Project: Drainage in Nouakchott – Nature-based solution

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Starting date: November 11th, 2025

Finish date (delivery): December 09th, 2025

*** IMPORTANT ***

In groups of 2 people, present the results of the project in a report-style document with a maximum of 10 to 15 pages (written in English). Hand in the Excel sheets associated with your simulations.

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Nouakchott City, the capital of Mauritania, has been facing a recurrent flooding problem due to excess soil saturation since 2010. Located between the Atlantic Ocean (west) and the Sahara Desert (east), the city covers an area of approximately 200 km^2 according to data from 2017 (***Fig. 1*****Fig.** *1*). The elevation in the city is between -2 and +13 m above sea level (masl). Considering the hot desert climate, rainfall is scarce and equal to 105 mm/year, with most of it directly evaporating from the ground in the urban environment. The city has very limited vegetation cover.

A shallow groundwater table flows in the sandy soils of the city. Boreholes throughout the city have shown that aquifer sand is 20 m thick on average and lies on impermeable marine clay. Pumping tests have shown a relatively homogeneous hydraulic conductivity of 1.10^{-3} $m.s^{-1}$.

Groundwater levels are measured in a network of observation wells, located on an east-west axis in the center of the city (***Table 1***). On the eastern limit of Nouakchott City, the groundwater level is relatively stable at an elevation of approximately -2 masl throughout the year.

Table 1. Annual average groundwater level measurements (in meters above sea level).

Observation well	Groundwater level (masl)	Distance to the shore (m)
W1	0.60	570
W2	1.10	1520
W3	0.75	2990
W4	-2.00	4110

In 2010, a new water supply was built, delivering a total of 180 000 m^3/d to the Nouakchott area, of which 1/3 is dedicated to farming (outside of the city), 1/3 to industrial uses (outside of the city), and the last 1/3 to domestic water. However, the city does not have a sewage network that collects wastewater, leaving every household equipped with individual septic systems that directly infiltrate the domestic water back into the ground.

The city of Nouakchott can be divided into 3 parts (***Fig. 2***). The central (historic) neighborhoods, are equipped with a domestic water network and use 75% of the domestic water. The outer (more recently developed) neighborhoods are partially equipped with a domestic water network and use the remaining 25% of the water supply. The most recent neighborhoods (temporary settlements, new constructions) do not have access to the domestic water network and their water consumption is negligible. For the purposes of this project, the geography of the city will be simplified as a rectangle with dimensions of 10 km in the north-south direction and 4.1 km in the west-east direction (***Fig. 2***).

The feasibility of nature-based solution utilizing afforestation (i.e., planting trees) to remediate the flooding problem is currently being considered. To assess the feasibility of such a solution, 5 tree species that could be effective for the project have been identified (***Fig. 3***).

The transpiration rates of these tree species have been monitored in situ using sap flow meters (***Table 2***). Considering the relatively dense built environment at the center of Nouakchott, the available area for planting trees is <7 % of the area. The outer neighborhoods are less dense and are characterized by larger houses with private gardens, making the potential area that could be vegetated up to 10 %. Finally, the recently developed neighborhoods are facing random development, and the land is often temporarily occupied, making the available space for vegetation rather limited and <3 %.

Table 2. Characteristics of the monitored trees from the selected tree species.

Species	Sap velocity (cm/hr)*	Transpiration (l/d)*	N of trees (-)	Age (yr)	Circumference at BH (cm)	Average planar area (m^2)
Azadirachta indica	2	17	1	15	74	15
Casuarina equisetifolia	3.8	16	3	30, 25, 20	58, 51, 37	20
Eucalyptus camaldulensis	6.1	29	2	30, 20	60, 48	30
Phoenix dactylifera	1.0**	34	2	4, 40	29, 43***	15
Tamarix aphylla	2.2	47	1	45	101	23

*24h average
**l/d/leafblade
***Number of leafblades

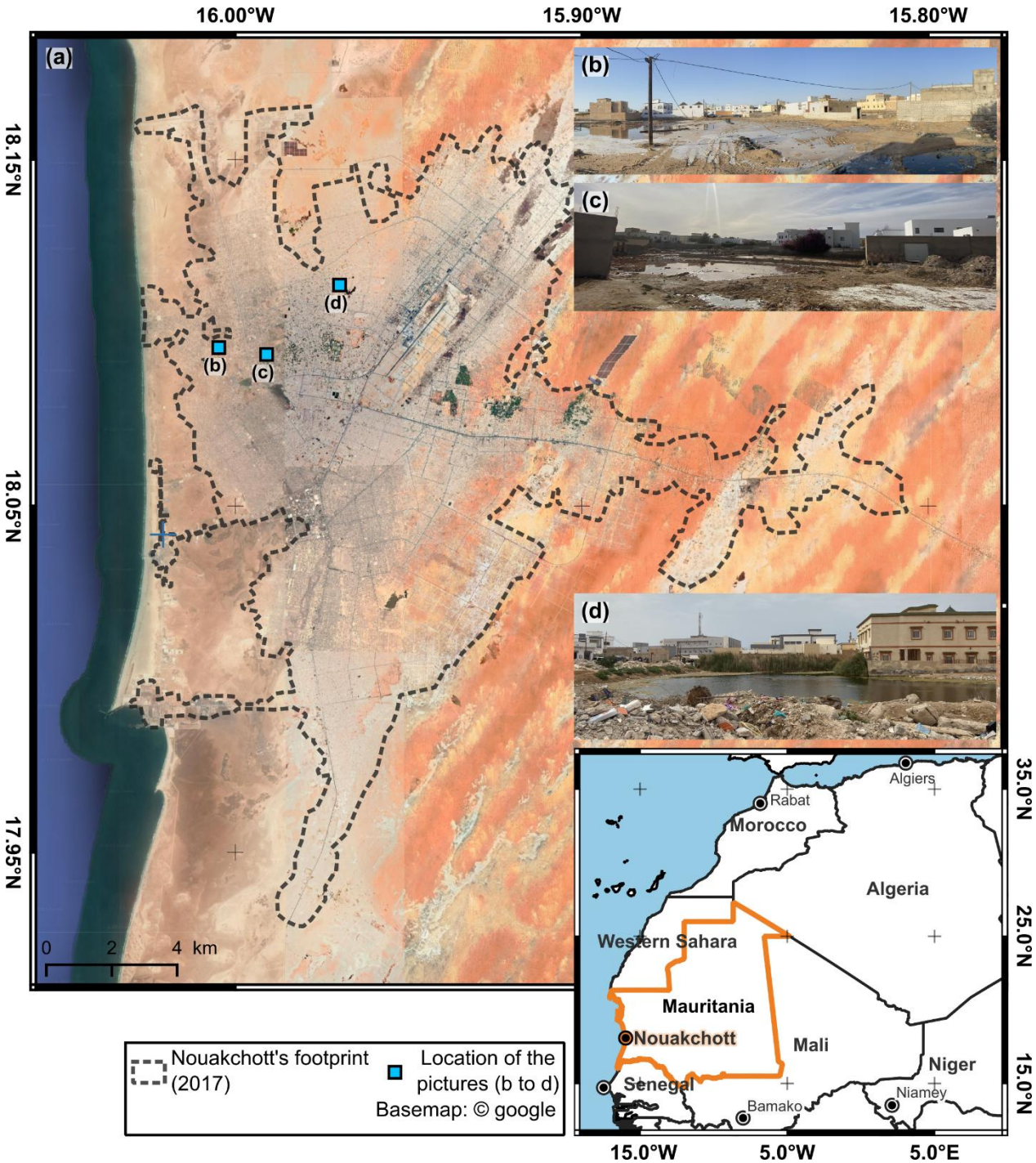

Fig. 1. Location of Nouakchott City (Mauritania) (a) and pictures of the flooding problem (b to d) (from Dubois et al., 2024).

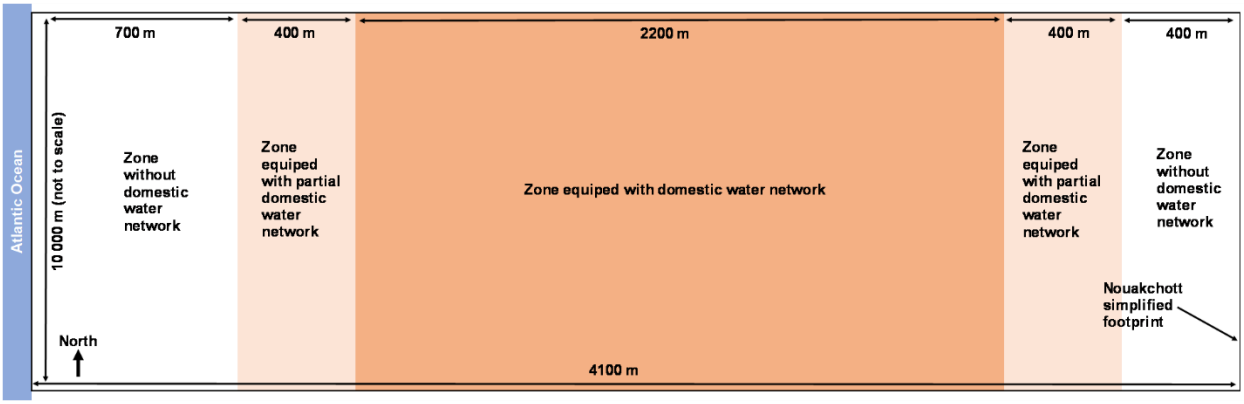

Fig. 2. Simplified view of the urban organization of Nouakchott City. The city is developed on approximately 10 km in the north-south axis.

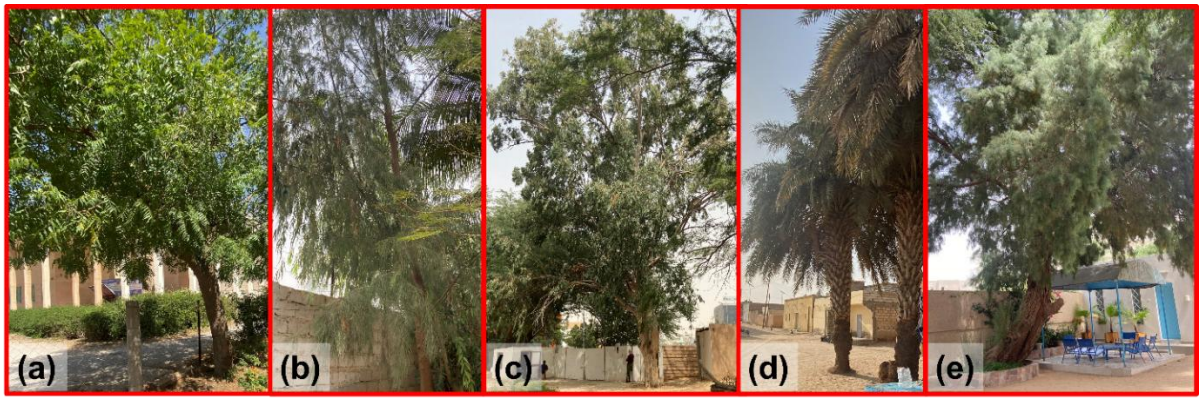

Fig. 3. Main tree species identified for the project, based on species currently found in the city, (a) Azadirachta indica, (b) Casuarina equisetifolia, (c) Eucalyptus camaldulensis, (d) Phoenix dactylifera (Date palm), and (e) Tamarix aphylla.

Available data:

1) West-east topographic cross section in the middle of the city.