



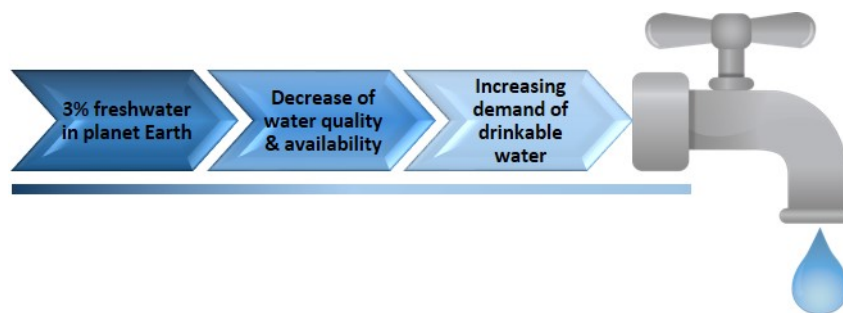
## The smart use of water to fight WUI fires

*Water scarcity is increasing in many European countries, being the climate change crisis and the growing water demand in urban areas their main drivers. Within an overall EU framework of sustainable water management, GUARDIAN water cycle is developed and implemented to fight forest fires at La Vallesa Wildland-Urban Interface through Circular Economy principles and novel technology solutions. Preventive, pre-suppression and direct attack water delivery is being engineered for an optimum and efficient water use to mitigate WUI fire risk.*

## Water, the most prized good for humankind

Water is a precious good and a scarce resource in many countries. Despite a large part of our planet is covered in water, it is mainly salt water (97%), being only the remaining 3% of freshwater meeting the needs of people and living beings. Moreover, only 1/3 of this residual part is surface or ground water available to be used.

The climate change crisis, inducing extreme weather events, has a direct negative impact on water quality and availability. In addition, a global growing demand of drinkable water, particularly in urban areas, leads to an overall water balance totally disturbed.



*Water scarcity and climate change causes and consequences*

The European Environment Agency (EEA) estimates that around 1/3 of the EU experiences permanent or temporary water stress. Certainly, Mediterranean countries are frequently exposed to severe droughts periods in summer time. However, water scarcity is already becoming a problem in Northern latitudes (e.g. United Kingdom and Germany). Performed by EEA, a full analysis of water needs and their associated environmental pressure in the European context can be found in the following link. Check out the statistics and navigate through the interactive maps!

<https://www.eea.europa.eu/themes/water/european-waters/water-use-and-environmental-pressures>

### **Water for fighting forest fires: let's use it wisely!**

Europeans use billions of cubic metres of water every year not only for drinking and household needs, but also for agriculture, industry, commerce, tourism and recreation.

Water uses also include fire-fighting, either for industrial, urban or forest fires. As a matter of fact, water is the most widely used fire-fighting agent as it is easy to use and transport, and more available and low-cost compared to other fire suppressants. But most importantly, water acts in many different and complementary ways when applied to fires:

- **Cooling:** water thermal characteristics are excellent to extract heat from flames, hot products and hot fuels. The phase change from liquid to vapour is particularly effective in extracting thermal energy.
- **Smothering:** With evaporation, water experiences a 1700-fold volume expansion which displaces oxygen from the fire scene disrupting combustion.
- **Starving:** water contributes to fuel dilution in some liquid-fuels and may help dispersing solid fuels by mechanical impact if applied at high pressure.



*Suppression mechanisms within the fire triangle*

In addition, **water efficiently absorbs thermal radiation**. As such, in a fire scenario, pre-wetting adjacent fuels helps controlling fire spread, by providing a heat-sink which delays ignition or eventually prevents it.

All these mechanisms act together when **water meets a forest fire**. Water **directly applied onto the wildfire front**, will cool down and smother the wildfire scene and will help separating flames from available fuel when applied with enough momentum.

However, when it comes to fight forest fires, the overall role of water deserves a closer look. It is very well known that fuel moisture content (i.e. **amount of water present in the vegetation**) plays a key role in the ignition process. The more moisture the fuel contains the greater the energy needed to allow ignition, up to a certain point in which the amount of moisture may totally inhibit combustion!

Moreover, the effect of **water present on the fuel surface** as a result of a wetting operation in pre-suppression conditions is also crucial. As stated by University of North Carolina (USA) research scientist Joe Urbas PhD, pre-wetting of landscaping vegetation have been found effective and recommended as a viable option for preventing the spread of Wildland-Urban Interface (WUI) fires to structures. Dr. Urbas gives us the clue to understand the performance of irrigation in pre-suppression conditions in his contribution at the Encyclopedia of Wildfires and Wildland-Urban Interface fires [https://link.springer.com/referenceworkentry/10.1007/978-3-319-51727-8\\_30-1](https://link.springer.com/referenceworkentry/10.1007/978-3-319-51727-8_30-1)

*“Pre-wetting takes advantage of water’s heat of evaporation to keep the temperature of fuels covered by water in some form under or at about 100 °C [...] The amount of water on the fuels at the time the fire effects begin will, therefore, determine to some extent how long the fuels will be able to resist ignition”*

In a nutshell, in forest fire management at the wildland-urban interface, water can be used for different purposes at different stages as:

- **Preventive irrigation:** to increase fuel moisture anytime during the fire season,
- **Pre-suppression wetting:** for fuel blanketing, during the preparedness stage in case a fire is declared nearby,
- **Direct attack:** water applied directly at the fire front, as a response operation.



*Water uses during a drill of the WUI fire self-protection plan at Sant Blai (Carcaixent, Valencia, Spain). Source: Medi XXI*

Three different options, complementing each other, with different particular objectives and different fire management phases to be applied (see [Journal 1](#) to recall the concept of Integrated Fire Management), rather than the classical approach of fighting the fire only when it's there!

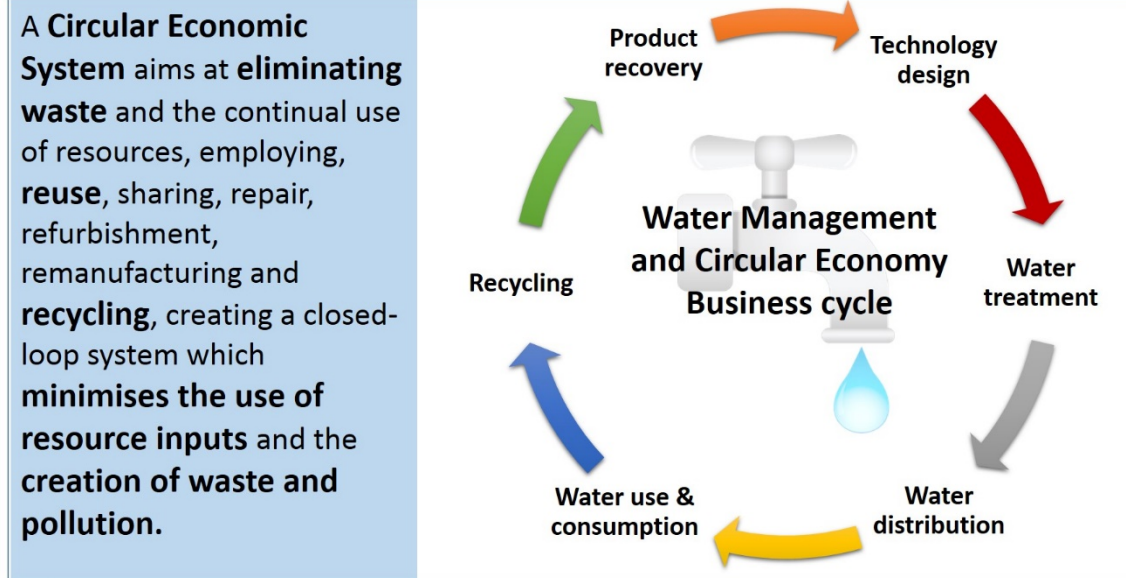
In the [web article 1](#), I tried to make clear that it's not only fire-fighters' responsibility (responsible of direct attack in case of fire) to protect us against fires in the interface with urban areas. Now, the issues are for decision-makers and practitioners working at the WUI 1) to learn to use these different choices wisely through an integrated fire resilient strategy, 2) to build hydraulic infrastructure capable of implementing irrigation solutions with optimum design, and 3) to consider a sustainable water cycle meeting water availability with water needs.

Challenging? Indeed, but feasible with the right approach, as the one GUARDIAN is following! GUARDIAN relies on **sustainable water management principles** as the cornerstone of the integrated project for resilient fire defence at the interface area on Riba-Roja and Paterna. Let's see how circular economy principles can help us in this endeavour!

### **Water Management and Circular Economy, common opportunities arise!**

EU's water management approach has to be necessarily designed and governed encouraging Member States to implement sustainable practices and improve efficiency in water supply and use in line with **Circular Economy Principles**.

## Water Management and Circular Economy



Sustainable water management can be achieved by applying circular economy concepts in different ways. The white paper on Water and Circular Economy (<https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/Water-and-Circular-Economy-White-paper-WIP-2018-04-13.pdf>) explains the foundations of how to intersect water management and circular economy best practices, giving sound examples regarding different water uses and cycle steps, for instance:

- Optimisation for water reuse and energy use
- Capture of chemicals and nutrients from runoff or waste biomass
- Reuse of treated effluents
- Extracting value from by-products from greywater processing

Now the question is, **how can we apply this approach to our WUI fire management / water management problem?**

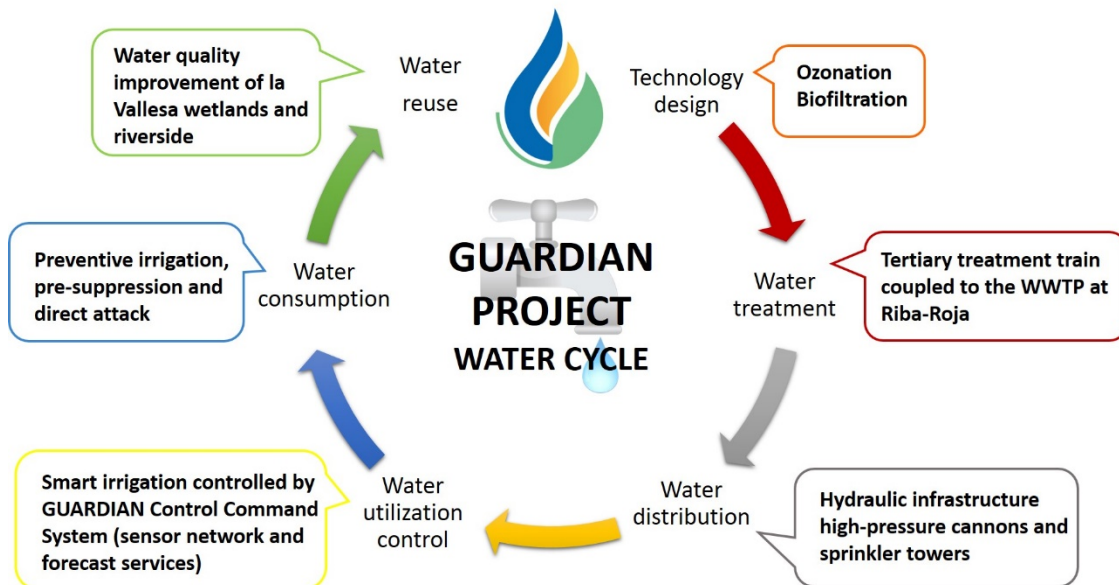
GUARDIAN overall concept relies on circular economy principles by using **recycled water for forest fires prevention and suppression and ecosystems maintenance**. Professor Francesc Hernández, (Universitat de València) in charge of validating the economic payback and efficiency in GUARDIAN puts it very clearly in a recent interview (in Spanish) <https://iambiente.es/2020/08/francesc-hernandez-la-reutilizacion-del-agua-es-puro-sentido-comun/>:

*“Water reuse is purely common-sense. It is reasonable but we have to put into practice. We don’t have to stick with the concept but to contribute to its implementation”.*

GUARDIAN is an outstanding example of a **practical implementation of a water management and use solution applied to fight forest fires based on circular economy**. Let’s look at it in more detail...

## The water cycle in the Guardian project

The overall strategy on which the GUARDIAN project is based relies on the use of recycled water applied to increase WUI fire resilience, providing preventive, pre-suppression and suppression watering infrastructure linked to the city wastewater treatment plant. The following figure depicts the basic steps considered in the GUARDIAN water cycle:



- **Technology design:** GUARDIAN solution is based on front-line water treatment research, development and innovation. Adapting solutions of past European projects (LIFE Programme AWARE <http://www.life-aware.eu/>), GUARDIAN implements an advanced water treatment technology to eliminate organic micropollutants, mainly coming from pesticide contents.
- **Water treatment:** This innovative solution will be implemented at the Water Reclamation Plant (WRP), coupled as a tertiary treatment train to the existing Waste Water Treatment Plant (WWTP) Camp de Turia II at Riba-Roja, from which secondary effluents will be taken as inlets.
- **Water distribution:** water will be distributed through ad-hoc hydraulic infrastructure (pipelines, pumping stations, water tanks, etc.) to convey water to the WUI area of La Vallesa. Water will be delivered by high-pressure cannons (either on tripods or towers depending on its final use).
- **Water use control:** GUARDIAN irrigation will be smartly programmed by monitoring vegetation and ambient key state variables, through weather forecast services and a network of sensors deployed in the field conforming the overall Guardian CCS (Control Command System).
- **Water consumption:** GUARDIAN will supply water to La Vallesa WUI area (preventive irrigation, pre-suppression wetting and direct attack) in different stages, flowrate and duration according to the CCS signals linked to electronic water control devices.
- **Water reuse:** excess recycled water will have a secondary use to improve ecosystems' quality at La Vallesa wetland, currently feed by poor water quality inlets.

**Stay tuned at future GUARDIAN posts and journals, as all these bits and pieces will be soon analysed in all detail!**