Climate change increases the drought risk in Mediterranean forests: what are the options for adaptation?

Workshop on Climate Change Adaptation in the Economic Development Sector Using Integrated Water Resources Management (IWRM) Tools. Amman, 25-27 May 2016

Touhami Rzigui

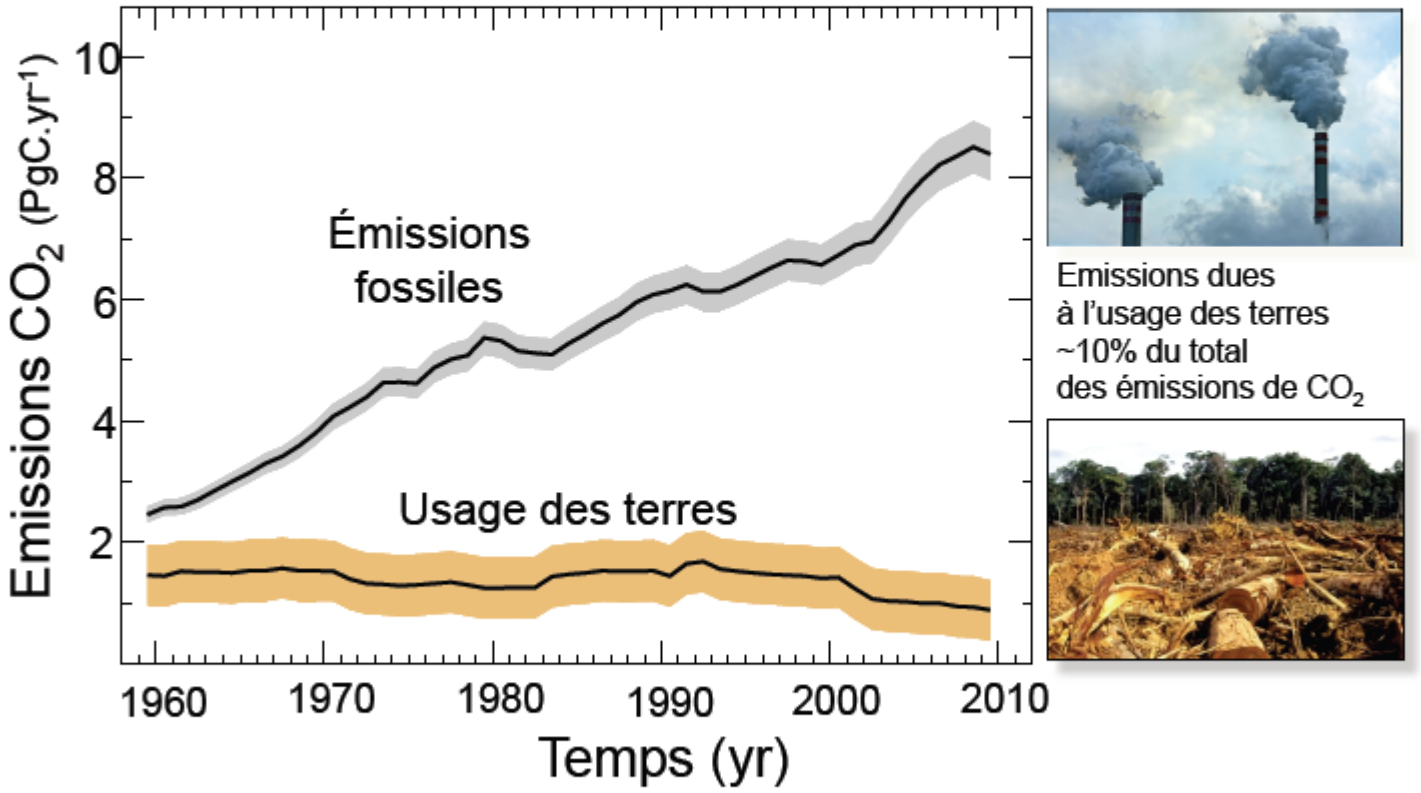
[1]*Silvopastoral Institute —Tabarka*

[2]*National Research Institute of Rural Engineering, Water and Forestry (INRGREF). Laboratory of Management and Valorisation of Forest Resources. BP 10 2080-Ariana. Tunisia.*

Anthropogenic CO2 emissions: emissions produced by human activities

Evolution du CO_2 atmosphérique

Emissions anthropiques de CO_2



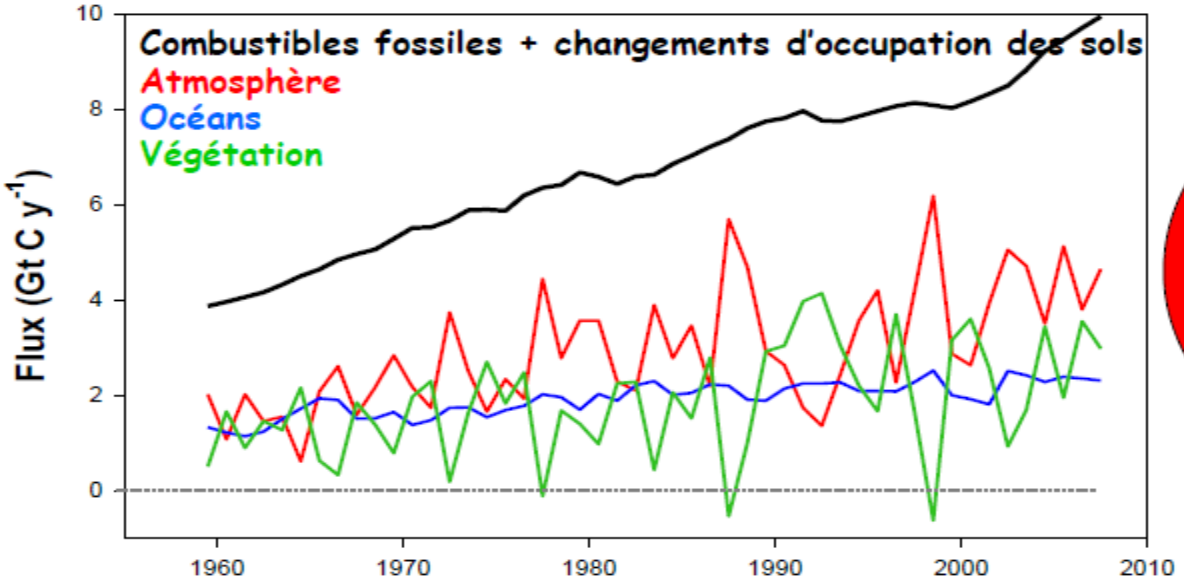
Emissions dues à l'usage des terres ~10% du total des émissions de CO_2

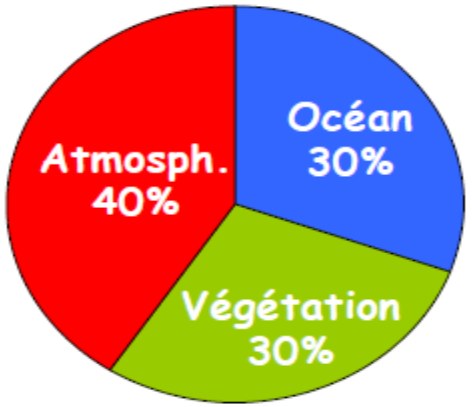
Emissions actuelles (2000-2009): 8.8 PgC.yr^{-1}

Friedlingstein et al., 2010

- The need for significant carbon sink to balance the total carbon budget
- 50% of emissions should be absorbed

La végétation terrestre régule la concentration atmosphérique en [CO_2]



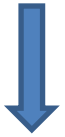


- Végétation continentale représente 50% de la fixation
  - Forêts ~60% de la fixation par la végétation

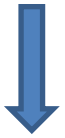
Le Quéré et al., 2009

Climate change and forests: Current and Future Impacts

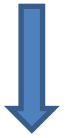
Observations
Experiments
Models (BPM)



rising atmospheric CO_2 concentrations + climate change



Alteration of functioning and distribution of
trees over the coming decades



major economic, ecological and social impacts, especially if characterised by
widespread tree mortality

Chaieb et al. 2012, Ecology Letter

There is, however, substantial uncertainty in the extent that climate change will alter tree distributions for four main reasons:

(1) high uncertainty in future greenhouse gas emissions

(2) Important unknowns in climate sensitivity

(3) lack of understanding of key aspects of tree function, biotic interactions and disturbance

(4)large differences in the simplifying assumptions and parameter choices made in models of tree response to climate.

Rigorous estimates of these uncertainties are essential if models are to be used as decision support for forest managers, for projections of changes in terrestrial carbon storage, etc.

Projected changes in hydrology and implications for Ecosystems and Biodiversity

Precipitation during the coming decades is projected to be more concentrated into more intense events, with longer periods of little precipitation in between (IPCC).

Temperature and moisture regimes are among the key variables that determine the distribution, growth and productivity, and reproduction of plants and animals.

Animals and plants are already showing discernible changes consistent with the climatic trends of the 20th century

The changes of ecosystem and biodiversity were consistent with observed temperature change, but it should be recognised that temperature can also exert its influence on species through changes in moisture availability.

Changes in hydrology Impact on major ecosystem types: ***Lakes and streams, Freshwater wetlands, Freshwater wetlands….***

Impacts of changes in hydrology on Forests

The availability of water is a key factor in the restructuring of forest and grassland systems as the climate warms.

Climate change is known to alter the likelihood of increased wildfire size and frequency, while also inducing stress in trees, which indirectly exacerbates the effects of these disturbances.

from impacts to adaptation

Forest will have to face environmental conditions which are becoming increasingly severe for many decades, even more than a century.

Climate changes will have many repercussions, more or less complex, on forests from different bioclimatic regions and on the globally distribution of tree species.

Strategies

To deal with such scenarios, it is essential to implement various strategies to conserve forests.

1/ It is difficult to predict the impact of climate change without a better understanding of the effect of increasing of the concentration of atmospheric CO_2 and drought.

Understanding the mechanisms that underlie the response of communities to such droughts is a major challenge for predicting climate change effects Ecosystem (Smith 2014; journal of Ecology).

selection to produce adaptation (Gould et al. 2014; journal of Ecology)

Spatial variance in climatic conditions within populations has long been shown to drive population-level differentiation in plants.

2/ Measuring, analyzing, and managing ecosystem services

To manage ecosystem services in a changing world, we need to know how human activities affect the key species or functional groups that provide these services, and the spatial and temporal scales of both disturbance and recovery (Kermen and Ostfeld, 2005; ***Front Ecol Environ)***.

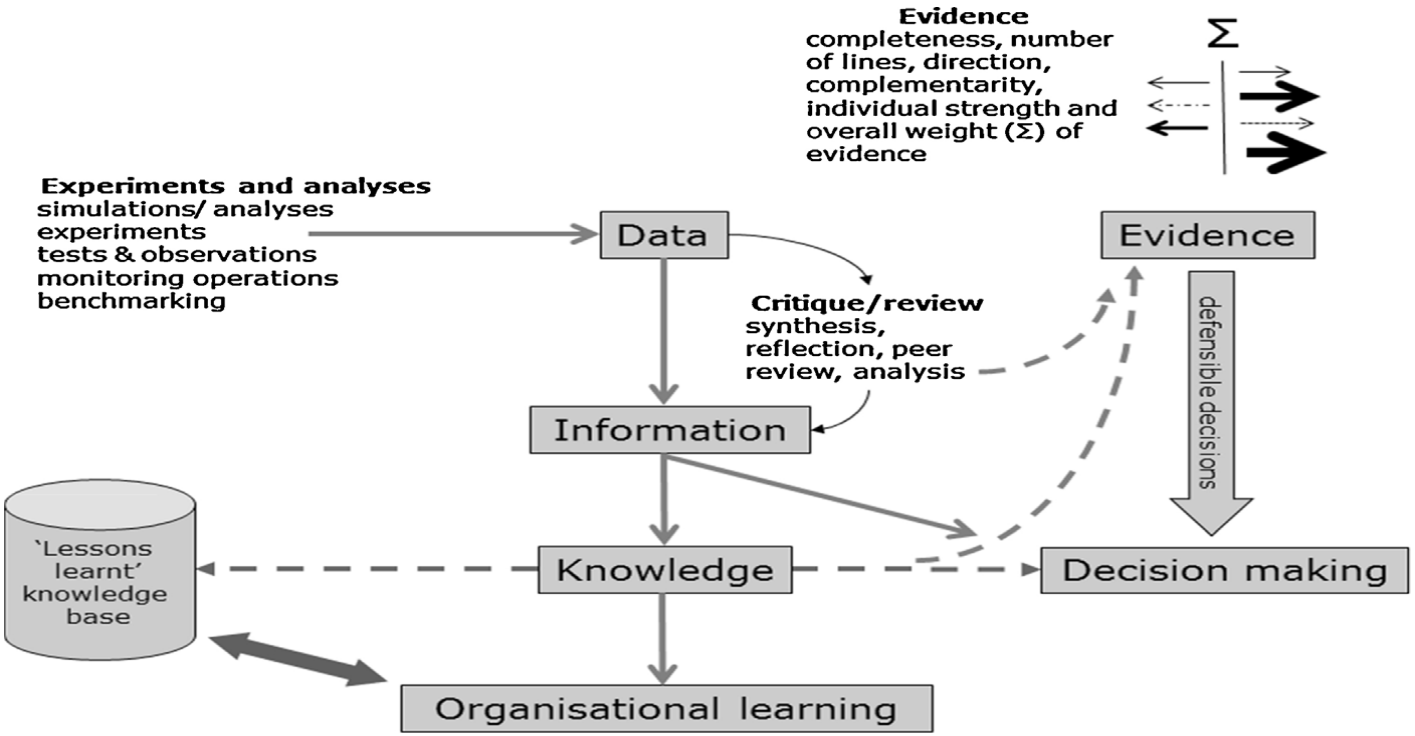


Fig. 1 – Relationships between data, information, knowledge and evidence for defensible decision-making.

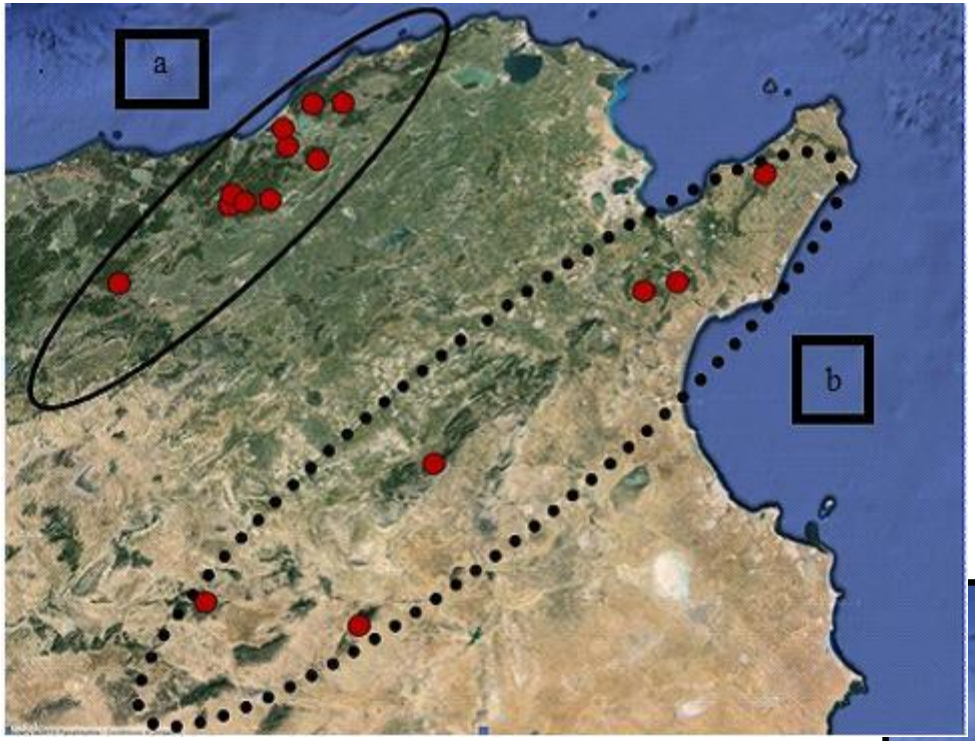
Mauelshagen et al. 2014; e n v i r o n m e n t a l s c i e n c e & p o l i c y

Physiological Behavior of Cork-Oak (*Quercus suber* L.) and Selection of the Best Ecotypes Adapted to Climate Change

Cork oak forests have high ecological, social and economic value in most Mediterranean countries.

In Tunisia, cork oak forests are mainly located in the northwest region, on low fertility soils, where local inhabitants use the land for grazing, and highly social and economically valued nowadays for their cork revenues and livestock production

Few relict areas constitute the far southern limit of the species



The processes controlling the development of tree populations are divided into two blocks, i.e. (i) physiological and (ii) growth performances under the influence of environment.

Zouhair Nasr, Touhami Rzigui, Bouthayna Stiti, Ali Khorchani et Abdelhamid Khaldi. La forêt de Quercus suber au Nord de la Tunisie,source ou puits de carbone ? **XIV WORLD FORESTRY CONGRESS,** Durban, South Africa, 7-11 September 2015

Rzigui T, Khiari H, Abbes Z, Baaziz KB, Jaouadi I, Nasr Z, 2015. Light acclimation of leaf gas exchange in two Tunisian cork oak populations from contrasting environmental conditions. **iForest 8: 700-706**

Touhami Rzigui, Jaouhra Cherif , Abdelhamid Khaldi, Walid Zorrig and Zouheir Nasr. Photosynthetic Response to a Transfer from Low to High Light in two Tunisian Cork Oak (*Quercus suber* L.*)* Populations from Contrasting Localities. Accepted in **iForest**.

Touhami Rzigui, Rahma ben Fradj, Zouheir Nasr Drought-induced photosynthetic inhibition and autumn recovery in Tunisan cork oak population. In preparation

Effects of management on the distribution of biomass in a stone pine plantation in northwestern Tunisia

Thinning practices are of primary importance in controlling the stocking of timber and carbon in forests and the carbon fixation rate into the forest ecosystems

The problems faced in forest management are how to maintain and enhance the capacity to sequester and store carbon in the ecosystems, and at the same time meet the needs of timber production.

DOES MANAGEMENT IMPROVE THE PHOTOSTNTHETIC CAPACITY OF STONE PINE (*Pinus pinea* L.) IN THE NORTHWESTEAR OF TUNISIA?

Site 1 (sans éclaircie)

- ✓Planté en 1989
- ✓Aucun aménagement sylvicole
- ✓Elagage de passage
- ✓Densité de plantation : 1600pieds/ha
- ✓Absence du maquis

Site 2 (avec éclaircie)

- ✓Planté en 1989
- ✓Une première éclaircie une ligne sur deux en 2005
- ✓Une deuxième éclaircie un arbre sur deux en 2010
- ✓Densité de plantation : 400 pieds/ha
- ✓Peu de maquis

A empiric model was used to identify how thinning and climate change affected carbon sequestration in Stone pine (Pinus sylvestris) stands in in the northwestern provinces of Tunisia

The link between climate change and the world's forests is now increasingly recognized by the public at large to be a real and present issue (Bricen˜ o-Elizondo et al. e n v i r onmental s c i e nc e & pol i cy). The role of forests in responding to the international needs of reducing the net carbon dioxide (CO2) emissions into the atmosphere has been emphasized, as outlined in the Kyoto Protocol (UNFCCC, 1997)