VirtualForests

Co-funded by the Erasmus+ Programme of the European Union

IO3 Internet of Trees

Deliverable review. May 25th 2023

UVa

Hochschule für nachhaltige Entwicklung Eberswalde

cesefor

IEFC

HUS VNU UNIVERSITY OF SCIENCE

AgroParisTech Talents for a sustainable planet

Asesoramiento técnico | Taller y laboratorio en tecnología de la madera | Digitalización | I+D+i | Gestion del conocimiento y comunicación | Formación | Gestión de proyectos

Cesefor works to improve the forestry sector, through projects in innovation and structuring. Our daily work is aimed at trying to help you in your work as a manager, owner, researcher, etc., in order to promote the growth of the forest bio-economy and the future of the rural environment

- Non profit regional Foundation
- 72 workers
- 50%, women
- 7 offices and remote work
- 4,5M Euros/year in projects

Deliverable index:

1. State of the art of a forest plantation sensoring.

2. Existing technology

3. Why to sensor a plantation.

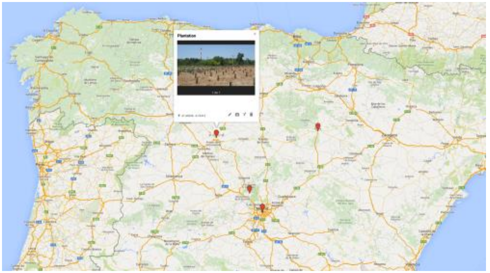
   3.1 A sensorized experimental urban forest: How sensorization can help to manage a non-irrigated urban forest plantation. The QUF project.
   3.2. A sensorized experimental chestnut stand.
   3.3 A sensorized Pinus pinaster forest to study resin production.

4. How to sensor a plantation step by step

Underlined: what we see today

1. Background and context.
2. Design of the plantation
3. Data and analysis
4. Results and conclusions

Location



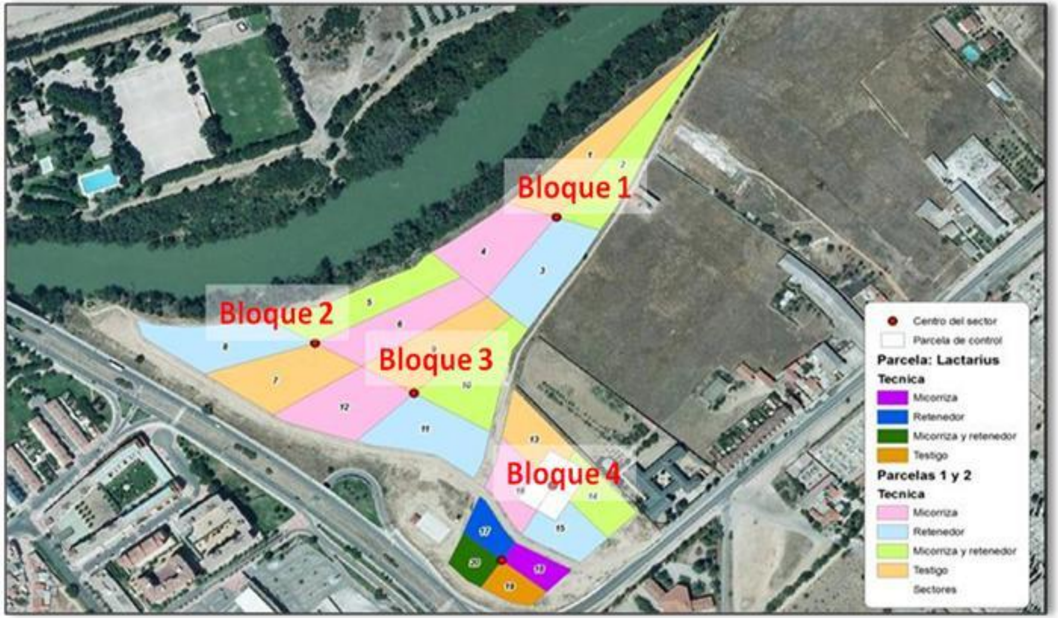
Objective:

- main objective is to promote **arid and industrial urban areas forestation** using methodologies to improve trees growing and survival without irrigation.
- The aim is to demonstrate the fact to create green areas and recover degraded soils in cities without investing in irrigation infrastructure

1. Background and context

Specifically:

- Promote sustainable urban forestry in Mediterranean cities and develop more efficient green infrastructures
- Improve the capacity of water absorption of the soil during events of heavy rain by keeping higher levels of moisture for longer periods (1).
- A pilot: non- irrigated 13ha urban forest in Valladolid (414.000 inhabitants)



Plantation:

- 6 species in mixed stands: *Pinus pinea, Quercus ilex, Quercus faginea, Juniperus thurifera, Acer campestre and Amigdalus comunis*
- 4 treatments:
  - No treatment
  - Mycorrhiza
  - Retainer
  - Mixed (retainer and mycorrhiza)
- 5 blocks with 4 sections each (1 section per treatment)
  - 3 blocks of 2 ha (0,54 ha/sector)
  - 1 block of 1,32 ha (0,33 ha/sector)
  - 1 block of 0,6 ha – *Pinus pinea with Lactarius deliciousus*

Landscape improvement: Aromatic plants garden 11,224 plants, with the same methodology of treatments

Mycorrhiza:
Each plant species of the project were mycorrhizal with the following fungi:

- *Pinus pinea* with *Pisolithus tinctorius*
- *Almond, Juniperus* and *Arce* with *Glomus*
- *Q. faginea* and *Q. ilex* with *Pisolithus tinctorius* + *Scleroderma polyrrhizum*

Retainer:
The Stockosorb is an hydrogel formed by a polymer. By using this product in agriculture, a reduction of irrigation frequency of 50% is expected, because 1 kilogram of product retains 250 litres of water

Control plots

- 4 control plots in different areas of the plantation. In each plot 16 trees per control plot are motorized of 2 spices (*Pinus pinea* and *Quercus ilex*), 2 per treatment (No, Ret, Mic and Mixed)
- Galvanized steel poles, about 5 m high and at least 1 meter buried. The posts are coated wooden to go unnoticed. One data-logger per pole

Communication hub: it is hidden in an electricity tower

Sensor data in the control plots.

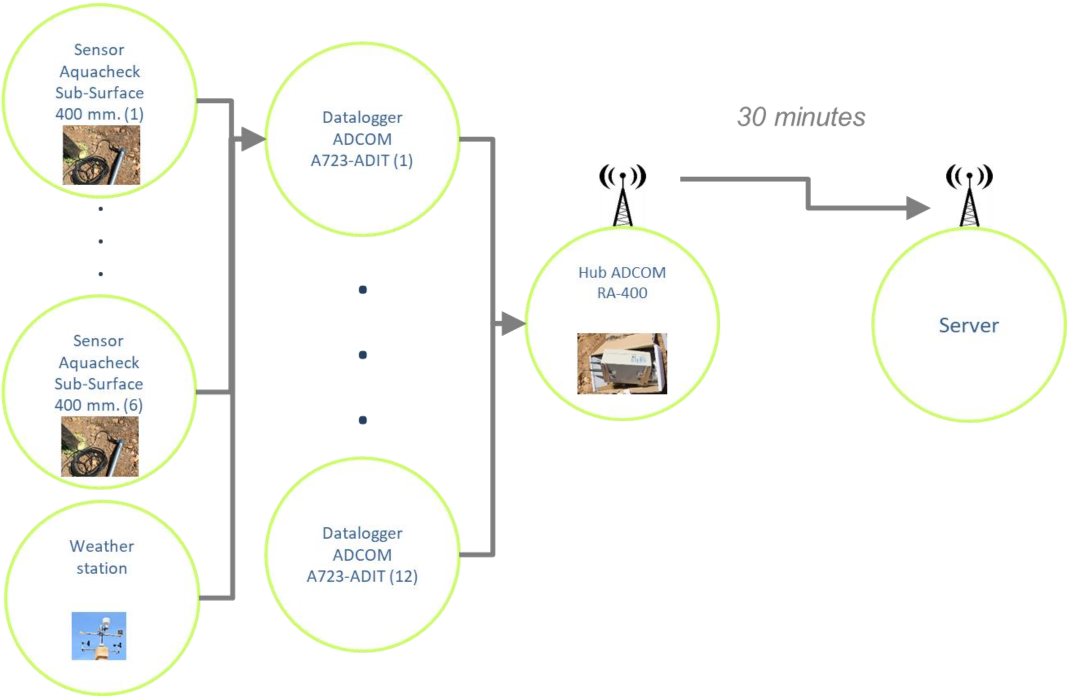
- The humidity and temperature data are obtained through sensors installed in 64 plants of 2 species 16 for treatment .
- For each plant two set of sensors are installed at 20 cm. and 40 cm. depth.
- Meteorological data are also obtained every half hour. In particular, the temperature (in ° C), precipitation (in mm.), relative humidity (in% RH) and the wind speed (km / h).

Characteristics of the **network**

1. Reliability. A failure in one of the elements does not affect the overall network

2. Flexibility. The network can be easily adapted to different needs. Trade-off between maturity, information provided, cost, and resistance against vandalism and theft.

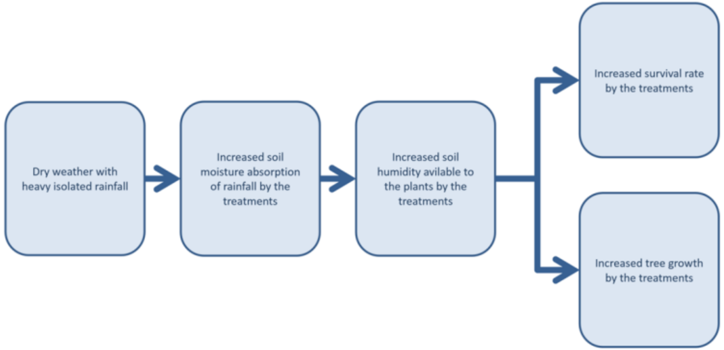
3. Scalability. The network can be easily scaled to add new sensors (both in number and type).

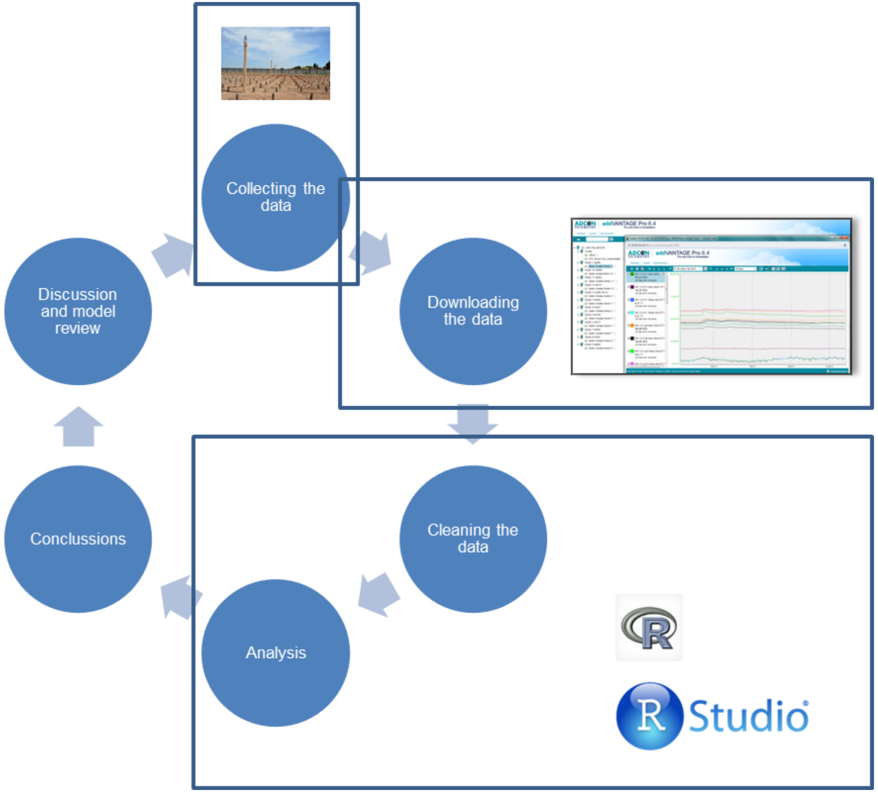


3. Data and analysis

Data collected:

1. Humidity and temperature of soil at 20 and 40 cm
2. Moisture absorption data of rainfalls
3. Survival Data
4. Biomass Data





3. Data and analysis

Data collected:

1. Data from sensors:
   - More than 2 million observations
   - Unable to calibrate the probes: it was used raw data

2. Survival Data

   Measurement of survival in the control plots is made on 1.436 trees of 6 species in the following times:
   - 1 month after the start of planting (June 2014).
   - 4 months after initial planting (August 2014).
   - Five months after the start of the planting (September 2014).
   - After the first winter (March 2015).
   - At the end of the second summer (September 2015).
   - At the end of spring of the third year (June 2016).
   - At the end of the third summer (November 2016).

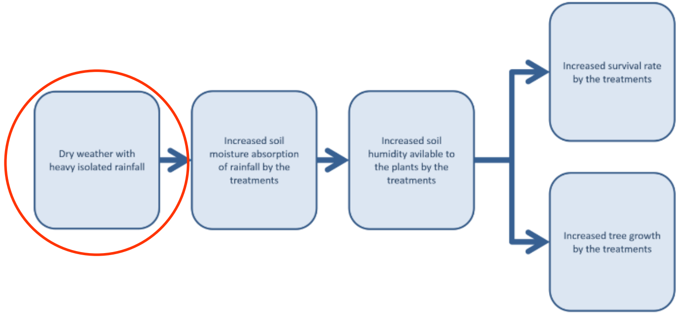
3. Biomass Data
   - Diameter
   - Height
   - Radical growth. Subsequently the radical part will be separate from the stem. In the laboratory the root biomass in green will be weighed (trying to remove as much soil as possible), the length of the main root will be measured and a count of the secondary roots will be estimated.
   - Stem growth

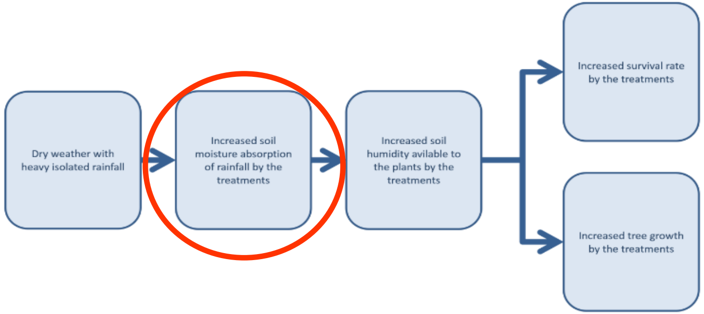
Weather information:

- Historical and experiment temperature, no big differences
- Strong differences in rainy pattern
- Heavy isolated rainfalls - Particularly in the vegetative period

Absorption results:

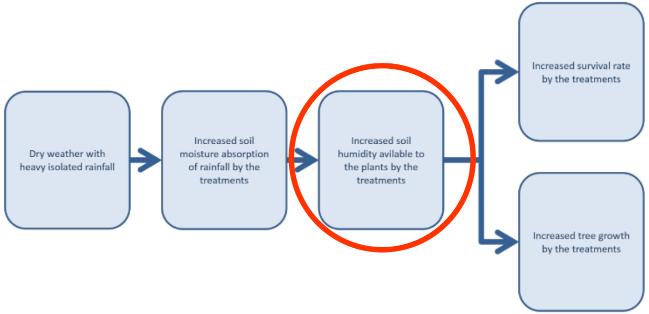
- Moisture absorption after rainfall is higher when using the treatments
- For 1 l/h, after 24h, humidity increases 0,15-0,2 when using treatment (statically significant at 20 cm. At 40 maybe needs longer)
- Strong differences between blocks: the effect is particularly strong in the dry soil

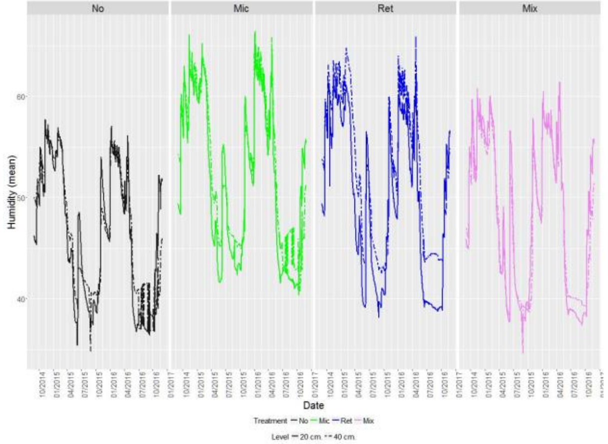




Moisture results:

- Slightly increased soil moisture with the treatments
- Only significant for the mycorrhiza treatment
- Although the effect is small it seems that using the treatments is related to an increase of the soil moisture
- The treatments decrease the absolute value of the difference of moisture at 20 and 40 cm
- The effect of the treatments on soil moisture depends on the soil characteristics
- Tº: only with retainers (alone or combine) slightly increases it in the no vegetative period and decreases in the vegetative period (always less than 1ºC).

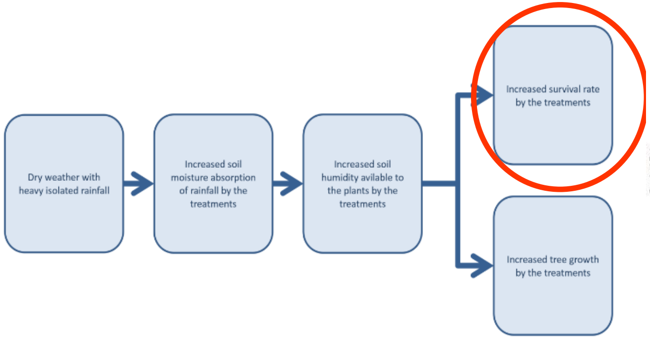


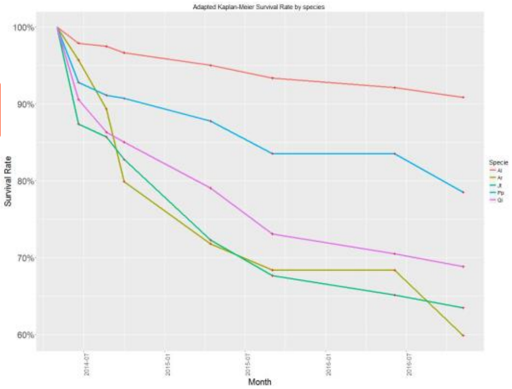


Survival results:

- Increased average survival rate with the treatments
  - < 70% with no treatment
  - 72% with mycorrhiza
  - 76% with retainers and mixed

- *Amigdalus communis:*
  - Not statistically significant => treatments do not have effects (it is a well adapted species – 90%)
- *Acer campestre:*
  - Slightly increases the survival rate although results are not statistically significant
- ***Juniperus thurifera:***
  - Substantially increases the survival rate when using retainers combined with mycorrhizas
- *Pinus pinea:*
  - *Pines do not significantly change the survival rate when using the treatments*

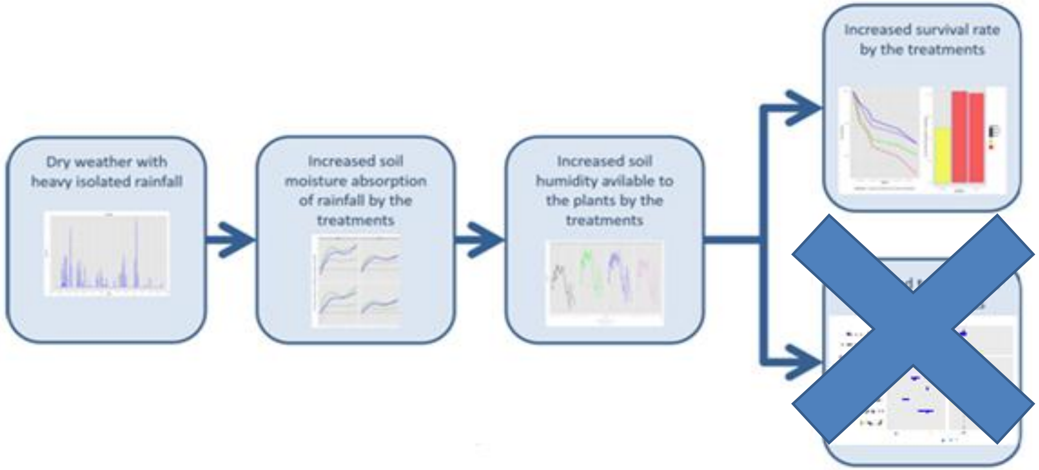




- ***Quercus ilex*:**
  - Substantially increases the survival rate when using retainers but not combined or with mycorrhizas
- *Quercus faginea*:
  - It was excluded or the analysis due to problems with the data

Biomass results:

- We find no significant effect of the treatments on biomass increase:
- The only hypotheses that we were unable to support is the increment in biomass due to the treatments
- Contradictory effects on *Pinus pinea*



4. Results and conclusions

Conclusions:

We find that the treatments might have a substantial effect on increasing the survival rate of the seedlings but only when some conditions hold:

1. Trees are partially adapted to tough weather conditions such as the Quercus or Junipers. There is an insignificant effect when working with species very well adapted to the dry climate (such as the almond or the pine) or very demanding (maple).
2. The treatment is easy to apply and yields short term benefits. We see a significant effect of the treatments including retainers (easy to apply) and an insignificant effect of Mycorrhizas, where reaching an effective level of mycorrhization may be very challenging or the effects can happen in the medium term.
3. There is a strong dependency on the soil characteristics.
4. We have no observed any improvement in biomass growth although it is likely that the small size of the trees are conditioning this result.

There are 2 aspects that deserve consideration when considering the results achieved by the project.

1. The first one is the savings that can be expected when using the treatments.

2. The second one are the overall socio-economic benefits of the project.

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¡Thank you!

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