Climate change leading to freshwater shortages is becoming a global challenge. 99.97% of H_2O resources on Earth are in the form of seawater or hard-to-collect deep groundwater. Available H_2O resources include fresh surface water, shallow groundwater and water vapor (fog/mist) present in the air. The total amount of fog is estimated to be about 10% of the capacity of all freshwater lakes on Earth. Collecting H_2O back from the gaseous form could help alleviate the problem, especially since long-distance water transport or technologies based on, for example, seawater desalination are not cost-effective. The development of advanced methods for atmospheric water harvesting (AWH) appears to be the pathway for water supply in the future. The design and fabrication of new structured functional materials for atmospheric water harvesting becomes a very important scientific challenge. In general, atmospheric water can be collected in two ways: passive AWH and active (sorption-based) water harvesting. Passive atmospheric water harvesting is based on capturing gaseous water molecules on specific structured surfaces, and then transporting and releasing the formed water droplets. Passive AWH systems appear to be closer to real-world applications. One example is the Warka Water Tower (Ethiopia), made of bamboo sticks and polyester mesh, which can capture fog and produce up to 100 liters of fresh water per day.

Research on functional systems for AWH has so far been mainly focused on the design of new materials and the engineering of surface microstructures to optimize the water harvesting process in laboratory-scale experiments. Nature-inspired biomimetic/bionic functional materials and microstructured surfaces have become a hot topic over the past decade. Various organisms living in water-scarce environments have evolutionarily developed systems to harvest moisture from the air, including 1D structures (spider silk and cactus) or 2D structures (*Stenocara* Namib Desert beetles). The *Stenocara* beetle has on its back an alternating pattern of hydrophilic bulges on a hydrophobic shell, which helps capture moisture from the air and rapid local droplet growth. The creation of surface energy gradients and patterning are therefore two important directions in regulating the wettability of solid surfaces. However, in addition to the effectiveness of the designed surface structure for mist condensation and water droplets transport, there are other important aspects, including the microbiological safety of the collected H_2O. Prolonged exposure of a water-collecting surface in humid conditions can result in microbial deposition and biofilm formation. The multifaceted problem of environmental corrosion of passive AWH systems can be mitigated by using a chemically stable, highly adherent, weather-resistant and antimicrobial material as a surface coating. The performance of the synthetic material (preferentially containing active components of natural origin) should be effective enough to repel aquatic microbiota and impede the formation of biofilms composed of bacteria, fungi and algae; but safe for other living species. Therefore, sustainable, effective and environmentally friendly strategies should be developed to address this problem.

The proposed project focuses on the knowledge gap in passive AWH systems related to their antimicrobial activity. The biomimetic polysilsesquioxane coatings that are the focus of the project will utilize mechanisms related to the *quorum-sensing* (QS) phenomenon characteristic of bacteria, fungi and algae. Microorganisms interact and communicate with each other by detecting the concentration of spontaneously released signalling molecules and regulate the processes of multicellular behavior (such as biofilm development and growth) accordingly. Interruption of intercellular communication in QS systems without killing pathogens is referred to as "*quorum quenching*" (QQ). The aim of the project is to develop innovative, environmentally friendly biomimetic functional coatings for use in passive AWH systems with covalently built-in antimicrobial and antibiofilm properties by incorporating specific functional groups - derivatives of natural compounds that are known for their anti-QS activity, and investigating the synergistic effect of various factors affecting the structure and function of the designed water collection systems.

The results of the project will provide information on the antimicrobial performance of the new hybrid materials as individual coating components and in multi-component systems for synergistic interactions. The proposed novel concept of "completely antimicrobial" structural functional coatings may be of interest not only for the technology of AWH systems, but also for all areas of life affected by microbial biofilms in general. Antimicrobial polymer coatings of this kind, based on natural active compounds of plant origin, could be a safe and effective alternative to conventional antibiotic-containing materials. Importantly, the approach based on inhibition of intercellular signalling is not only effective, but may also delay the acquired resistance of microorganisms to antibiotics.