

Various climate challenges such as extrem heat waves and flooding create a destructive feed back loops in urban environments and in agricultural areas.

This research studies focuses then on innovative approaches to sustainable future, towards resilient cities and food systems by undertaking solutions that target water ways and soils at the same time.

Rain water infiltration
Water sources
preservation
Accessible simplified
solution
Technologies in service of
Humanity

Effective solutions to remediate soils and improve water quality involve innovative engineering managements and biostimulants that have shown to improve stormwater the physical integrity of the soil, plant nutrient uptake and reduce the exchange fraction of pollutants in water and soil.

Innovative approaches to build resilient cities and food systems

Researcher: Asma Mabrouk

Supervisors: Prof. Dr. Eng. Ulrike Gayh

Prof. Christian Reitz

Building resilient cities and strenthening food systems begin by enhacing the soil structure as a starting point to reach the other targets.



Research areas and
scientific reflexions on
solutions:

- Enhancing soil tructure and vegetative growth
- Promoting rain water infiltration, reduce surface run off and soil sealing.
- Replishing water sources and promoting capillary rise.
- Integrating algorithms to offer a better quality of life for residents.



[HTTPS://DEMOCRATIA-AQUA.ORG](https://democratia-aqua.org)

© HSHD_WATER_TECHNOLOGY

▶ DEMOCRATIA AQUA



Deutscher Akademischer Austauschdienst
German Academic Exchange Service



Federal Foreign Office

This research innovative approaches are: Leonardite and the rain tree or "l'arbre de pluie".

In these studies we are testing the leonardite as a promizing biostimulant and an adsorbent to improve soil properties and waste water quality. Simulaneously, we are studying the impact of the rain tree in urban area to promote rain water infiltration, soil stability and water sources preservation.

Urban management

The rain tree is an urban management to mitigate the strain on sewage system. This strategy was successfully introduced in a french city of Lyon (Office Français de la biodiversité, 2022) to manage rainwater where it falls and reduce the volume of rain water runoff entering the sewage system, while simultaneously promoting biodiversity and improving soil health.

Researcher: Asma Mabrouk
Supervisors: Prof. Dr. Eng. Ulrike Gayh
Prof. Christian Reitz



Leonardite

Leonardite is the organic matter that has the higher degree of oxidation in the coalification process. The result of a humification that lasted up to 70 million years. This natural material is not a fertilizer, but a soil conditioner, biocatalyst and biostimulant for plants (humintech.de). Furthermore, it is long term effect because it is degraded more slowly than for example compost, because it contains more organic matter that is also more resistant to composers (humintech.de). It is, therefore, by nature the most sustainable and efficient raw material that can improve soil quality

Methodology

II. Rain Tree

In this research studies, I will evaluate the performance and the impact of the rain tree management in urban area, after the implementation of the infiltration trench by assessing the following measurements:

1. Management : Infiltration trench implementation
2. Assessments : Performance evaluation before leonardite application
3. Soil permeability using percol test and this formula:
 - Formula: $K = 1000 \times V \times S \times t$
 - ✓ Infiltration capacity + total infiltration by Horton's infiltration method (Yashwanth, 2019), using these formulas:
 - Formulas: $f_p = f_c + (f_0 - f_c) \times e^{-k \times t}$; $F = f_c \times t + [(f_0 - f_c) / k] \times [1 - e^{-(k \times t)}]$; $k = -[\ln(f_0 - f_c) / (f_0 - f_c)] / (t_0 - t_1)$
 - (f_0 = infiltration capacity, f_c = final capacity, F = total capacity and k = constant representing the rate of decrease of f_0)
 - ✓ RWC : Relative Water Content: → Fresh, dry and turgid of the rain tree leaves (Galati & CLEMENT-VIDAL Anne CIRAD/BIOS/UPRR 104-A/IVA, 2023)
 - Formulas : $RWC \% = (WF - WD) \times 100 \div (WT - WD)$ → $RWC \geq 80 \%$ (WF = fresh weight, WD = dry weight and WT = turgid weight)
 - ✓ Carbon dioxide (CO₂) in the tree (Toochi & Department of Forestry Wildlife Technology, Federal University Owerri, Nigeria, 2018), using this method:
 - Dry weight = $0.0613 \text{ DBH}^{1.749}$ Where : DBH = Diameter at breast height (Laboa SN. Et al., 2018)
 - Dry weight $\times 50 \%$
 - $CO_2 = C \times 3.6663$ where C = weight of carbon in the tree
 - ✓ Carbon dioxide in the soil using the flow throw chamber method (Franzuebbers & USD Agricultural Service, 2021) or estimating it using the stable fraction of the organic matter in the soil and this formula:
 - $CO_2 = (\text{final Corg} - \text{Initial Corg}) \times 3.6663$, where: Initial Corg: Corg in the beginning of the season, final Corg: Corg in the end of it and 3.6663: the weight of C (carbon) in CO₂

