

# **Climatic, Environmental and Pollution Traceability of the Monumental Olive and Cedar trees of Lebanon: Lessons from the Past to the Present**



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# WHY Olive and Cedar Trees

**Significant symbols**

**Among the oldest trees in the Mediterranean basin and not widely studied**

**In Lebanon, survived at diverse altitudes and not yet studied**

# **WHY Mediterranean Basin**

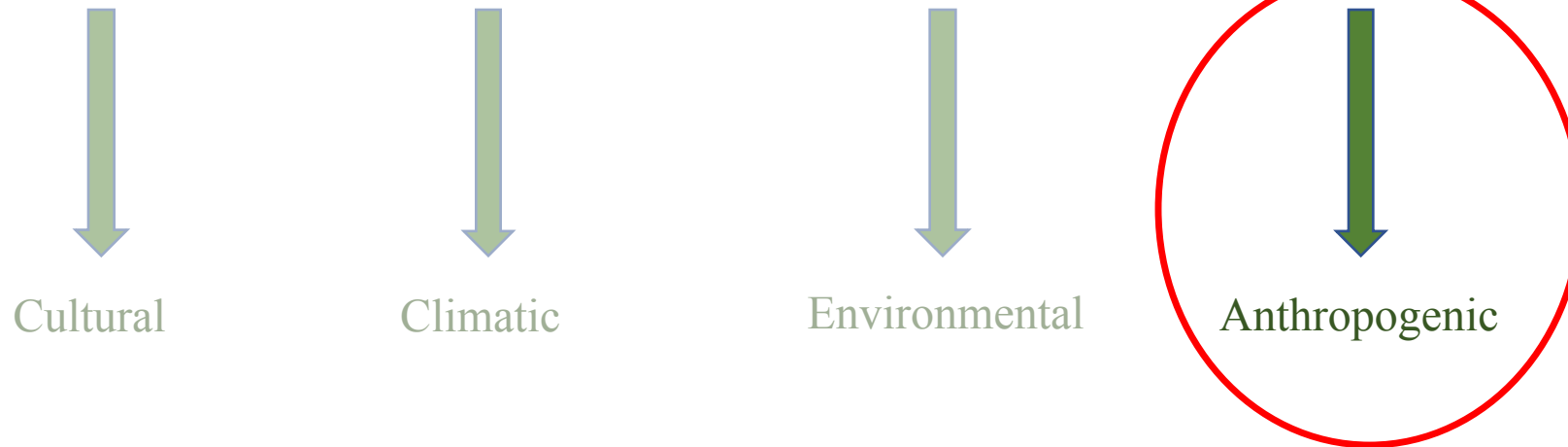
**Area vulnerable to climate change**

**Species persisted in it due to low  
amplitude of temperature change**

**Middle East and North Africa region, major contributor  
to global health and climate change emissions.**

# Scientific Challenges

**1-How these trees have and will survive the different shocks**



**2- how will they continue to persist among upcoming changes**

# Literature Review

**Higueras et al. 2014: Site: Spain-3 contaminated sites. Trees: Olive Trees- Study soil and Leaves**

- Heavy precipitation and use of insecticide: Cause higher Mercury concentration values (Shibar et al. 1978).

**Yang et al. 2017 : Site: Northeast USA. Trees: hardwoods and Conifers**

- Wood is the largest component in forest biomass
- $Hg_{Foliage} > Hg_{bark} > Hg_{bole}$  wood in both Hardwood and conifer stands.

**Yang et al. 2017 : Site: USA-White Mountain National Forest Measuring Mercury in Wood**

- Hg concentration in wood is below detection limits of some analytical methods.
- Wood promising indicator of Mercury

**Schneider et al. 2019. Site: Australia, Mining Site in Tasmania. Trees: Pine > 200 years old. Studied Tree Rings and Foliage**

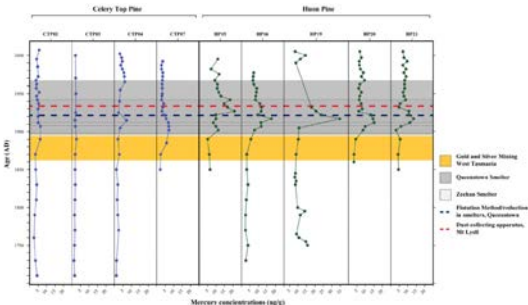


Figure 2. Temporal profile of Hg concentration in tree rings of celery top pine (*Phyllocladus aspleniifolia*) and huon pine (*Lagarostrobos frankii*) in Queenstown, Tasmania, Australia.

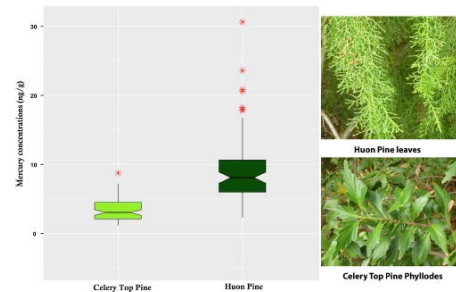


Figure 4. Mercury concentrations (ng/g) in celery top pine (*P. aspleniifolia*) and huon pine (*L. frankii*). Red stars indicate outliers. On the right side are illustrations of the foliage of huon pine and Phylloclades of celery top pine, the likely routes by which Hg is taken up from the atmosphere. Huon pine picture taken by Simon Maitland and celery top pine picture by Tamas Gorus.

**Higueras et al. 2012: Site: Spain-Almanden mining district. Tree: Olive Tree-Study Soil and Leaves**

- minimal to no relation between metallic trace elements in soil and leaves.

**Higueras et al. 2014: Site: Spain-3 contaminated sites. Trees: Olive Trees- Study soil and Leaves**

- Leaves absorb mercury from the atmosphere.
- $Hg_{Soil}$ : 182 up 23,488 ng/g
- (Higher values near contaminated sites)
- $Hg_{Foliage}$ : 161 up to 1213 ng/g

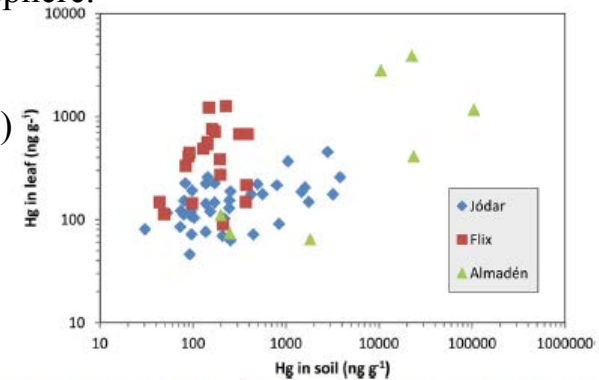


Fig. 1 Hg content ( $\mu g\ kg^{-1}$ ) in soil and olive tree leaves in Jódar, Flix and Almadén sites (logarithmic scale)

**Noharro et al. 2018: Site: Spain- 3 Young trees- Almanden mining site. Tree: Olive Tree-Study Leaves**

- $Hg_{foliage}$ : 40-50ng/g (Away from mining site) up to 330 ng/g (during Exposure to the mining site)



Focus on Hg  
concentration

**The study of Mercury concentration in olive trees different organs**

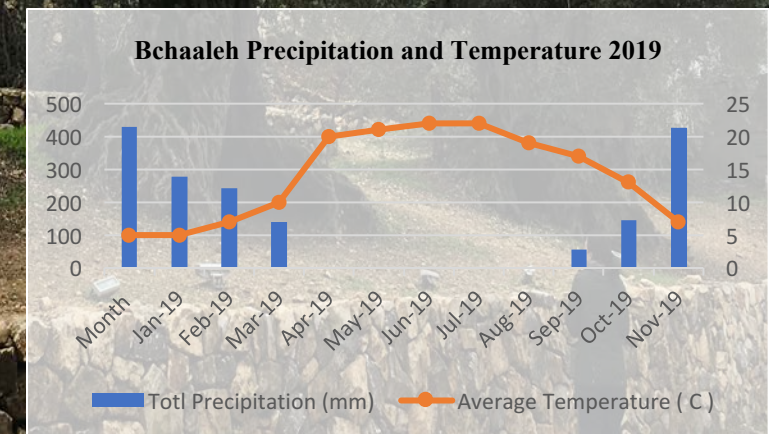
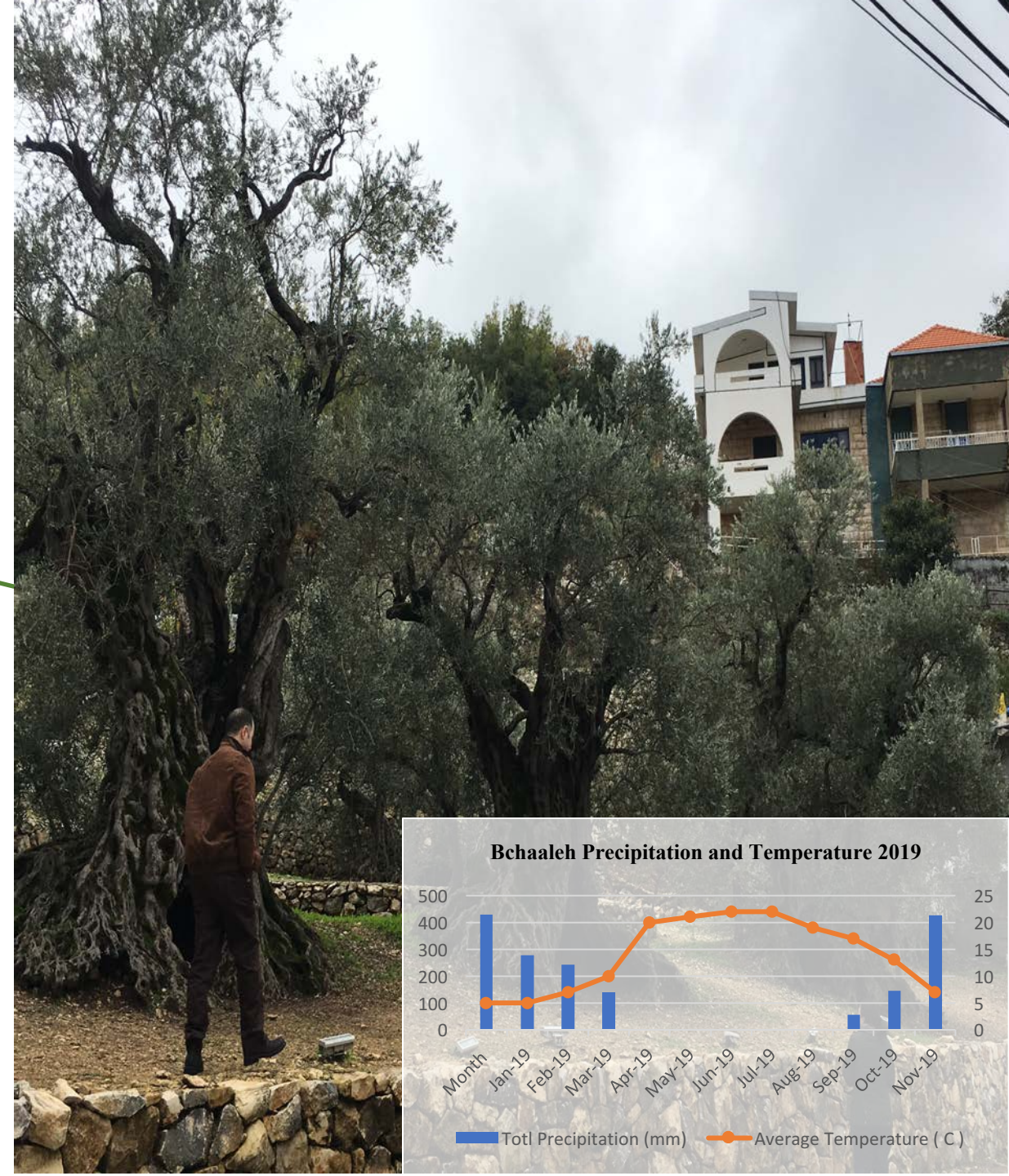
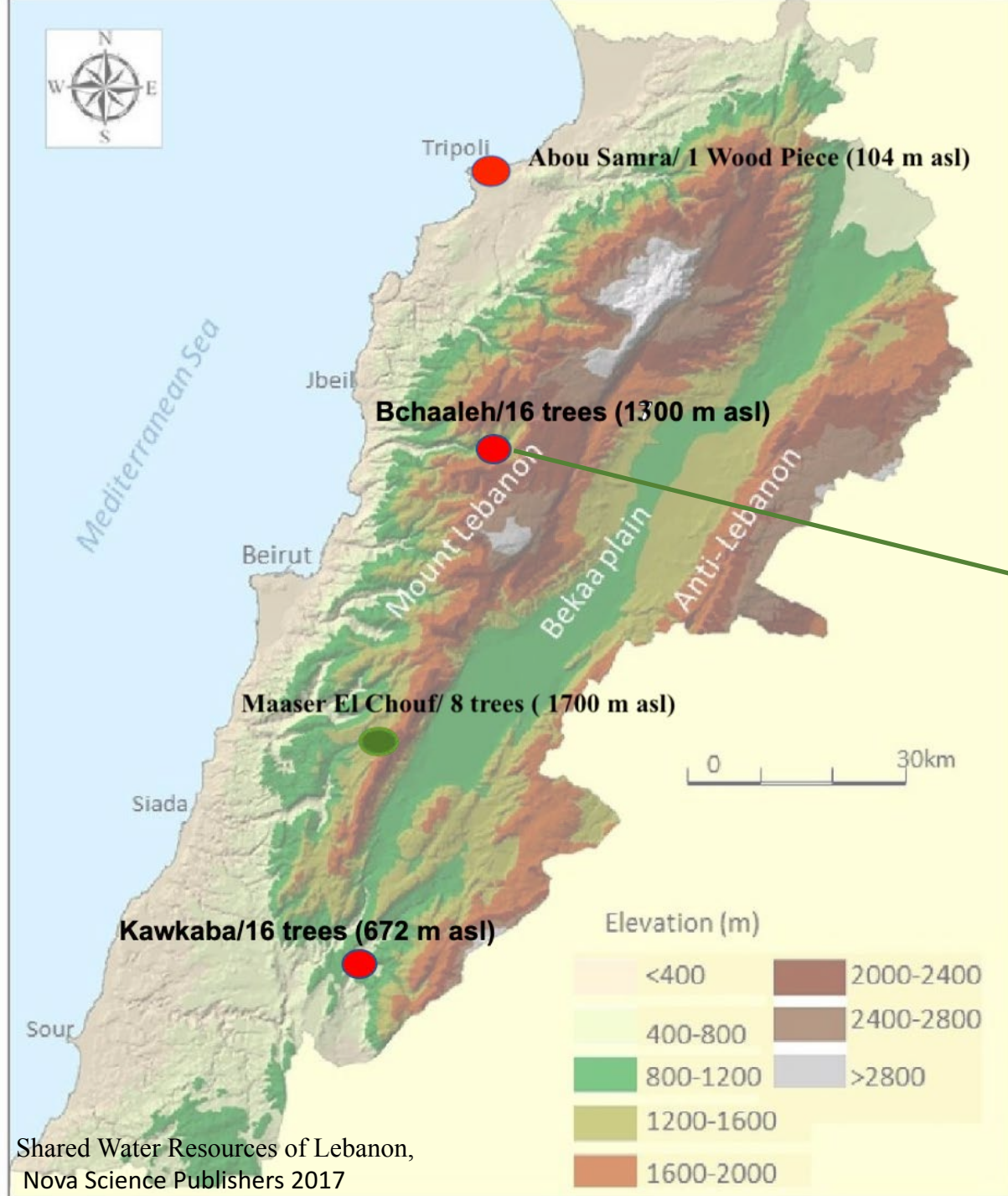


# Lebanon Geographical Location

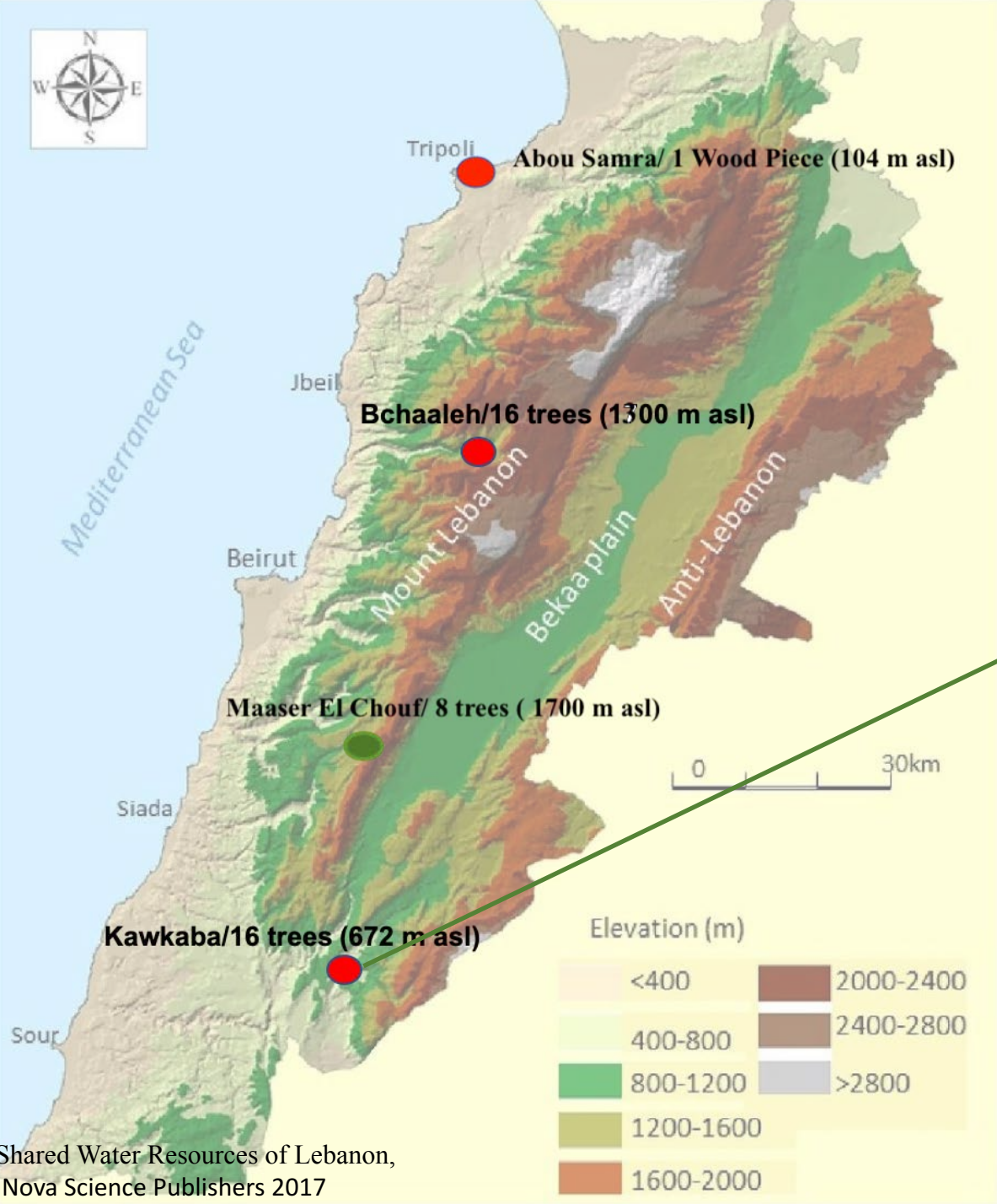


Mediterranean countries map, source: on the world map

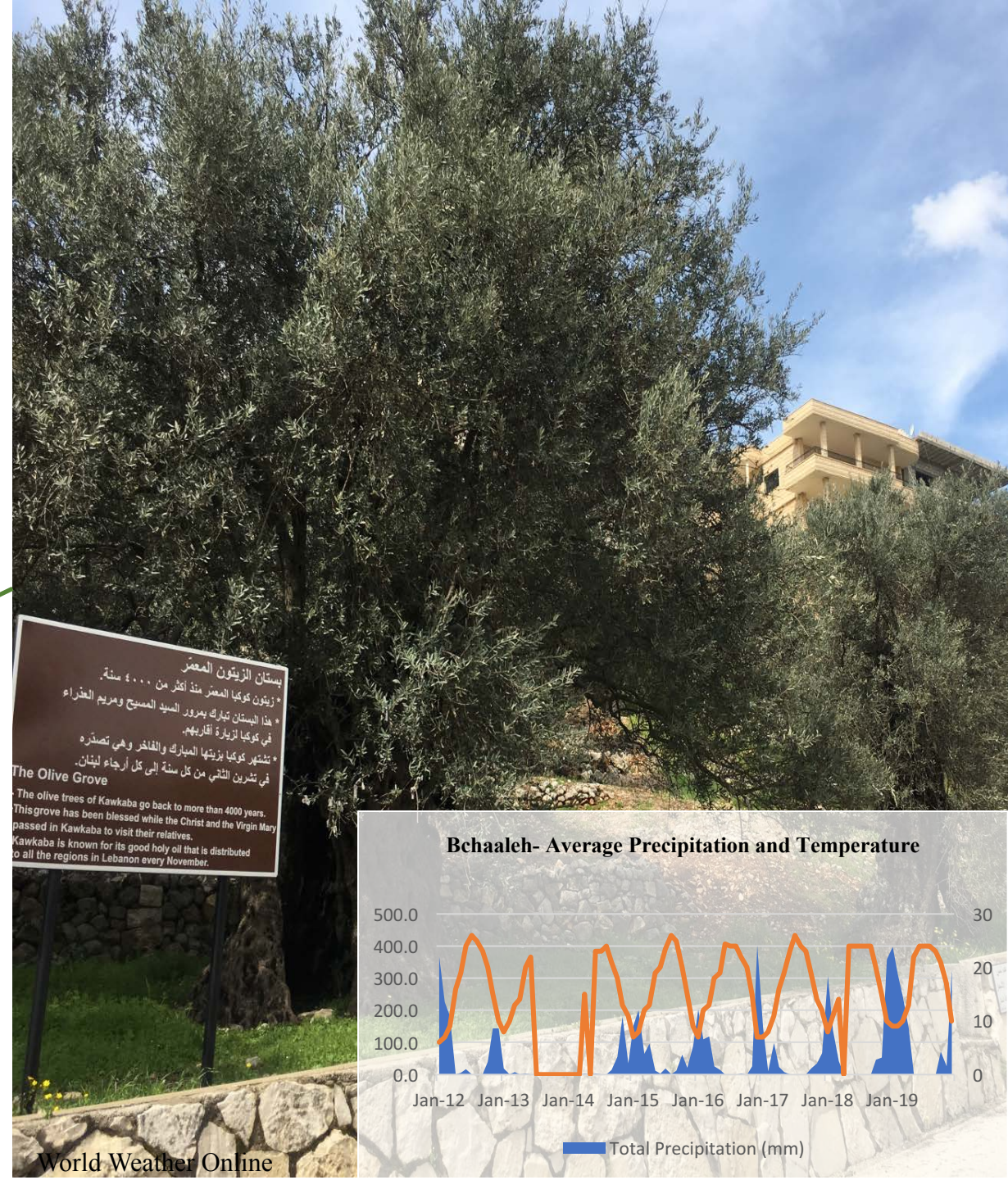






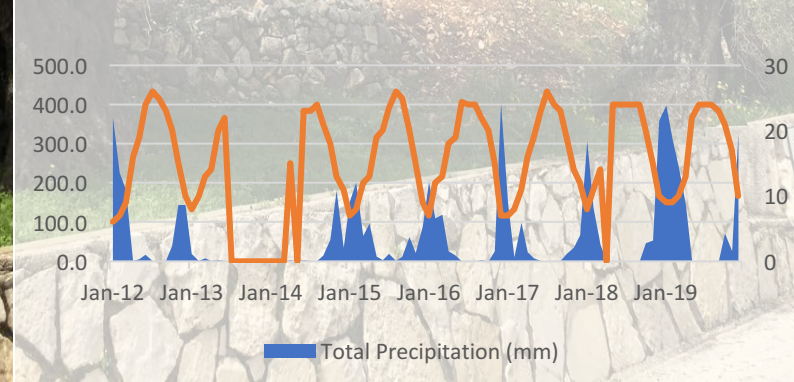


Shared Water Resources of Lebanon,  
Nova Science Publishers 2017



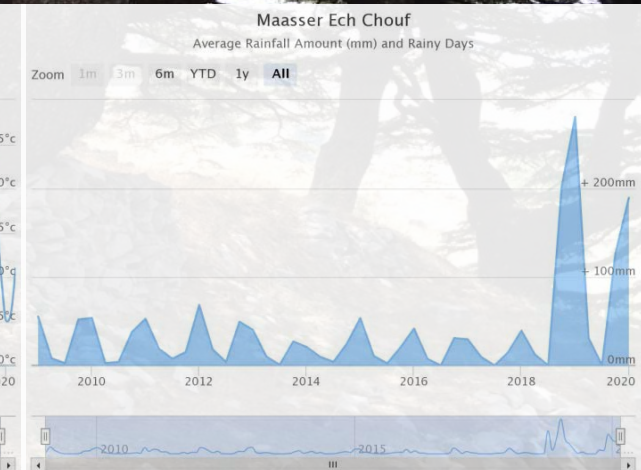
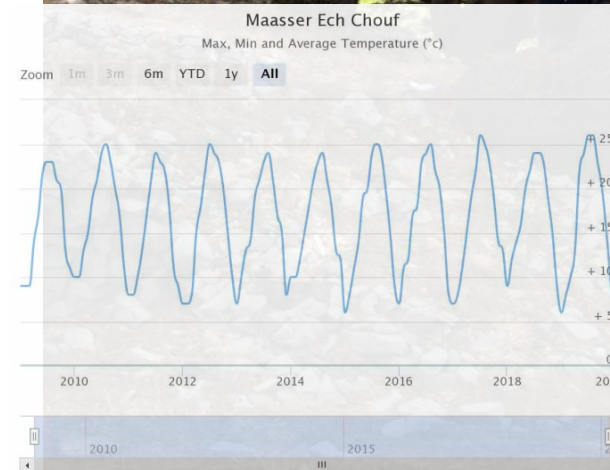
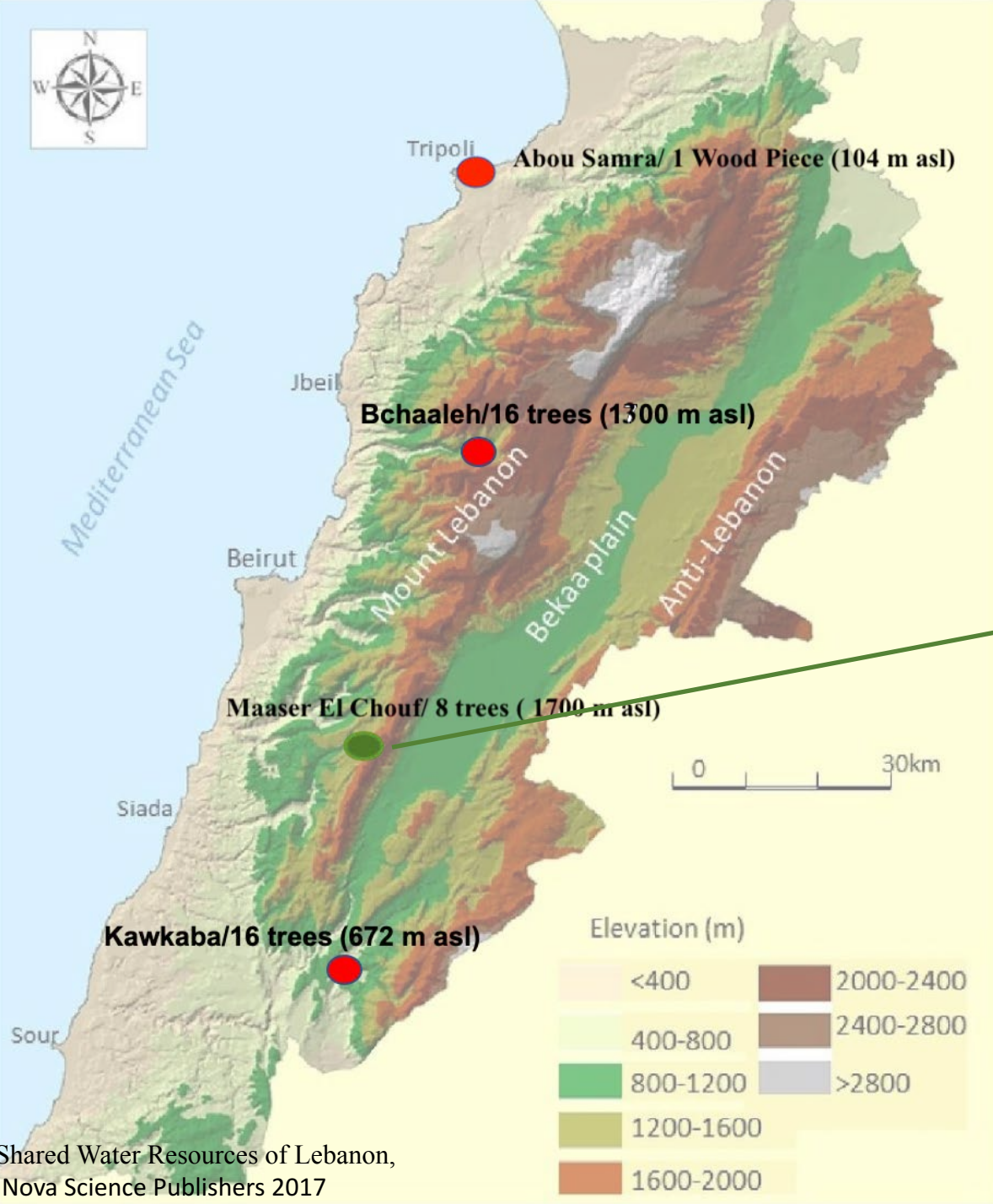
بستان الزيتون المعمر  
\* زيتون كوكبا المعمر منذ أكثر من ٤٠٠٠ سنة.  
\* هذا البستان تبارك بمرور السيد المسيح ومريم العذراء  
في كوكبا لأزيارة أقاربهم.  
\* تشتهر كوكبا بزيتها المبارك والفخر وهي تصدّره  
في تشرين الثاني من كل سنة إلى كل أرجاء لبنان.  
The Olive Grove  
The olive trees of Kawkaba go back to more than 4000 years.  
This grove has been blessed while the Christ and the Virgin Mary  
passed in Kawkaba to visit their relatives.  
Kawkaba is known for its good holy oil that is distributed  
to all the regions in Lebanon every November.

Bchaaleh- Average Precipitation and Temperature

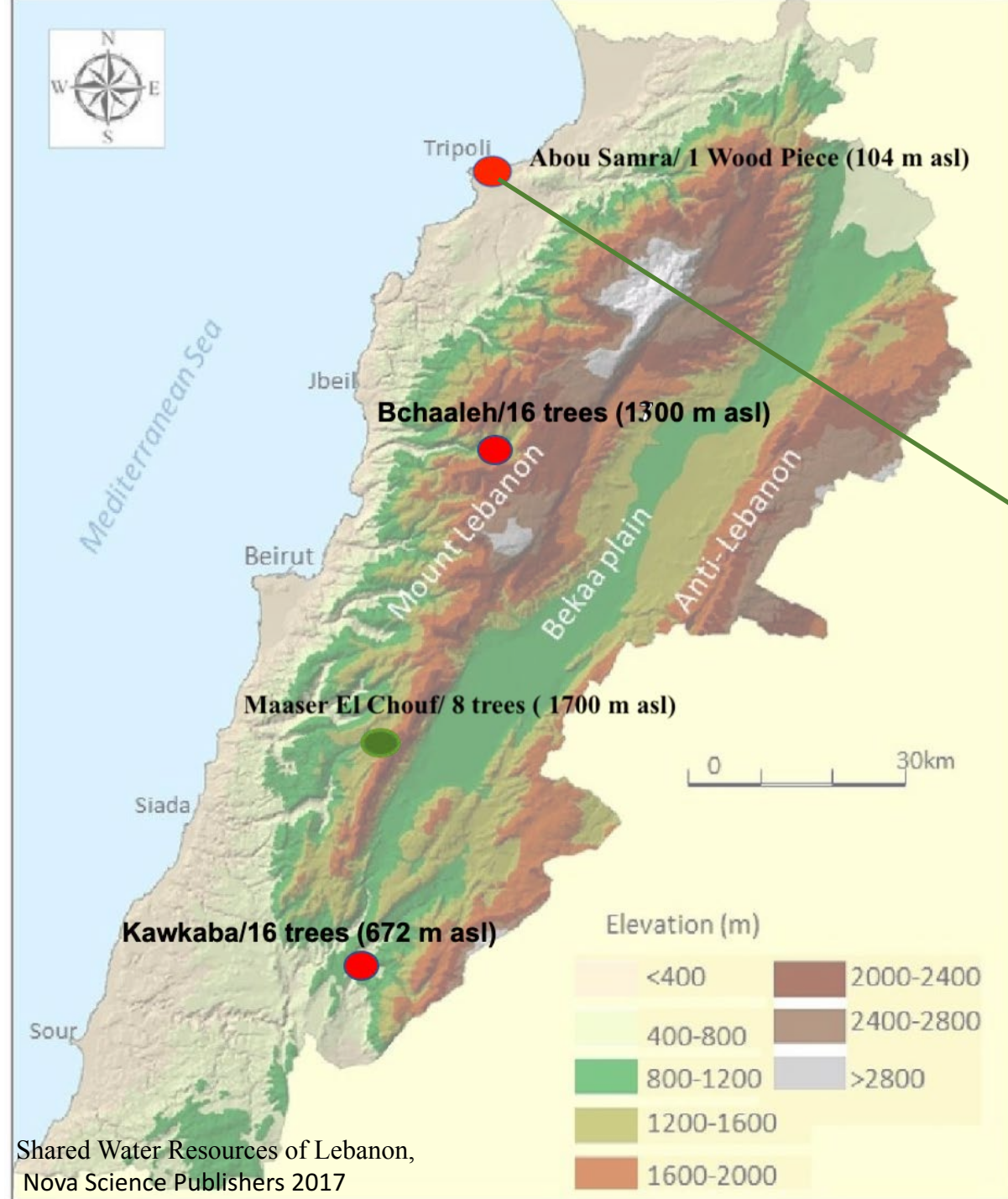


World Weather Online

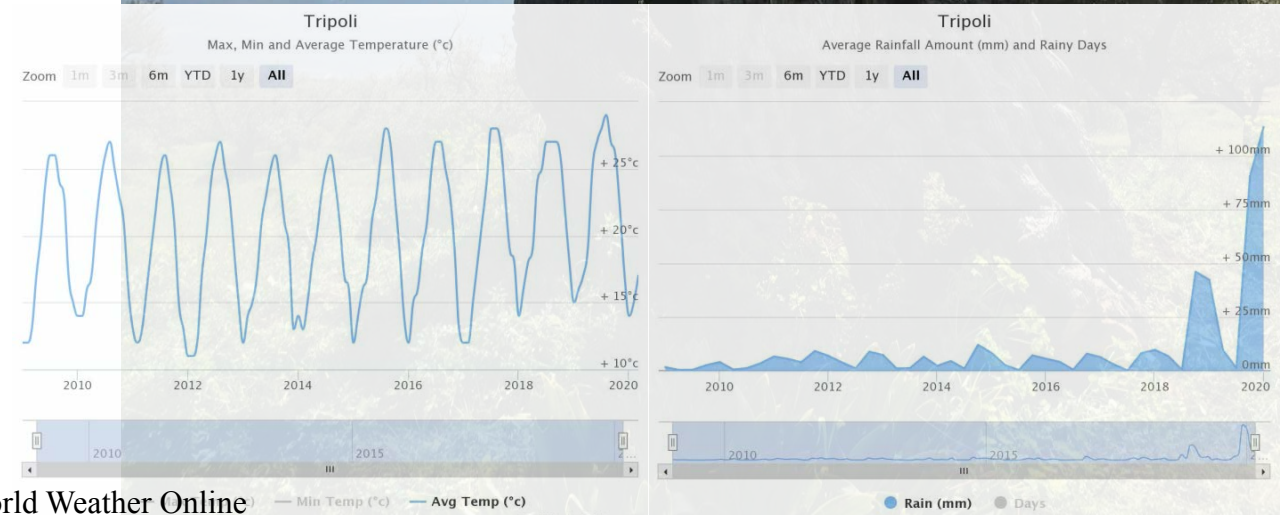








Shared Water Resources of Lebanon,  
Nova Science Publishers 2017



World Weather Online



# Field Work-Collected Samples



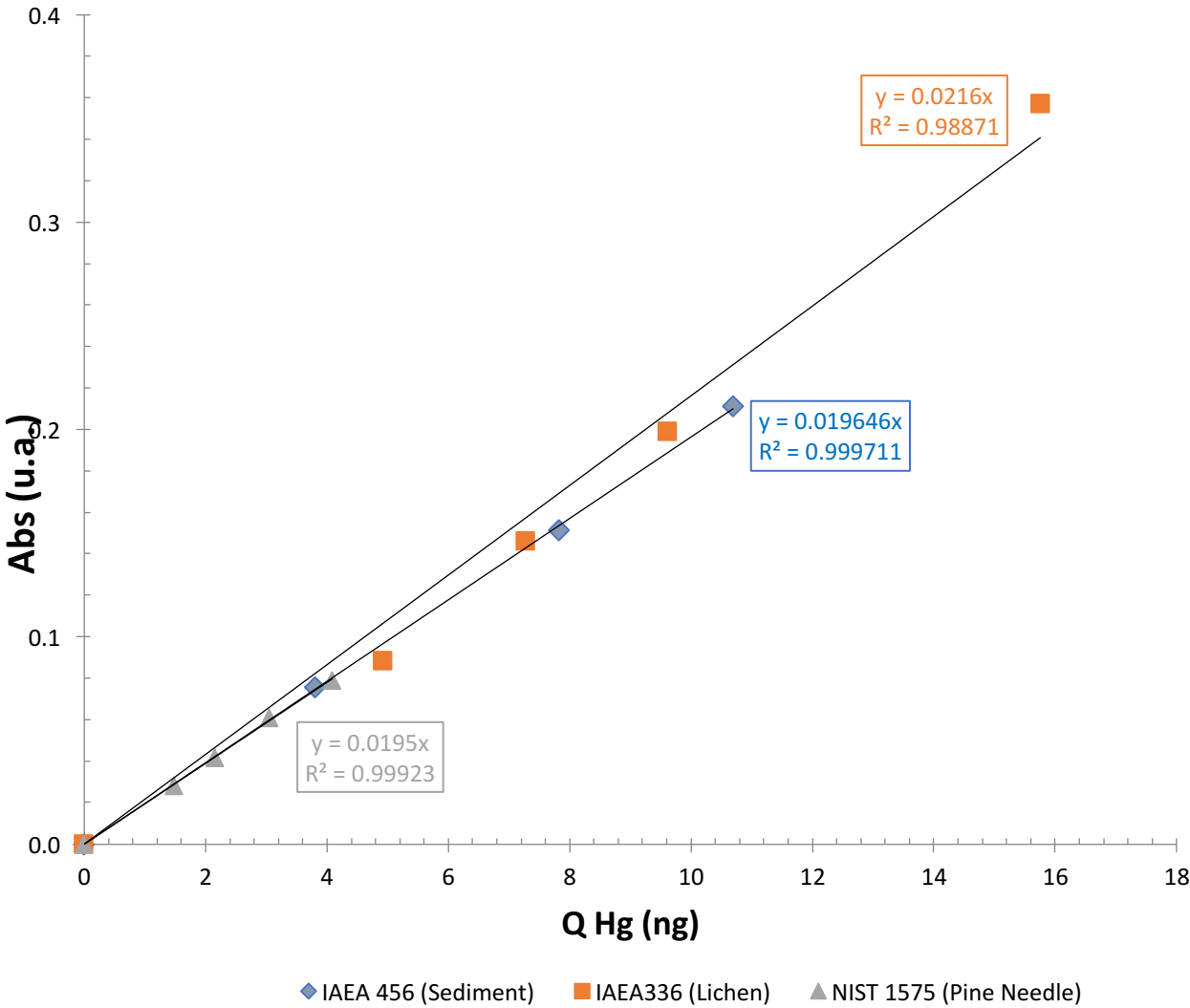
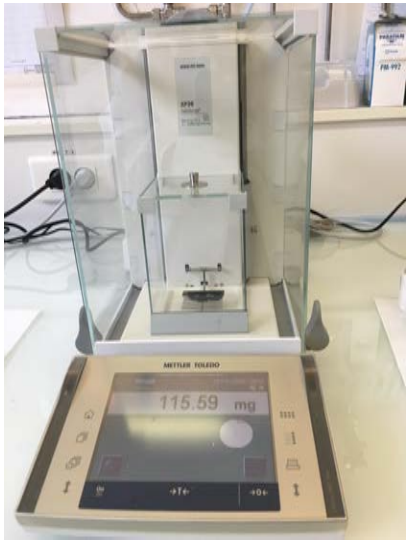


# Lab Work-Analyzed Samples

Site	220 powder Samples	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Bchaaleh (Tree 1-4-9-12)	Leaves and Stems											
	Litter and Soil											
	Grains											
Kawkaba (Tree 1-2-3-4)	Leaves and Stems											
	Litter and Soil											
	Grains											
Maaser El Chouf (Tree 1-2-3-9)	Leaves and Stems											
	Litter and Soil											
About Samra (Tree 1)	Piece of Wood (Tree Rings)											



# Mercury Analyzer AMA 254

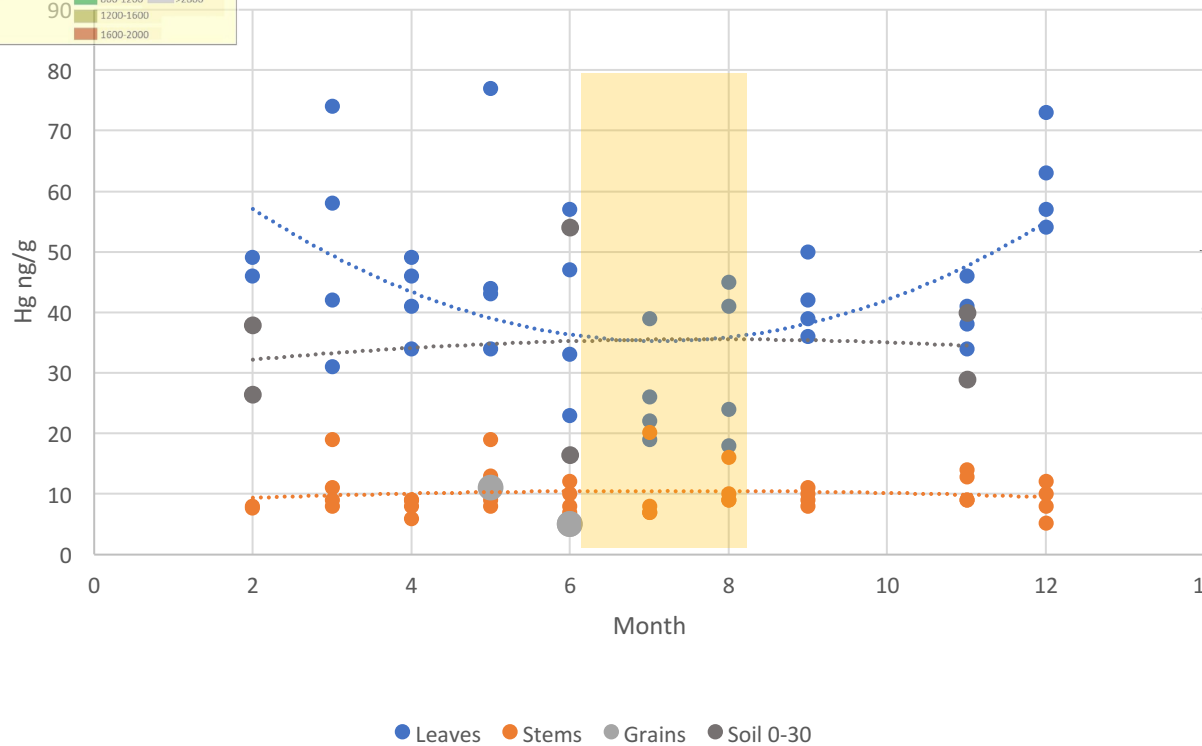




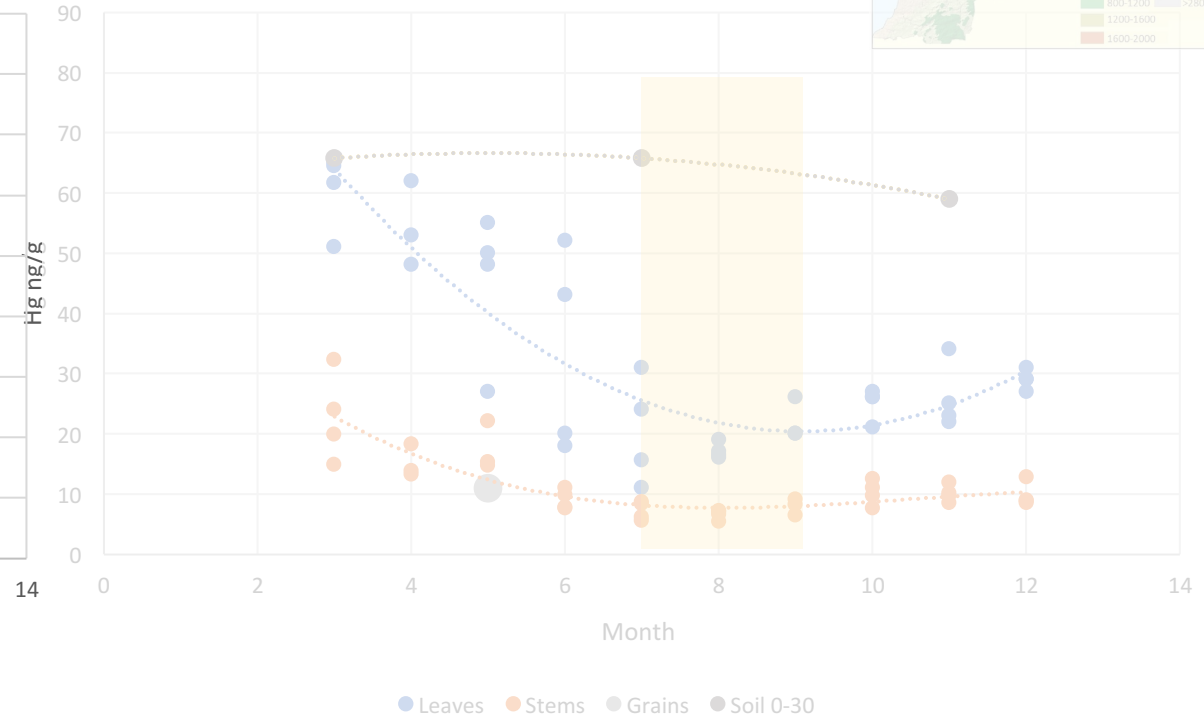
# Results & Discussion

## 1.1- Monthly variations of Hg contents (ng/g) : Four trees/site

BCHAALEH 2019-OLIVE TREES



KAWKABA 2019-OLIVE TREES



$$\rightarrow Hg_{(Leaves)} > Hg_{(Stems)} = Hg_{(Seeds)}$$

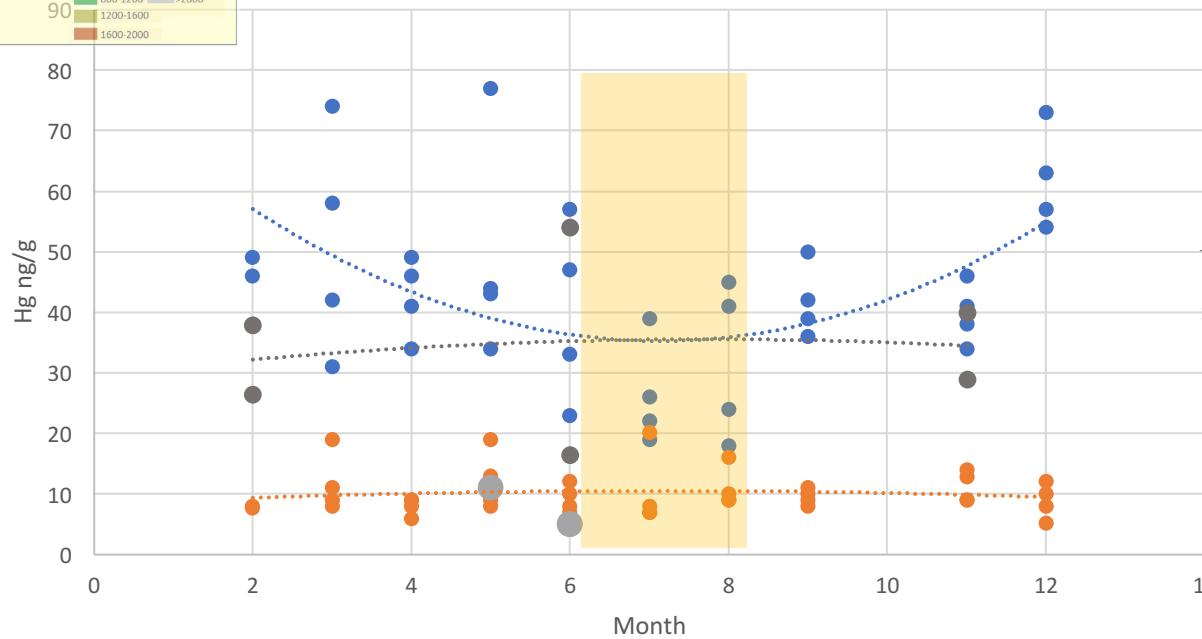
$\rightarrow$  In general **lowest** values in **summer** for plant material

$\rightarrow$  While **similar** content is observed **between soil and leaves at Bchaaleh**, we note **Higher  $Hg_{(soil)}$**  compared to plant material at **Kawkaba**

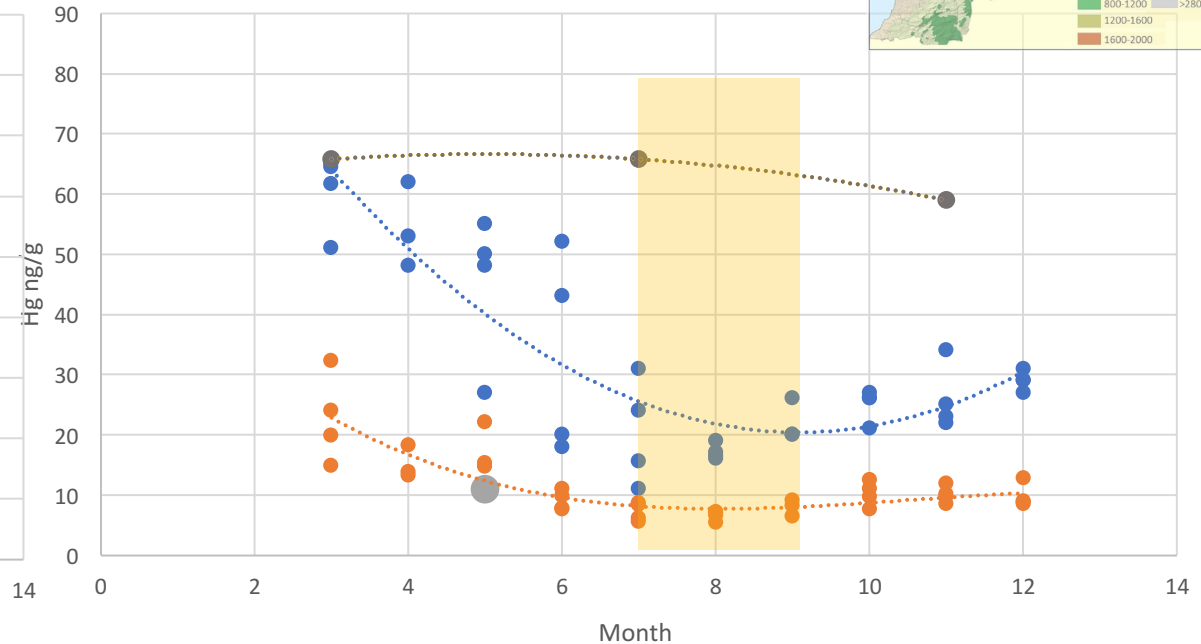
# Results & Discussion

## 1.1- Monthly variations of Hg contents (ng/g) : Four trees/site

BCHAALEH 2019-OLIVE TREES



KAWKABA 2019-OLIVE TREES



● Leaves ● Stems ● Grains ● Soil 0-30

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## 1.2- Cedar August Hg content compared to Bchaaleh and Kawkaba Monthly variations of Hg contents (ng/g)

Cedar Soil 0-30

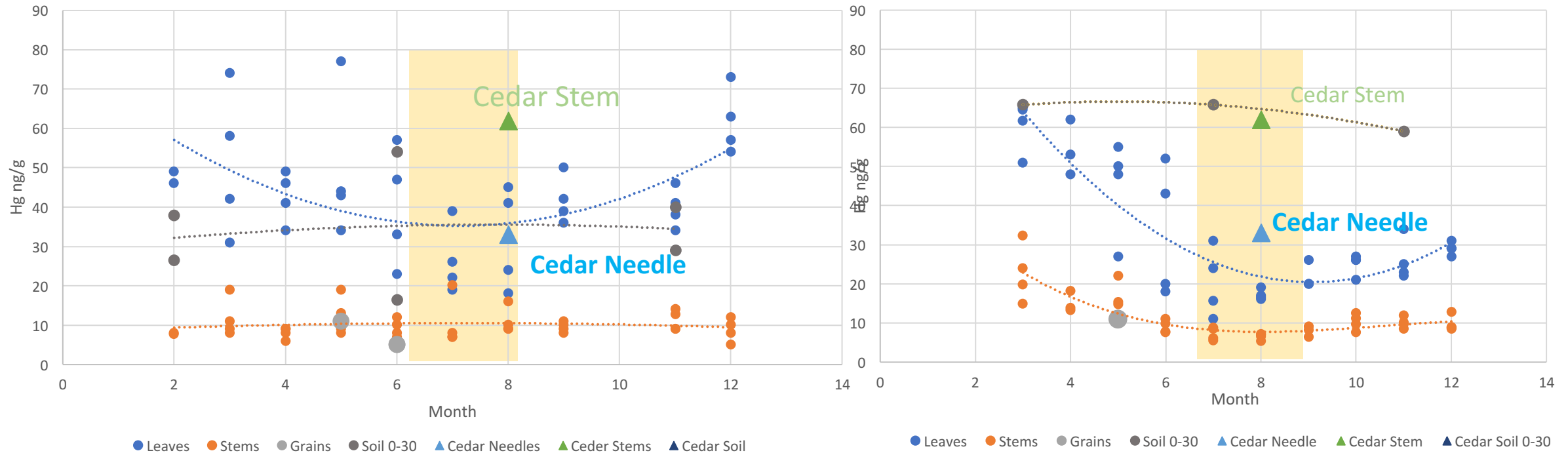


Bchaaleh and Maaser (Cedar)

Cedar Soil 0-30



KAWKABA 2019-OLIVE TREES



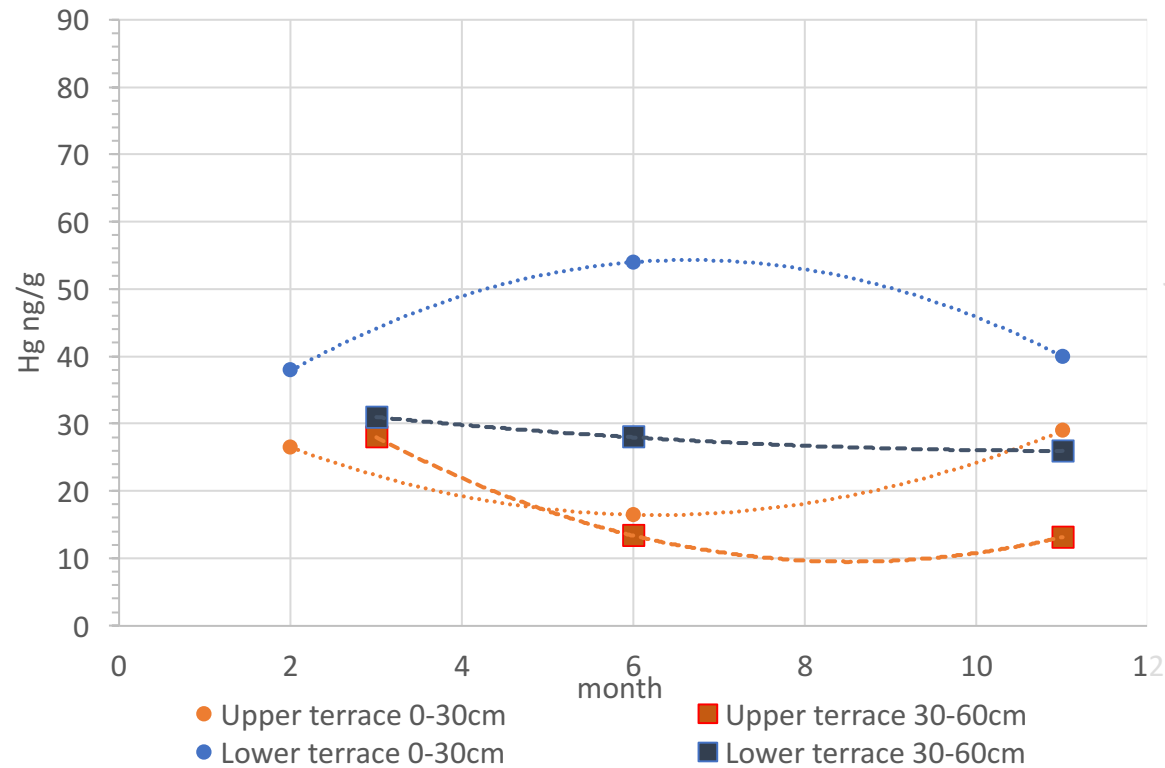
$$\rightarrow Hg_{(Leave)} > Hg_{(Stems)} = Hg_{(Seeds)}$$

→ In general **lowest** values in **summer** for plant material

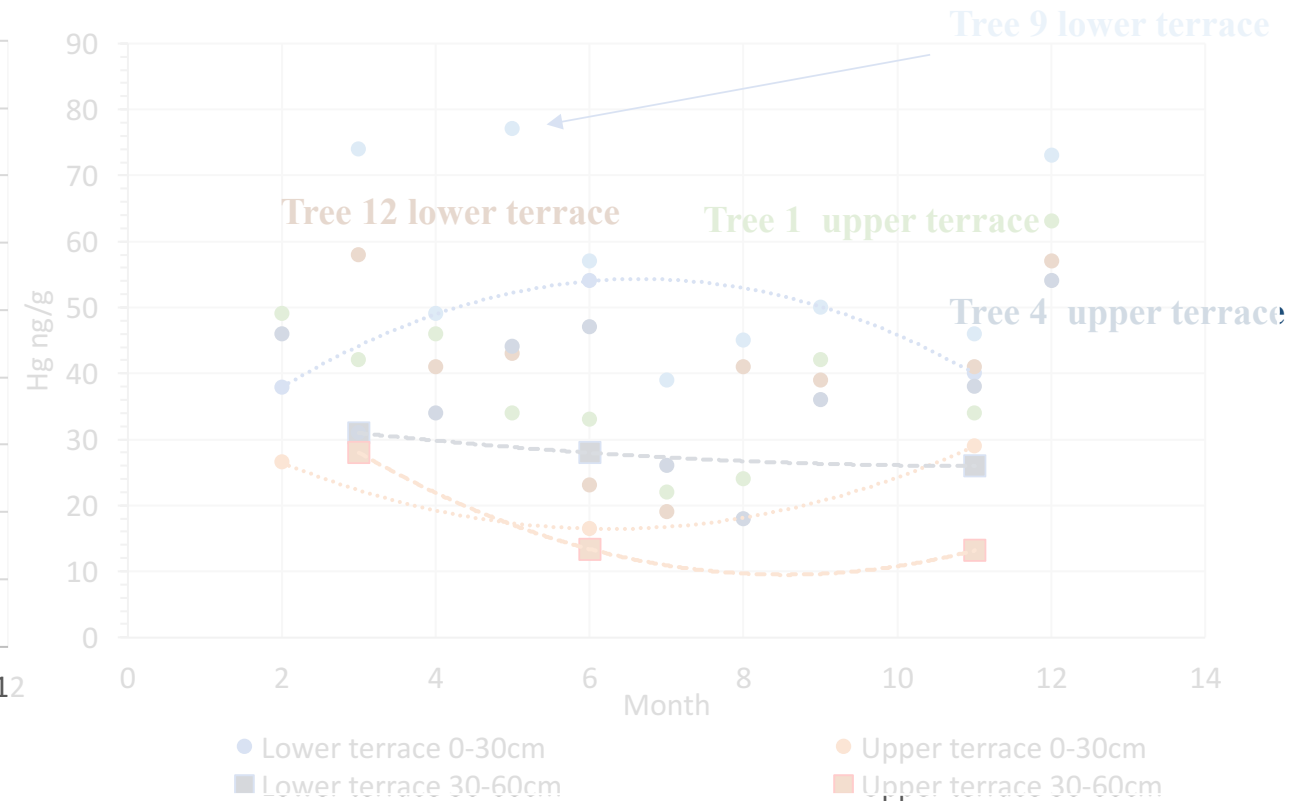
→ While **similar** content is observed **between soil and leaves at Bchaaleh**, we note **Higher  $Hg_{(soil)}$  (186 ng/g)** compared to plant material at **Kawkaba**

## 2.1- Soil Hg content (ng/g)

Bchaaleh Soil 2019



Bchaaleh 2019-Hg of soil and leaves



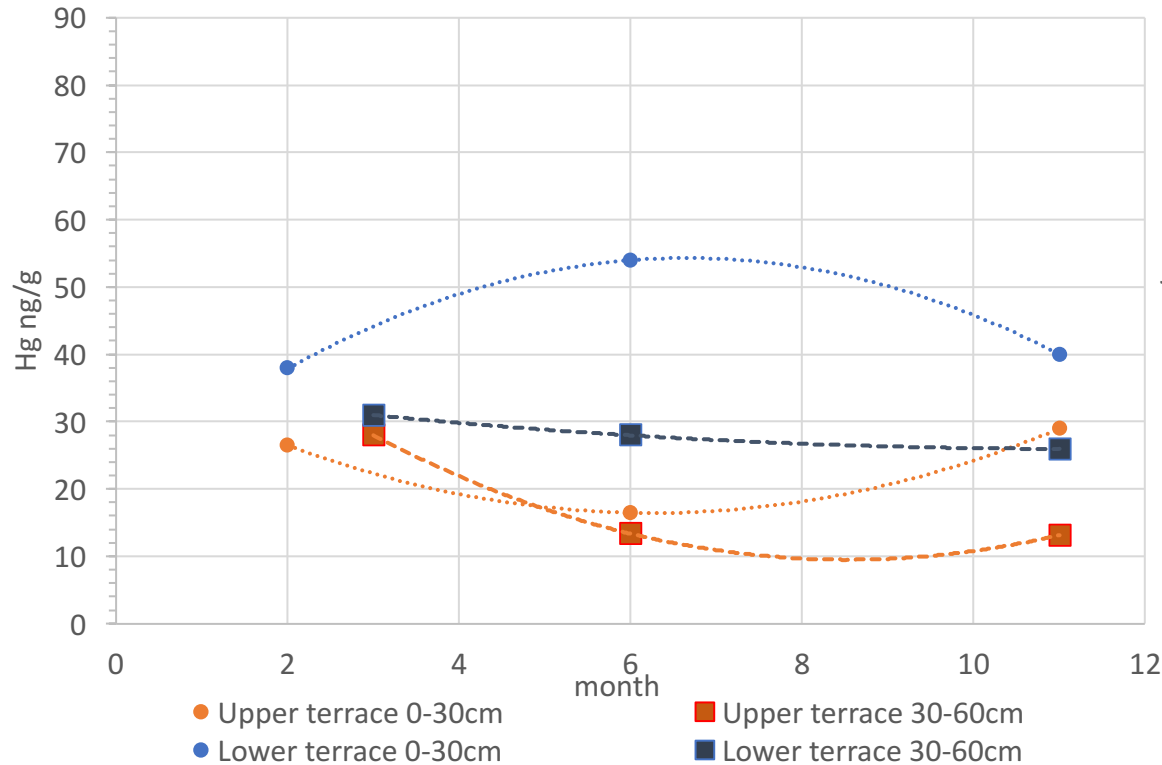
→ The **Lower Terrace** Have Higher Hg concentration for **SOIL (0-30 cm)** than the Upper terrace.

This might be due to the cultivation practices, insecticides (Shiber et al. 1978)

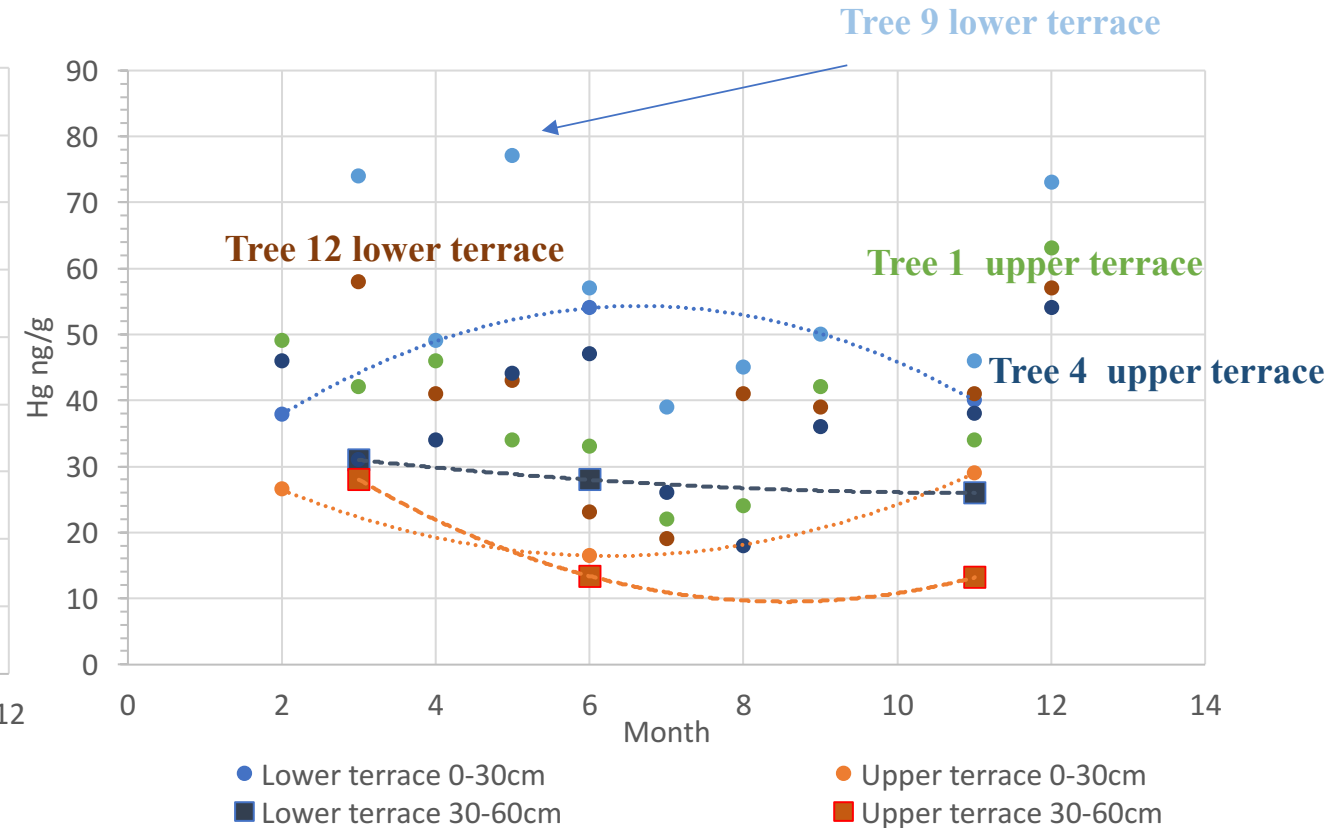


## 2.2- Soil Hg content (ng/g)

Bchaaleh Soil 2019



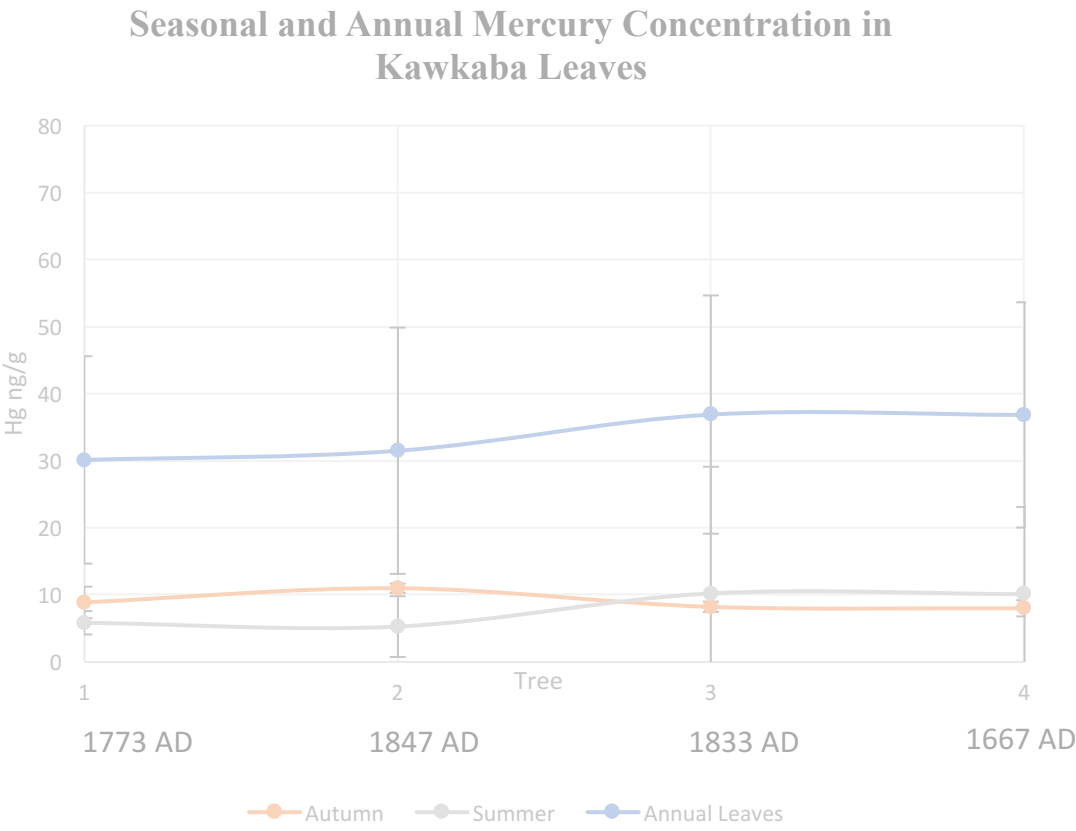
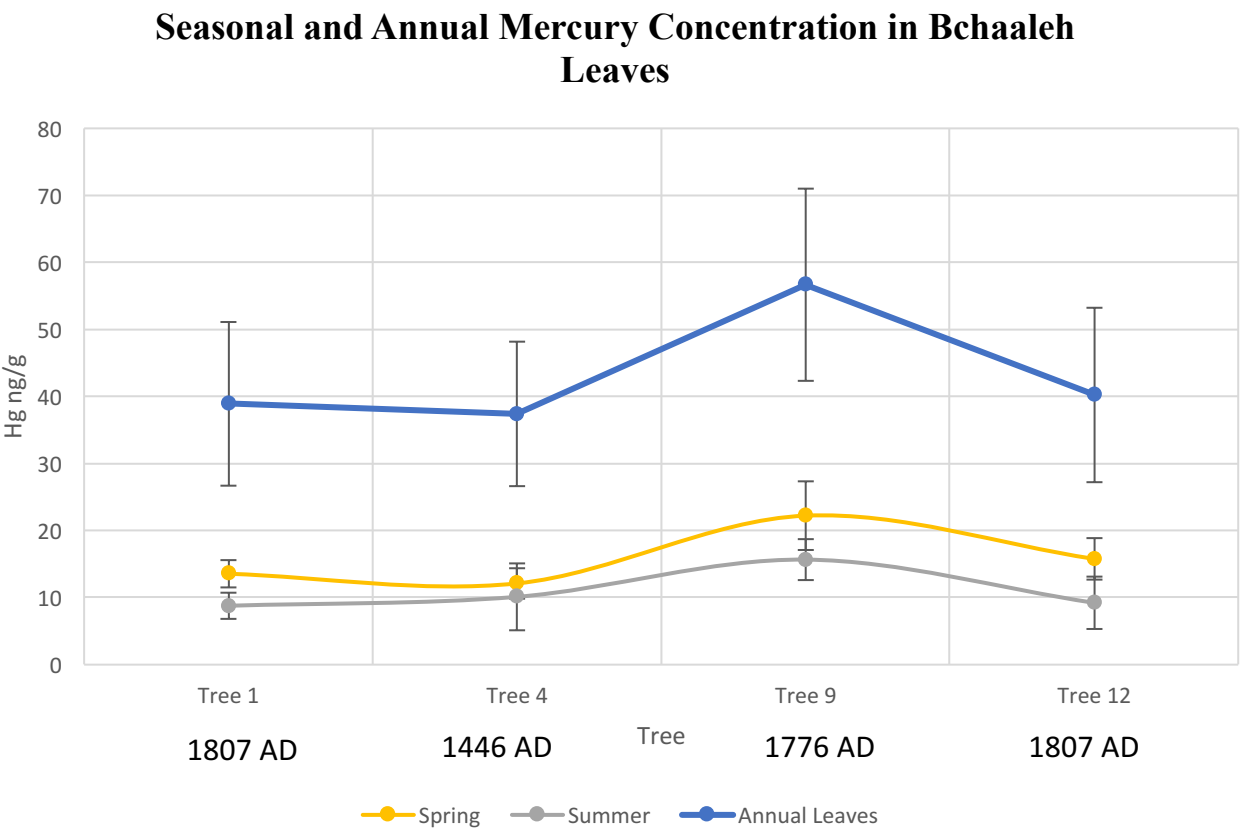
Bchaaleh 2019-Hg of soil and leaves



→ Also the **Leaves** show **higher** values in the **lower terrace** than the Upper terrace

→ **BUT Tree 9** on the lower terrace is the most enriched in Mercury, this can be due to insecticides use (Shiber et al. 1978) or age related (Schneider et al. 2019).

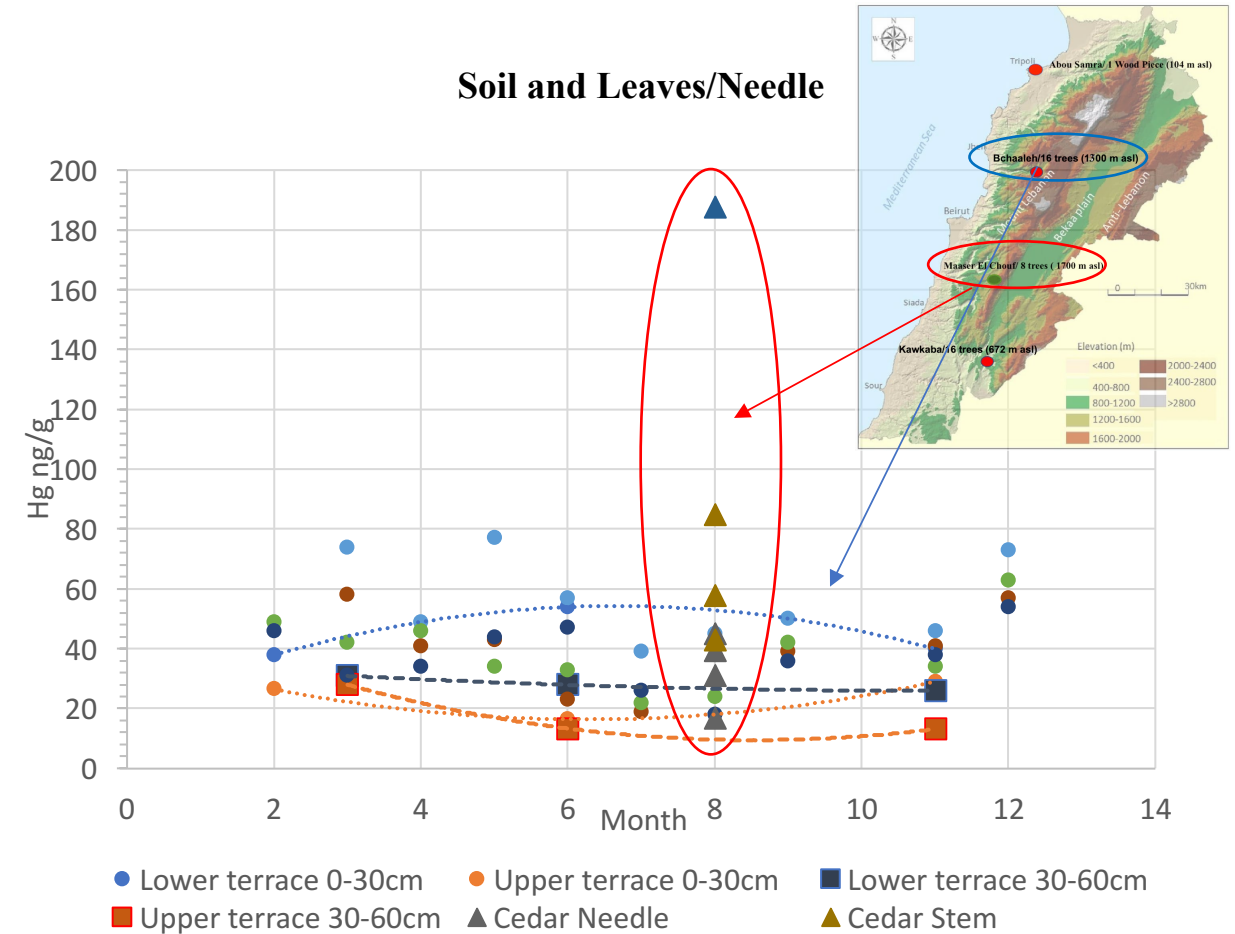
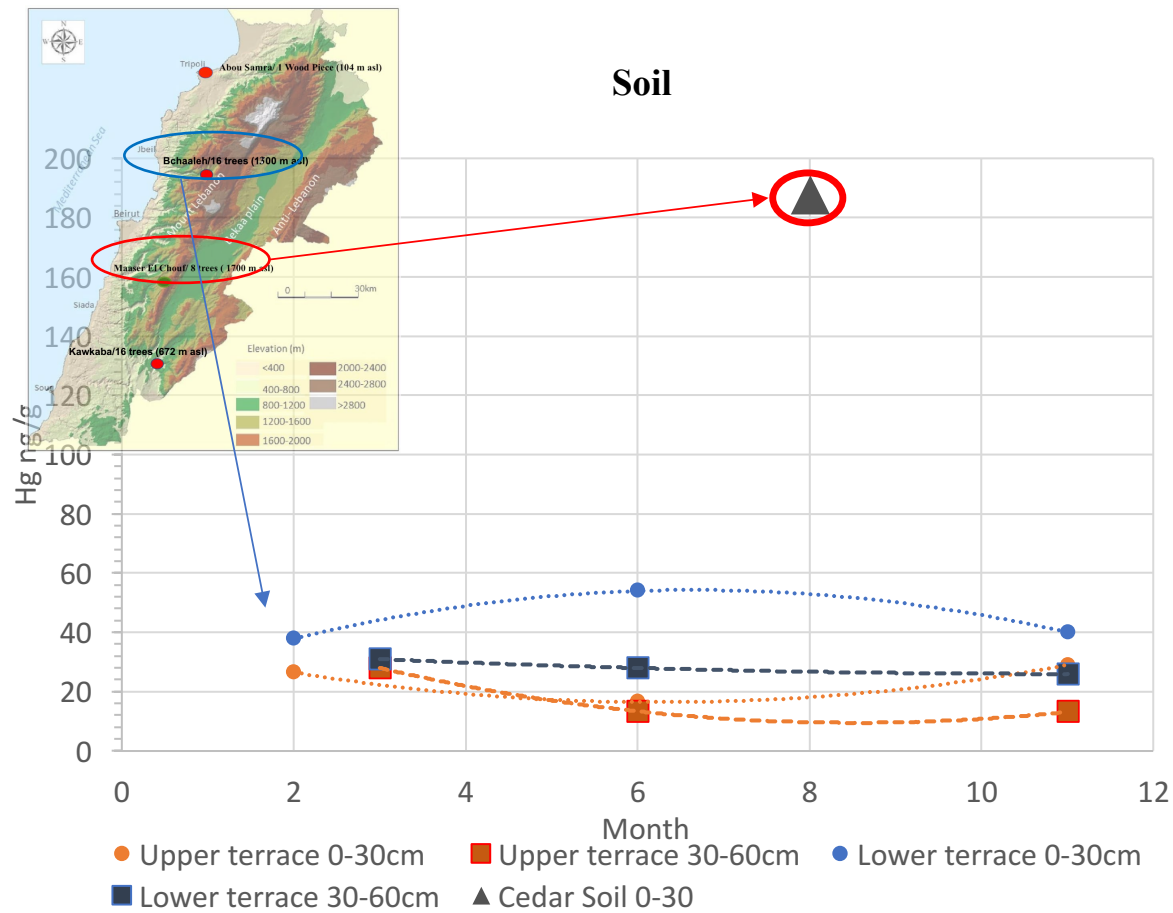
# Seasonal and Annual Mercury Concentration in Leaves



**Summer have the Lowest Mercury Concentration, Winter needs more collected data to confirm the highest values during the season as per Shiber et al. 1978**

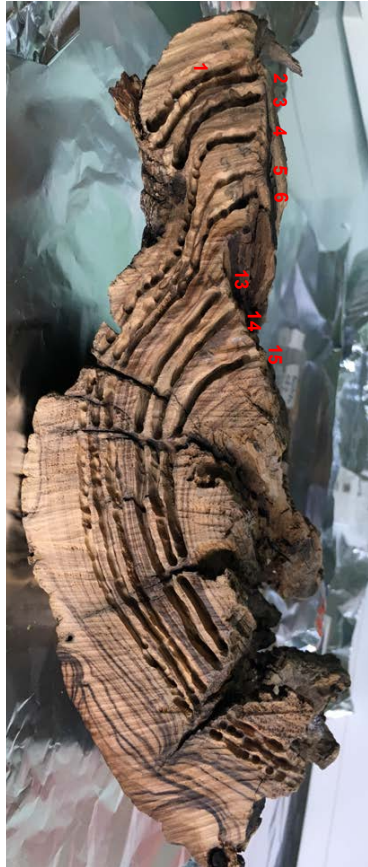


## 2- Cedar Tree in August-Maaser El Chouf Compared to the monthly Mercury variation in Bchaaleh

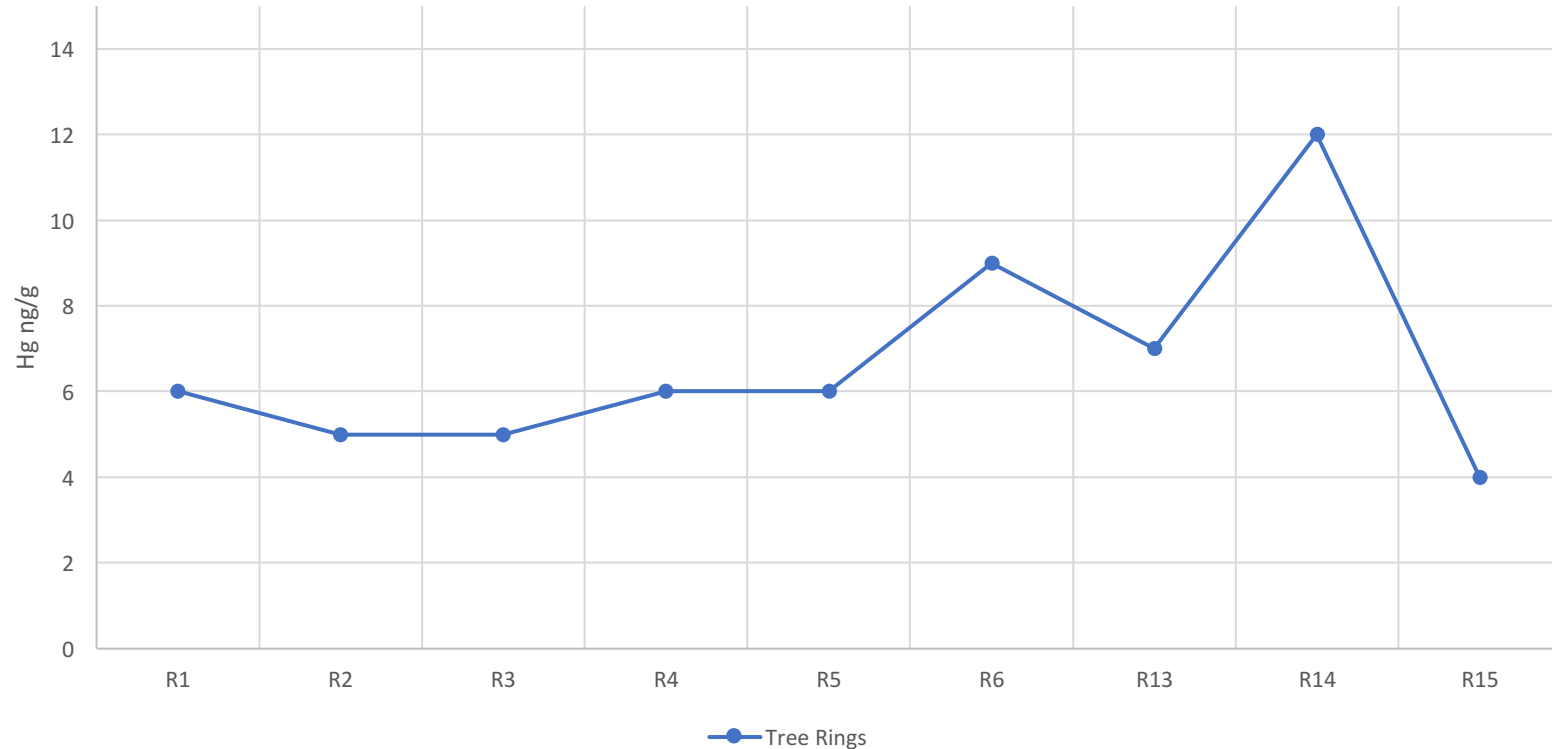


→ In Mount Lebanon-Cedar site, the soil (0-30 cm) have the highest Hg concentration, noting that  $Hg_{stems} > Hg_{needles}$ .

→ (A time series needs to be built to confirm those results)



**Trial Sample-Abou Samra Tree Rings Mercury Concentration**



**The Trial sample showed that Tree Rings have the lowest Mercury Concentration among all Plant Material but 2 rings (Ring 6 and 13) have higher values.**

As per other studies done on Pine, it shows that can represent a larger Hg pool than foliage and bark in spite of its low concentration along a time scale  $\text{Hg}_{\text{wood}}$  (0.32g/ha) Twice the size of  $\text{Hg}_{\text{foliar}}$  pool (0.15g/ha) (Yang et al.2017).



# Conclusion

**Olive Trees are good indicators of mercury concentration and not yet deeply studied in the Eastern Mediterranean.**

**Wood rings have great potentials to study the mercury concentration of the past even with lower concentration than that over other plant material.**

**Using X-Ray Tomography and C14 can help build a reliable chronology for olive tree wood rings and study the Hg content variation in a more precise time resolution**

**This study uses all the plant material of olive tree (Leaves, stems, Soil and wood) to study the concentration in olive trees showing the variation among all elements**

**This was the first step to gather information and understand the possible source of pollution. So the next step is to study the stable isotopes of Mercury.**

# Acknowledgement

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- This work has been possible thanks to the free access granted to the AMA 254 instrument and due to the help of IPREM team without any cost.
- BIODIVMEX MISTRAL WG4 diversity of Past, Present and Future Mediterranean Landscapes.





المجلس الوطني للبحوث العلمية

National Council for Scientific Research



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- **AMOUREUX David, TESSIER Emmanuel**



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