Science serving forestry in the Mediterranean Region: the ways ahead

by Yves BIROT

The aim of the first session of the Mediterranean Forest Week, held in Avignon on April 5-8, 2011, was to present the current context: the environment of the Mediterranean Rim in a mutating world and, especially, an account of the role of forests and science faced with the major challenges and issues. In this context Yves Birot gave a synopsis of the different approaches science has to offer on these questions: what has been learnt and achieved, pooling knowledge, perspectives...

Mediterranean lands are characterized by a high complexity in social, political, economical, physiographic and bio-physical features. The rate of changes concerning many of these aspects raises the question of our capacity to sustain the woodlands themselves, and the goods and services they provide. In a growing context of a knowledge-based bio-economy, science is believed to be a major background for improved forest management. Therefore, our collective ambition should be to develop a stronger and more efficient research. The present paper suggests some ways to achieve this by answering three main questions:

a.- What are the main challenges for Mediterranean forests and the research priorities derived from them?

b.- How to advance forest science?

c.- How to be more efficient through knowledge sharing?

Main challenges for Mediterranean forests and related research

It is nowadays recognized that Mediterranean forests can be seen as the most important "ecological infrastructure" of the region. They are key elements for the resilience and adaptability of the region submitted to marked evolutionary drivers (at global and local scale) related to climate, environment, society, economy, in many aspects: biodiversity, soil and water resources, food security, energy, etc. Mediterranean forests and woodlands also provide a broad range of crucial goods and services. However, their future is hampered by multiple uncertainties (including land-use and climate changes). For example, climate change related uncertainties can be expected on: i) socio-economic scenarios; ii) climatic scenarios and in particular the intensity and frequency of extreme events; iii) the biological response of living organisms; iv) the impact on biotic interactions in complex ecosystems; v) the impact of adaptive measures.

In such a context, it is essential that researchers and stakeholders come up with a shared vision of the future of Mediterranean forests and of the main challenges to meet. This major step was achieved with the publication in 2009, of a consensus-based document: the Mediterranean Forest Research Agenda (MFRA), catalysed by EFIMED, under the auspices of the European Forest-based sector Technology Platform. Four main areas were identified, from which jointly agreed research priorities were derived:

1. Impact of climate and land-use changes on Mediterranean forest ecosystems functioning: assessing and monitoring main physical and biological processes including biodiversity.

2. Integration of the risk of forest fires in land-use and landscape planning and management

3. Policy, economic and institutional aspects for sustainable provision of forest goods and services

4. Forests in the context of integrated management of land resources: models and decision systems for optimising multi-objective and multi-actor problems

Another aspect that was shared by researchers and stakeholders in the development of the MFRA, was that Forest Science should serve both: the technological innovations and the policy making process. It is today well established that, subject to economic feasibility and social acceptance, some scientific breakthroughs can result into technological innovations. Science is also feeding the collective expertise which is needed for founding policy from local: e.g. fire, water, to global: e.g. carbon. In this regard, with the two scientific expert reviews on fire (2009) and water (2011), EFIMED has brought a substantial contribution. In a changing and uncertain "environment" with complex feedbacks, climate-ecosystems- economy-society, policymaking should be based on scientific knowledge and a fluent science-policy-society dialogue, as exemplified by the session during which this paper was presented.

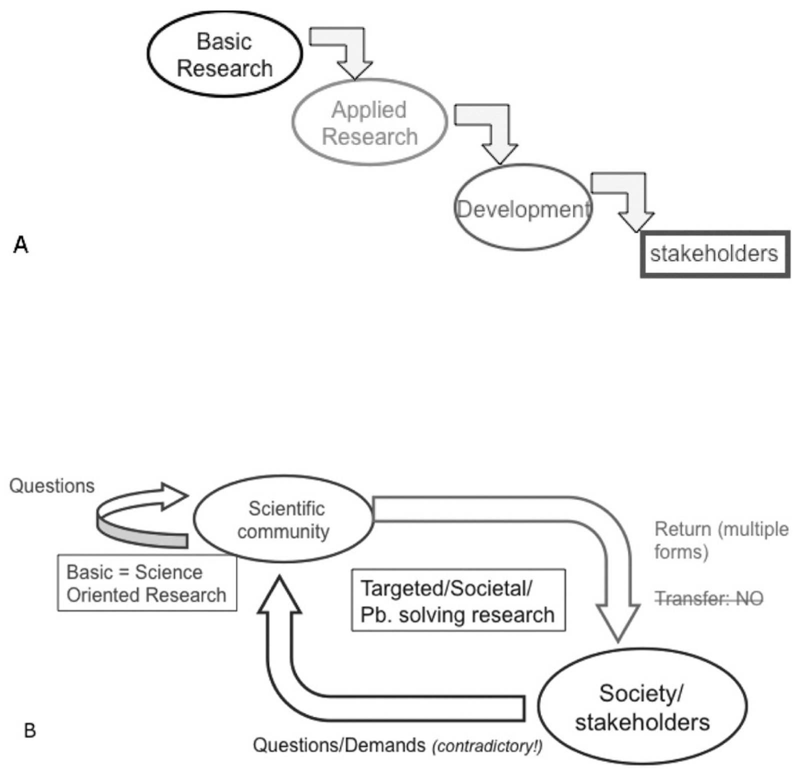


Figure 1:
A research typology
A: the "old fashion" view: the "cascade" continuum
B: the today's thinking: cluster and interactions

The traditional way of seeing research as a « cascade continuum » flowing from basic research to applied research, development and lastly stakeholders and end-users is nowadays definitely obsolete (see Figure 1 A). The current view (see Figure 1 B) is more related to interactive processes within a cluster consisting of researchers and various stakeholders: end-users, decision makers, civil society, etc. Most of forest related research is usually qualified as societal, targeted or problem solving. The scientific community can take up research demands from the society (sometimes contradictory!) and its own questioning. It is the responsibility of researcher to turn up these questions into scientific approaches. It may happen that the issue in question requires a more science-oriented research. Once it is produced, knowledge cannot in general be just "transferred" as a simple product. Its dissemination requires further elaboration, "digestion", assembling, etc., and should use various channels: education, continued education, development, workshops, policy advice, scientific expert review, etc.

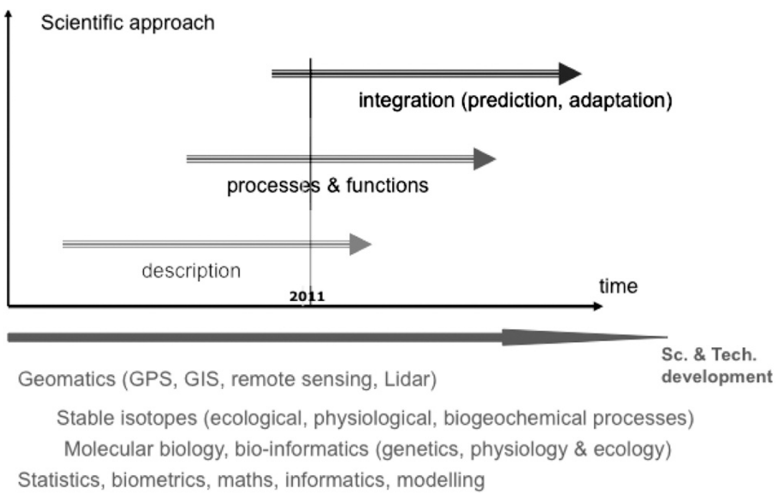


Figure 2: Steps in advancing forest science: a conceptual framework

How to advance forest science?

Looking back over the past 50 years, we see that forest science development was characterized by a three-step process, with some overlaps on the time scale (see Fig. 2). The first step was based on a descriptive and empirical approach aimed at observing the phenomena and quantifying them through data analysis, starting with graphical techniques and continuing into more advanced statistical methods. Such an approach is still used to a large extent. The second step has focused on functions and processes in trees and forest ecosystems. It can be referred to as a deterministic or mechanistic approach leading to the understanding of the functioning of complex systems. The third step aims at organizing and integrating the available knowledge into methods and instruments allowing researchers to predict the dynamics of forest ecosystems in relation to evolving conditions, and adapt to this new and changing context. The nature of the 3 steps is also strongly linked to the scientific and technological developments, which have provided methods and tools for observing, assessing, analyzing, inferring, etc.

The descriptive/empirical approach has been (and still is) quite successful in many disciplines and fields such as, inter alia: site classification and mapping, yield tables and empirical growth models, geographic variation within tree species and seed source studies, biological cycle of pest and pathogens, etc. This has been largely transferred into practical forest management.

This approach, however, was implicitly assuming the invariance of environmental conditions, so that for example, the site index value was constant in given site conditions, or the genotype x site interaction was stable. Since about 20 years, we know that Nature is not invariant. We have found clear scientific evidence of changes in forest productivity, in plant, insect and micro-organism geographic distribution. Forest ecosystems are submitted to evolutionary drivers due to man-induced effects (increased carbon dioxide, temperature and drought, nitrogen deposition), which lead to changes, in dynamics, composition and characteristics. These findings question the concepts of climax, biodiversity (if seen as a state) and most of hypotheses underlying forest management rules. This calls for changing some major paradigms of forestry, including conservation aspects..

Because of the intrinsic limits of the descriptive approach, which prevents to use it for projections, as it reflects a situation from the past, it is compulsory for scientists to try to "open the black boxes" by investigating and deciphering functional aspects and processes, whatever they are: bio-physical, social or economic. Understanding for managing becomes the target. Forest practitioners should also acknowledge that this evolution of research towards more "basic aspects" is a necessity. Over the last two decades, forest research, including in the Mediterranean region, has evolved in this direction. To illustrate this shift, an example regarding physical processes regarding forest fire propagation is given below.

Understanding fire propagation in relation to vegetation, climate and topography features is crucial concerning the assessment of fire hazards, their prevention and fire suppression operations. This issue has been addressed until recently through empirical propagation models, mainly developed in North America. Because of simplistic assumptions, these models have limited applications for forecast purposes. In the last 15 yeas, researchers 'have considered basic fire processes such as ignition combustion thermal degradation, heat transfer, and their coupling with atmospheric variables. They have been able to develop mechanistic models integrating explicitly combustion &

aerodynamic effects resulting from: interaction between local wind, fire induced winds, vegetation & topography (DUPUY, 2010). Such simulation models (See Figure 3) pave the way to a number of applications in the field of fire management.

The scientific approaches dealing with processes can be very powerful when they are able to integrate complex and multiple processes into comprehensive models and simulation tools. A good example of this is given by the biophysical process based model Gotilwa + (GRACIA, 2010) whose a simplified scheme is presented on Figure 4. This model can simulate complex interactions in forest ecosystems and their response to drivers related to environment and management. In a context of rapid changes, we all know that time for experimenting is limited. It is thus necessary to use all the available knowledge in an optimized way. The challenge is to move the walls: we have to integrate the knowledge derived from empirical and mechanistic approaches, the disciplines and scales in an endeavour to prediction and adaptation. Modelling methods offer promising perspectives in that respect.

It is also obvious that adapting Mediterranean forests to global changes will require advancing forest science in an integrated manner based on trans-disciplinary research projects by combining bio-physical and economic approaches as illustrated below (See Fig. 5).

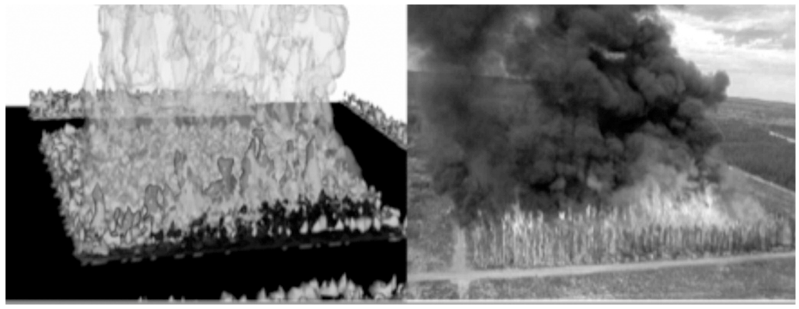


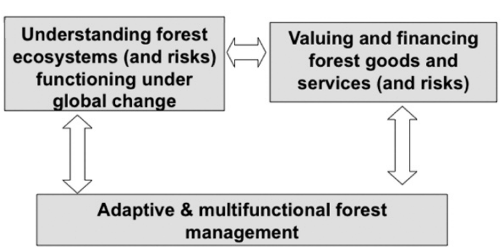
Figure 3:
Actual (right) and numerically simulated (left) fire propagation in 3D and natural conditions at landscape scale.
From Dupuy (2010)

How to be more efficient in knowledge sharing: increasing research efforts and cooperation?

Acting now and taking steps for adapting our forest ecosystems to the future is absolutely crucial. We cannot wait passively until new research results become available. We have to use adaptive management approaches, which allow some flexibility and the integration of available knowledge at a given time. It is important to make sure that the available knowledge is fully used and the existing research capacities are mobilized in this respect. All efforts should also be undertaken to stimulate better communication between scientists and practitioners. Innovative structures favouring a crossed culture between these two communities should be set up, as exemplified by some countries that have created networks and joint units mixing researchers and managers on certain topics.

At the same time, advancing science through research remains a permanent objective, as is the source of tomorrow's

Figure 5:



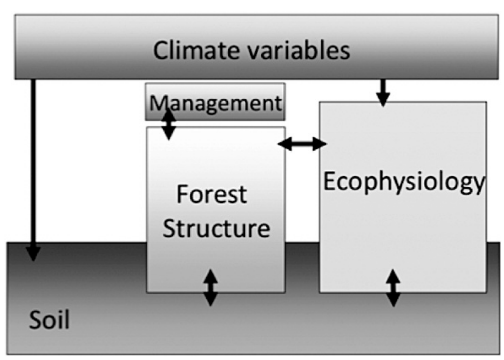


Figure 4:
Simplified flow chart of the process based model GOTILWA+ (*Gracia* 2010)

applications. This requires a constant endeavour towards scientific disciplinary excellence, wherever it can be reasonably achieved, in particular through the strengthening of research capacities. Moreover, as pointed out in the previous section, we should aim at constructing trans-disciplinary research based on concrete research projects, for example modelling approaches combining knowledge from genetics, ecophysiology, dynamics and silviculture. In addition to research efforts on some priority topics, it is also the scientist's responsibility to invest in scientific monitoring and/or technological watch, in particular n adjacent or emerging domains, such as off equilibrium and complex systems, threshold effect systems, etc.

With the Mediterranean Forest Research Agenda, we have a road-map which tells us where to go. To implement it properly, increased scientific cooperation is needed, through:

– New & shared capacities: long-term funding & research experiments, joint labs ;

– ERA-Net: FORESTERRA.

It is also advisable to seek for partnership with Mediterranean-like areas which face similar problems: Australia, California, South Africa, Chile. This can be achieved trough various means, including the implementation of joint research projects.

In the current context of uncertainties and risks related to technological, economic and environmental factors, knowledge is believed to constitute the best response, as pointed out by the French biologist Jean Rostand (1894-1977) in a statement which is still very relevant: « *The obligation to endure gives us the right to know. And the fact of knowing offers us the possibility for changing* ».

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