

## Lessons Drawn from the Past: an Historical Perspective on Forest Hydrology and Soil Conservation in the North and South of the Mediterranean Basin

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Problems of soil conservation and forest hydrology are strictly linked to the process of deforestation. In the Mediterranean area, the destruction of forest cover started in prehistoric times due, in part, to the result of a planned transformation of forests into agricultural land – by terracing, organising water flow and drainage, cultivating herbaceous and tree crops – or the irrational use of forests for grazing or various systems of shifting cultivation. From the hydrological point of view, these activities resulted in frequent floods that caused heavy damages to communities living in the valleys and in the plains. Negative consequences of human activities were exacerbated by some adverse environmental conditions specific to the Mediterranean area: the climate, the rough topography and the wide distribution of limestone. Locally, temporary declines in population sometimes led to land abandonment and a secondary succession re-established a woodland cover; however, the prevailing trend has been, at least in some parts of the northern rim of the Mediterranean, intense land exploitation until the mid-19<sup>th</sup> or mid-20<sup>th</sup> century. This is the situation that countries on the eastern and southern rims are currently facing with perhaps additional aspects related to water resources management (dam siltation).

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In response to major hydrological catastrophes, large-scale watershed management programmes, based on biological and civil engineering and implemented in Europe since the second half of the 19<sup>th</sup> century, have been largely successful in spite of limited knowledge in forest hydrology and insufficient consideration of social factors. Today, the challenge is how to maintain the protective functions through the renewal of planted areas and equipment in totally different social and economic contexts.

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Watershed management work was usually realised by the central state in the middle of the 19<sup>th</sup> century (a few decades earlier in Austria) in response to the need to control floods and reduce soil erosion, which frequently caused loss of life and major damag-

### Box 23. From 1860 to present: the French Programme on the Restoration of Mountainous Terrains (RTM)

Following catastrophic floods in the mid 1800s affecting the lower parts of river catchments, arguably due to forest removal caused by excessive pressure by man (demography, overgrazing and cultivation), an active political debate emerged at the national level. It resulted in a series of acts and laws – the most well-known is that of 1882 on the “restoration and conservation of mountainous terrains”. This legal and judicial framework coupled to a substantial public funding, allowed the development of an ambitious State policy resulting in the purchase of 380,000 ha of land, on which biological and civil engineering works were carried out to prevent and control runoff and erosion and limit their impacts on both people and the infrastructure. This took place in an overall context of a booming industrialisation and of the undertaking of major national programmes such as developing the railways, land-use planning and rehabilitation through drainage and afforestation (Landes, Sologne and Champagne) at a time when the ideology of technology-based progress was flourishing.

In addition to the emergence of a real ideology built around the RTM concepts and goals, the Forest Administration, given the task to implement this policy, was able to successfully set up a corpus of methods and technologies, based on the pioneering theoretical and applied works of Surrel and Demontzey. The operations, concentrated in the heads of watershed and/or in the vulnerable areas, were based on a combination of: i) re-vegetation or vegetation encroachment with trees (local species and *Pinus nigra*) on slopes and shrubs and grass along the banks and in the gullies completed by some terracing; and ii) civil engineering, which consisted of building staircase-like dams in the torrent-bed to reduce erosion and that of the banks and to limit the transport of materials. Looking back to the conditions that prevailed some 150 years ago, there is no doubt that this policy, pursued decade after decade, has been rather successful. This success story, or RTM saga, was presented as a panacea and used as background for a “copy and paste” transfer of RTM concepts and principles to European and other countries, and to Maghreb during the colonial period. In the latter case, the underestimation of a different ecological, socioeconomic and cultural context sometimes resulted in failure (see Box 25).

Some figures on RTM's achievements

Reforestation >260,000 ha

Number of municipalities concerned: 950 in 25 “départements” in middle or high mountain areas; 1,100 torrents “treated”; 100,000 small dams built; work on 115 landslides and 100 avalanche corridors.

However, seen from a social angle, it must be stressed that the RTM has been mainly a top-down process which has, in some cases, resulted in conflicts with local rural populations (farmers were forced to sell their land) or accelerated their migration to cities or other areas. This must also be put in the context of the 19th century, characterised by a marked centralisation and the conviction that such a public interest driven policy, balancing the needs of up-stream and down-stream areas (even broader areas) and addressing long-term objectives should be centrally designed and implemented.

The “golden age” of RTM was between 1882 and World War I. In 1909, more than two-thirds of designated RTM areas were already treated. The period from 1914–1940 was characterised by the maintenance and management of existing work due to the economic and demographic impact of the War. The decline came after World War II as a result of less funding and the increasing weight of maintenance costs (in particular labour costs). In 1980, however, the RTM was deeply reformed and re-established within the National Forestry Board (ONF).

Today, the main challenges, in a context of limited financial resources, are to find tradeoffs between the maintenance/renewal of forest stands and equipment, and how to address the security needs (acceptable, accepted risks) in relation to various natural hazards in mountainous areas. Moreover, the articulation of the State policy with the local authorities and competencies is of primary importance today. The RTM policy in the 19th century was a response to catastrophic events through new legislation and considerable financial means. Will updating the RTM be strong and efficient enough without waiting for next ecological or human catastrophes?

### Box 24. River catchment, runoff, dam, sediments: the Italian story

During the past 150 years, afforestation and hydraulic engineering works have developed side by side in the Italian mountains. Mountains and hills dominate the Italian landscape, while plains occupy only 20% of the country. At the end of the 19th century, after many centuries of over-exploitation of mountainous area – resulting in high population density and irrational land use practices – the Italian territory was characterised by a dramatically reduced forest cover and extremely active torrential erosion, while the plains between the mountains and the sea were frequently occupied by swamps.

Some afforestation and torrent control work was carried out already at the end of the 19th century. However, a new integrated land use policy launched in 1933 addressed the *bonifica integrale* (comprehensive reclamation) of watersheds by means of drainage, road constructions and new settlements in the plains, together with engineering and forestry works in the mountains. In the same period, the development of hydro-electricity required erosion control measures to limit sediment accumulation in artificial reservoirs. Between 1867 and 1950, the planted areas totalled 194,000 ha. The swamp reclamation work was pursued for a longer time.

In the 1950s, a new wave of afforestation was undertaken to mitigate the high unemployment rate in rural areas. Between 1950 and 1959, 159,000 ha of plantations were established, mainly in the southern part of the country. The most common technique employed in steep terrain was the use of *gradoni* – small terraces built on contour lines in which young plants could have enough soil and moisture to survive during the dry season. On the Apennines and on the lower part of the Alps, degraded site conditions required the almost exclusive use of Black pine (*Pinus nigra*) seedlings, even if occasionally hardwood was seeded between the young pines, quite unsuccessfully. Plantations carried out since the 1960s frequently used better soils, hence Silver fir (*Abies alba*) and Douglas fir (*Pseudotsuga menziesii*) have been employed. A different feature was the afforestation – mainly done with stone pine (*Pinus pinea*) – on the sandy soils along the coast, aimed at stopping wind erosion and dune movements, as well as protecting agricultural crops, settlements and infrastructures.

From a social point of view, it is true that afforestation programmes in the mountainous areas created many job opportunities. There was, however, at least at the beginning and especially in southern Italy, a marked opposition to plantations from shepherds and large landowners renting their land to small tenants. As a consequence, young plantations were quite often destroyed by fire and illegal grazing.

Watershed management by means of civil engineering and afforestation, usually done on private land, was always hindered by lack of public financial resources. This lack of funds did not allow understorey control and thinning in the plantations as well as maintenance works on dams in recent years. Over the last few decades, the value of timber has dropped heavily while new forests are now being appreciated for their recreational and aesthetic values; for these reasons, the social importance of forest maintenance has grown, but with no advantage for land owners. Today, most plantations are excessively dense and dry summer periods cause heavy mortality, which increases fuel accumulation on the ground leading to fire risk. Natural regeneration of introduced species is usually absent, and the establishment of other species (renaturalisation) is not common. Foresters are currently facing new economical, technical, social and political problems.

es to settlements and infrastructures in the lower parts of the valleys and on the plains (Box 23 and 24). Work carried out during the 20<sup>th</sup> century was also aimed at protecting mountain slopes surrounding artificial water reservoirs built for the electricity industry. In most cases, this work – the construction of dams and reforestation – was also a precious support to employment in mountain regions where depopulation was already a widespread phenomenon. Plantations were usually done with pioneer tree species. Civil engineering techniques implemented for mountain torrents and reforestation techniques were largely discussed and became university courses; in addition, local experiences stimulated international contacts and visits.

However, some of the factors (agriculture and pastoralism) which caused deforestation and soil erosion also acted, at least locally, as barriers to the formation of a new for-

### Box 25. Soil conservation programmes in the Maghreb with a particular emphasis on the DRS “Défense & Restauration des Sols” Programme in Algeria from 1940 to 1980

Following the silting up of Oran harbour and various spectacular phenomena linked to water-related erosion in the mountain range of northern Algeria, the French colonial Forest Administration consulted an American specialist of soil conservation, W.C. Lowdermilk, and then undertook an ambitious programme on soil and water conservation called DRS. This programme was based on contour lines terracing work on cultivated lands (called absorption and diversion “banquettes”), complemented by RTM-like work (see Box 23) of torrent and gully control, and the afforestation of degraded and overgrazed lands mainly in the upstream of watersheds. Such works were based on empirical knowledge with practically no research to validate them. Between 1940 and 1980, about one million hectares in the Maghreb region were treated by the DRS Specialised Service under the auspices of various Ministries. Considerable funding and means were allocated by the colonial administration and then by the State for counteracting spectacular erosion phenomena through the development of huge work sites for terracing in the watersheds including dams, reforesting the upper parts of watersheds (more than 800,000 ha for Algeria only), correcting gullies and stabilising temporary water courses (oueds), and for protecting large threatened constructions such as dams.

In the 1980s and beyond, assessments of these water and soil conservation programmes have been carried out in Algeria as well as in Tunisia and Morocco. They have shown in general a limited positive impact of these huge investments. Floods, dam siltation and the low production of wood and crops still prevail today. In Algeria, an enquiry has shown that among the 350,000 ha treated, 20% of banquettes have been intentionally destroyed by ploughing, 60% are subject to gullying – they have never been maintained and are no more operational, while only 20% are in good status but are located in non-erosion prone areas. In Morocco, studies have shown that most of banquettes built on certain soil types and parent material (argillite, soft schist, marl) on steep slopes (25%) have actually contributed to landslides and gullying, worse than the previous sheet erosion.

Since 1985, a new method has been employed in Algeria, based on a participatory approach of integrated rural development that is proposed, discussed and tested. This incorporates new research results (limited level of sheet erosion, detrimental effect of some tillage practices) and new criteria such as a better exploitation of land producing crops for local people and forage for domestic animals while reducing the risk of erosion at the same time. In Morocco, recent studies on traditional management techniques of surface water and soil fertility have shown the use of a broad range of techniques in relation to local agro-ecological and human conditions. Improvements are proposed to enhance their cost-effectiveness and their efficiency for controlling soil losses, C sequestration and biodiversity.

est cover since plantations were reducing grazing areas and inhibiting traditional land use practices deeply rooted in remote rural areas. Reforestation, not always strictly linked to watershed management work, was not just a technical problem dealing with ecology and civil engineering. Watershed management was aimed at improving living condition for the most important sectors of the population and economy, modern agriculture on the plains, cities, industries, roads and railways, etc. In some cases, they were also an occasion to mark the activity of the political power: the “new” landscape was a permanent signature of the ruling power. Undoubtedly, it was also a relief to unemployment – at least temporary. Very little has been said about the local traditional societies living in mountain territories; eroded land and poor vegetation were still supporting a rural economy. Afforestation, especially when implemented on common land (as on the baldios in Portugal) or large private ownership rented to small farmers was sharpening already existing economic difficulties and stimulating social unrest. Illegal grazing and fires were the obvious answers.

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The very large programmes of soil and water conservation undertaken on the southern rim of the Mediterranean with a more integrated approach addressing together pastoralism, agriculture and forestry, have produced somewhat contrasting results, much below expectations. This is due to insufficient scientific knowledge and an excessively top-down approach.

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Forest hydrology and soil conservation measures developed much later on the southern rim (Morocco, Algeria and Tunisia) of the Mediterranean. This has been undertaken on a very large scale by the French colonial administration since 1940 through ambitious programmes on watershed management, by restoring degraded land through afforestation and constructing terraces (banquettes), and agroforestry management. The RTM model (see Box 23) inspired the whole enterprise but in a different context, in particular because it was implemented in densely populated areas and with a more integrative approach of rural activities and development at the landscape level. To a large extent, it was also combining biological engineering and civil engineering – for the latter, the technological developments made possible the use of heavy machinery (tractors, dozers, etc.).

This work, extending over one million hectares in Algeria, Tunisia and Morocco, was aimed at creating a forest cover, reinforcing slopes and protecting large settlements, developing sustainable agricultural and pastoral practices as well as protecting human infrastructures. These programmes were pursued after the countries regained their independence but with variable levels of investments (Figure 57). Box 25 gives an overview of these programmes and their results, which were carried out, with limited knowledge of erosion processes, and a marked top-down, centrally driven policy in its design and implementation (the “participatory approach” was not at that time “fashionable”).



Figure 57. Reforestation operations in Italy in 1895.



**Figure 58.** Torrent control equipments in Morocco. Photos by Mohamed Sabir.

The main reasons for the general failure of these programmes are due to both technical and social problems which can be summarized as follows: i) poor knowledge of local geology and soil dynamics; ii) the overestimation of sheet erosion; iii) in general, the overestimation of runoff on an average, even if it can be important in case of heavy and intense rainfall; iv) poor tree planting material and tendency to large scale mono-specific plantations; v) the reluctance of local population to change their practices such as cultural and pastoral techniques; and vi) legal aspects regarding land property, etc.

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Updating and adjusting policies of water and soil conservation as related to tree and forests should be rethought in today's context. This should be undertaken as soon as possible without waiting for new catastrophes to occur, by using latest knowledge, and by integrating all aspects related to sustainable development.

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The lessons to be drawn from these past undertakings for controlling water disorders and soil losses are manifold:

- a) It is clearly apparent that environmental problems and solutions are not only technical but also socio-economical and cultural. To be efficient and long lasting, any project should be developed without deep involvement of the local people. Local administrations should be more responsible for both new urban development and traditional rural activities.
- b) The environmental problems are complex and cover inter alia the water budget, soil fertility loss through erosion, and rural economic development. The solution must therefore integrate all the aspects of sustainable development.
- c) It is crucial to define acceptable risks and tradeoffs between different and/or interrelated hazards.

Looking at the present context, it becomes obvious that a holistic approach of landscapes and territories management and planning is needed. Recent events in southern Italy have shown how conservation problems involve not only traditional watershed management and afforestation but also inappropriate land use for buildings and infrastructures on geologically frail ground. Sheet erosion has in fact decreased over recent decades due to forest area increase (mainly through secondary succession) and careful soil tillage; however, forest fires can cause sudden and serious damage to surface soil layers. Landslides and gully erosion are the most important contributors to debris transportation. The climate and its vagaries – like the 2003 summer drought and the heavy precipitations of winter 2010 – remind us that natural phenomena cannot be underestimated. Since the beginning of the watershed management policy, many changes took place and new problems emerged: the regeneration of the oldest plantations, the lack of thinnings and the increased fire danger, the impact of wildlife (ungulates), the new role of forests for recreation, CO<sub>2</sub> fixation and biodiversity. These issues must be jointly addressed.

### Recommended reading

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– A Challenging Balance

Yves Birot, Carlos Gracia and Marc Palahí (editors)





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