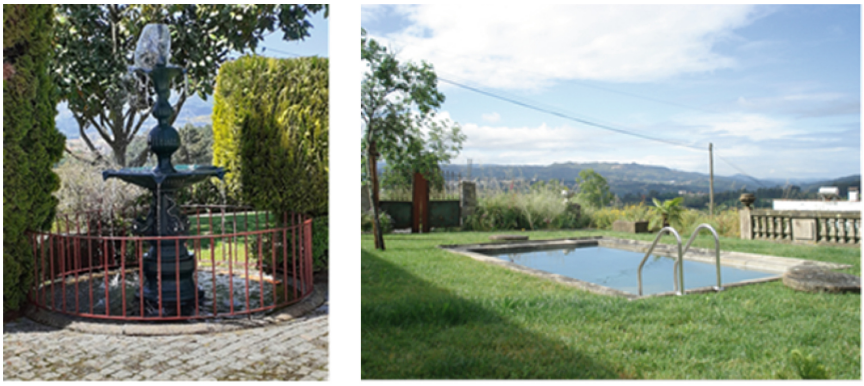
These situations can be oblivious to using intelligent systems to control and actuate in dangerous situations, so there is much scientific work to be done in these areas.

4 Some Mitigating Measures

Traditionally, care has been taken to prevent water accidents.

Good evidence supports building and maintaining four-sided fenced polls to prevent drowning. Enclosing the pool (isolation fence) is better than surrounding the property and the pool together because it further reduces the risk of exposure. Recent European research confirms that fences should be at least 1,1m hight, without footholds, to be most effective. Ornamental bar fences are attractive, provide visibility and are harder to climb than chain-like fences, which young children can easily scale [10].

Metal and stone safety barriers were used. Figure 5 shows two examples in which the safety barrier was the technical measure adopted to avoid accidents in water storage zones. At the same time, the swimming pool, Fig. 5.b, was also considered a gate and flower bed borders to work as obstacles from the main house to the water reservoir.



a) Fountain b) Swimming pool

Fig. 5. Safety barrier, gate and flower bed border.

Creating a barrier between children and water by covering them with heavy grills reduces the risk of drowning. In Portugal, a national law was enacted in 2002 requiring newly constructed wells access points to be a minimum of 80 cm from the ground and have secure covers [10].

On the other hand, the distance between the main house and the water storage zone is another essential technical aspect that can save lives. In the case of Fig. 6, it was

possible to have a distance of 9.0 m. There are also obstacles between the path, such as stone artefacts (detail A) and a flower bed border of 1.6 m width. Furthermore, a stone pavement of 2.6 m in width is made of rough granite stones (detail B, Fig. 6). There is also a difference of 1.0 m between the level of the pavement and the swimming pool. All these measures may hinder an infant's access to the swimming pool without them noticing it.

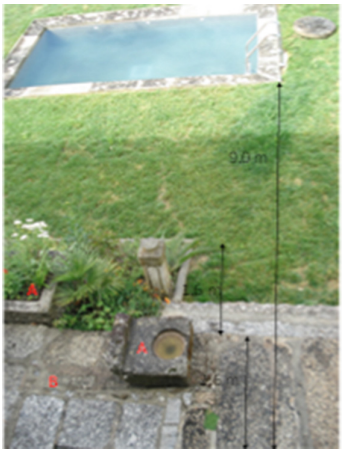


Fig. 6. Distance and accessibility.

At the same time, raising the water level from the soil level may also be an excellent procedure to reduce risk.

Having a proper stair also helps improve the safety of a water storage zone (Fig. 5.b).

When the water level is underground, it seems adequate to use a proper covering that meets all the standards for this type of use.

As the previous works cited show, shifting the response from drowning detection to drowning prevention is imperative.

Closed-Circuit Television (CCTV) cameras cannot prevent swimming pool drownings without image-correction capability, but Artificial Intelligence (AI) technology can transform standard CCTV cameras into intelligent cameras. They effectively see through the water and allow the system to track swimmers doing everything from diving to splashing around. Surface water disturbances, such as waves, ripples and glare, no longer pose a problem. Standard CCTV cameras can be converted into intelligent cameras that utilise AI image-correction software to see everything happening in the swimming pool. Machine learning algorithms recognise the predictable behaviours present when a swimmer is drowning. So combining algorithms and AI image correction can create a one-of-a-kind technology to prevent swimming pool drownings [13, 14].

Cepeda-Pacheco et al. developed a novel 5G and beyond child drowning prevention system based on deep learning that detects and classifies distractions of inattentive parents or caregivers and alerts them to focus on active child supervision in swimming pools [15].

A real-time system that will track swimmers in a pool using machine learning techniques and prevents drowning accidents is proposed by Abdel Alshbatat et al. The system consists of a Raspberry Pi with the Raspbian operating system, a Pixy camera, an Arduino Nano board, stepper motors, an alarm system, and motor drivers. The proposed approach is based on the colour-based algorithm to position and rescue drowning swimmers. The device then sends an alarm to the lifeguards [16].

Nasrin Salehi et al. developed software that can detect a drowning person in indoor swimming pools and sends an alarm to the lifeguard rescues if the previously seen person is missing for a specific amount of time [17].

Alvin Kam et al. investigated numerous technical challenges in developing a novel real-time video surveillance system capable of detecting potential drowning incidents in a swimming pool. In future work, they suggested expanding the sophistication of the existing descriptor set to facilitate more accurate event modelling [18]. This work provides several interesting insights into human detection and tracking within a dynamic environment and the recognition of highly complex events through the incorporation of domain expert knowledge.

5 Main Conclusions

Different existing water storage zone types in the Baixo Tâmega Valley were identified, such as rivers, brooks, river beaches, swimming pools, washing tanks, fountains, watering holes, watering tanks and wells. Most of them are built traditionally.

Several kinds of consequences of accidents related to water reservoirs were identified, and also some technical aspects that may affect this type of accident were indicated.

Some traditional mitigating measures to prevent water accidents were also presented. Safety barriers and gates are the main ones.

Policymakers should pass legislation or building codes to mandate four-sided isolation pool fencing for new and existing residential and non-residential pools.

Most hazards can be oblivious to using intelligent systems to control and actuate in dangerous situations, so there is much scientific work to be done in these areas.

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