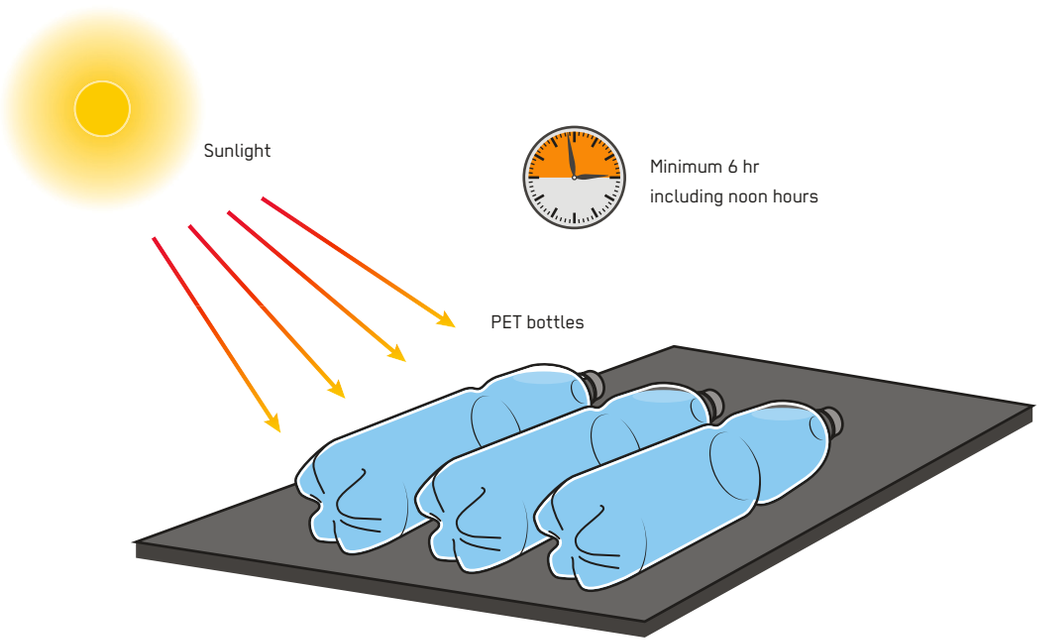
Solar Disinfection (SODIS)

Response Phase	Application Level	Management Level	Objectives / Key Features
** Acute Response ** Stabilisation ** Recovery	** Household ** Neighbourhood City	** Household * Shared Public	Point-of-use treatment, water disinfection
Local Availability	**Technical Complexity**	**Maturity Level**	
*** High	* Low	*** High	



Solar Water Disinfection (SODIS) purifies low turbidity water for drinking purposes through a combination of heat, ultraviolet (UV) irradiation and visible light radiation given by solar energy. It is appropriate for disinfecting small quantities of water with a low turbidity.

Used, clear polyethylene (PET) bottles are cleaned, filled with untreated water and closed tightly. The bottles are laid horizontally in the blazing sun for at least 6 hours. When the weather is cloudy, the duration of exposure should be extended to 48 hours. Alternatively, plastic UV penetrable bags, glass bottles or other containers, developed for SODIS, can be used. A good location for laying bottles is a reflective surface, like corrugated iron sheets. Reflection and higher temperatures accelerate the disinfection process. If reflective material is not available, bottles can also be set on any surface, as long as it is ensured that the containers are not shaded at any time.

Design Considerations: The bottles used for the disinfection process should be colourless and transparent, have no scratches/damage, have labels removed and be thoroughly cleaned. UV-radiation is reduced by increasing the water depth, which is why small bottles (1–1.5 L) are preferred over larger volumes (> 3 L). For example, at a water depth of 10 cm (usually the diameter of a 2 L PET bottle) and moderate turbidity level (< 30 NTU), UV-A radiation is reduced to 50 %. To achieve disinfection of > 99.9 % for bacteria and > 99 % for viruses, 3–5 hours of solar radiation above 500 W/m^2 is required. This depends on solar intensity, which depends on factors such as the geographical location, altitude and climate. In practice, this means exposure times from 6–48 hours. Therefore, when promoting SODIS, when it will not be clear to users at what point the water is safe, it may be best to just promote leaving the bottles out for 2 days. The containers should not be shaded by trees, houses or other objects. SODIS is not suitable for water with a turbidity over 30 NTU. In this case, other methods or pretreatment using clarification methods should be used.

Materials: No matter the material used, it must have a good UV-A transmittance and must be food grade. Good choices are PET or glass bottles with a volume of maximum of 3 litres or collapsible bags (e.g. specially produced SODIS bags or commercially available freezer bags). Bags have many advantages over bottles, such as being easier to store, transport, distribute and fill, as well as being easier to purchase in most markets throughout the world. The issue with bags, however, is that they do not last as long and create more of an environmental waste problem. It is recommended to replace plastic bottles after 6–12 months of daily use. Usually, PET bottles are labelled with a recycling sign 1 PET. Brown and green bottles should not be used, as these bottles partially absorb the UV light. A slight blue tinge, which many bottles have, is acceptable. Polyvinylchloride (PVC) bottles should not be used.

Applicability: SODIS is suitable for household use for microbially contaminated water. In particular, SODIS can be beneficial for disaster preparedness programmes. If people have been trained on SODIS and have access to suitable material, they can start treating their water before relief activities reach them. SODIS is not recommended in the acute response if people do not have previous knowledge, as the logistics of distributing empty bottles are not favourable, especially compared to other options (e.g. chemical disinfectants), and like all other household treatment technologies it is difficult in such settings to quickly introduce a new technology that requires significant training.

Operation and Maintenance: A prerequisite for SODIS is sunny weather. On cloudy days (where more than half of the sky is covered with clouds), the bottles must be placed in the sun for two consecutive days. On rainy days, SODIS does not work, meaning alternative options must be available (e.g. Rainwater Harvesting, **I.1 and I.2**). If the weather conditions are unsettled, electronic indicator devices or simple temperature sensors on paraffine bases can indicate the effectiveness of treatment. The SODIS method is appropriate only for water with a low turbidity up to 30 NTU. To decide if the water is too turbid and needs pretreatment, place the filled bottle on a newspaper in the shade (to avoid light interference) and look through the bottle from top to bottom. Being able to read the letters through the water indicates that water turbidity is less than 30 NTU. If the turbidity is too high, it can be reduced by flocculation/sedimentation (using alum sulphate or crushed Moringa oleifera seeds) or by filtration. To avoid recontamination, the treated water should be stored in the bottles in which water was disinfected until consumption. The treated water should be drunk directly from the bottle whenever possible to avoid recontamination.

Health and Safety: Studies have shown that SODIS significantly reduces the rate of disease linked to drinking contaminated water. This is mainly achieved by UV-A transmittance (wavelength: 320–400 nm) and temperatures above 50°C. Laboratory trials have demonstrated that disinfection with SODIS removes up to 99.99 % of bacteria and > 99 % of viruses as well as protozoa (Giardia and Cryptosporidium rendered noninfective after > 10 h of sun exposure).
Water contaminated with non-biological agents such as arsenic, fluoride or industrial agricultural organic contaminants or heavy metals require additional steps to make the water safe to drink.

Costs: If used bottles are available, there are no additional material costs. When used bottles are not available, freezer bags might be a low-cost alternative.

Social and Environmental Considerations: SODIS is a simple, affordable, effective and sustainable means of obtaining clean water used at the household level. SODIS provides effective treatment of any non-chlorinated water source with a low turbidity, and anyone can be trained to use SODIS locally. However, in some cases, the acceptance has been low. People stop using SODIS due to the time and efforts required to treat water for the entire household, concerns related to efficiency, limited access to bottles and unwillingness to pay for new bottles. Some people might reject the warm water, and it might develop an unpleasant taste. Empty PET bottles and plastic bags can cause a serious solid waste management problem. When empty bottles or SODIS bags are distributed in places without a functional waste management system, the impact of the distributed bottles and products should be considered. For example, the disposal of PET bottles in pit latrines can clog the vacuum truck pumping equipment, generating follow-up problems.

Strengths and Weaknesses:

⊕ Provides a simple, easy-to-use and low-cost method, requiring no external energy sources except sunlight
⊕ Efficiently reduces bacteria, viruses and protozoa
⊕ Convenient for storage and transportation, treated water is protected from recontamination in the bottle
⊕ Requires no maintenance (no chemicals, energy, or consumables)

⊖ Only treats small amounts of water of turbidity less than 30 NTU, and there is no residual protection
⊖ Several bottles are needed to treat water for the whole family
⊖ Bottles need to be replaced every 6–12 months, creating a waste problem for the environment
⊖ Has a waiting period of 6–48 hours depending on solar conditions and is unsuitable during continuous rainfall
⊖ Generally low volumes produced

→ **References and further reading material for this technology can be found on page 223**