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## **SILVICULTURE FOR SOIL CONSERVATION, WATER RESOURCES AND TO COMBAT DESERTIFICATION**

*Integrated management of water resources, mitigation of catastrophic phenomena and fight against desertification are topics of renewed interest on a local and international scale. Nowadays, the forest role in soil conservation must be considered in the wider extent of forest management sustainability, that is aimed at exalting the efficacy of forest systems on water resources, and at contrasting soil erosion processes as the most important symptoms of desertification.*

*The present work will illustrate the main aspects resulting from the reports on the three topics characterizing the third session of the congress. During that session, the analysis was focused on: the mechanisms involved in hidrogeological processes in forest systems, the effects of silvicultural actions on water availability, the role of forests and of silvicultural techniques in the regulation of water cycle, the efficacy of wood in the mitigation of alluvial events, the influence of riparian vegetation on maximum stream flow and the role of silviculture in its management.*

*Further topics were: soil management for degradation prevention, desertification risk, methods for quantification of vulnerability levels of forest areas and identification of their causes, along with the role of forest management for prevention and mitigation of desertification risk, as well as silviculture intended to grant soil conservation in the Apennines and Alps' forests.*

*Key words:* sustainable forest management; soil conservation; water resources.

### **1. INTRODUCTION**

Today, the role forests play in soil conservation has to be defined within the wider context of a sustainable forest management directed towards maintaining and promoting the efficiency of forest systems on water regulation, improving the water availability in soils, preventing the alteration of the processes that affect the quality of waters and contrasting the degradation phenomena and the soil erosion processes that are the most significant symptoms of desertification (IOVINO, 2009).

Forests play a significant role, not only in the prevention of soil erosion

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and loss, but also in the protection of drinking water resources (DUDLEY and STOLTON, 2003). They are an essential element of the European territory and cultural landscape covering about a third of Europe's surface and are of great value for water resources because they are the preferred resource for the production, the storage, the bio purification and capture of potable water required to meet the needs of the local population. The main role of 10% of European forests is soil and water preservation, especially in Italy where forest and mountain geography coincide (MCPFE, 2007 and MARCHETTI, 2009).

There has been a renewed interest in the integrated management of water resources, the mitigation of cataclysmic events and the fight against desertification at both international and national levels as evidenced by the numerous initiatives also developed by the European community.

During the third session of the National Forestry congress, 15 reports were presented, in addition to chairperson Prof. Fiorenzo Mancini's introduction, that dealt on the above mentioned three themes. The present article gives an account of the key points that emerged from the reports.

## 2. FORESTRY AND WATER RESOURCES

The multifunctional role forests play is more and more acknowledged by society, which not only benefits from the wide variety of products they provide, for example wood, but mostly for the ecosystem services they provide, taking into account the aesthetic aspect, the preservation of biodiversity and landscape and the protection of drainage basins (ALLEN *et al.*, 2010). It is common knowledge, for example, that water availability and quality are characteristics strongly influenced by forests and their management. The second resolution of the last Ministerial Conference on Protection of Forests in Europe, entitled "Water and Forests", outlines the need to improve the coordination, at the local, regional and international level, of forest and water policies on the protection against floods, soil erosion and drinking water. Therefore, political decision makers should focus their attention on the finalization of the role forestry and research have in the protection of water resources throughout SFM -sustainable forest management, the coordination of governance policies and the value of water/forest services. According to a research study of the Banca Mondiale (RUNNING PURE, 2003), out of 105 cities, 33 use fresh water from water basins located inside protected areas in which forest type soils are prevalent.

The difficulty of translating research data that have been performed at different scale levels, between different forest types and treatment forms, besides the lack of communication to local decision makers and planners,

emerges as a critical problem of this still underestimated field of study. The economic assessment of the services provided by the forest ecosystem could be of great help, considering that there is an increasing number of users asking for a variety of and often incompatible services. Several studies are now trying to develop models in order to monetize the services provided by the forest ecosystem (GATTO *et al.*, 2009).

It is well known that woods have a beneficial influence on the water cycle: from the interception to the evapotranspiration, the preservation of soil moisture to the capture of atmospheric humidity and the increase of infiltration and retention capacity. Forests have an influence on release times and soil stabilization and they minimize the erosion and sedimentation processes. Forest coenosis protect rivers and water bodies quantitatively and help maintain a high level of water quality.

Climate change can have positive effects on forests (increase of the forests vigor and efficiency of the use of water) and negative effects (increase of the mortality rate and stress of plants and a greater susceptibility to insect pathogens) (ALLEN *et al.*, 2010).

In this frame of reference, the mechanisms which regulate the hydrologic processes in forest systems and the effects of silvicultural treatments on water availability have been analyzed as well as the role forests and forestry techniques have in the regulation of the water cycle, the efficiency of woods in mitigating flooding events, the influence the riparian vegetation has on flood peaks and the role forestry plays in the management of this type of vegetation.

By illustrating the different environmental factors that control the evapotranspiration process of vegetation coverings of the herbaceous and arboreal types, it has been pointed out that environments in which the annual rainfalls were inferior to 1000 mm, forests plantations of grasslands and shrubberies promoted a greater loss of water through evapotranspiration, a decrease of the outflow of about 60%, and negative effects on the salinisation of the groundwater and on the nutrient cycle (BORGHETTI *et al.*, 2009).

The likely effects of thinning on the hydrological balance have also been examined taking into account the significant decrease in the next decades of rainfalls, the weathering of forest stands and the expansion of forests on abandoned farmlands and pastures. The most significant effects of thinning, also in coppice stands in conversion (DI MATTEO *et al.*, 2009), is an improvement of water availability in soils and water state of the remaining plants as well as a decreased vulnerability to droughts (BORGHETTI *et al.*, 2009; GARFI *et al.*, 2009); an aspect of great importance and interest for the Mediterranean region that has long dry periods which in the future could be accentuated by the current climate changes.

With regard to the role woods play in the mitigation of flooding events

in water basins with different characteristics, it has been outlined that their influence on such events is not always evident due to the complexity and the lack of knowledge about these phenomena. Some studies demonstrate how minor flooding events in small water basins, are in part mitigated by the presence of forests. On the other hand, in the case of more intense flooding events in larger water basins, their influence isn't as evident. In reference to the impact of forest management on flood formation, most of the case studies demonstrate the relative increase of the values of flood peaks and outflow volumes, depending on the type and the entity of the forestry treatment performed (VELTRI and FERRARI, 2009).

The influence of the riparian vegetation on flood peaks and the role forestry has in the management of this type of vegetation have been the object of reports that have highlighted many interconnected aspects. The influence the herbaceous-shrub and the arboreal vegetation has on the quantity water flow with which flood peaks transit with a defined return time, on a stretch of a water basin's mountain side has been analyzed. The results demonstrate how, in sections where the vegetation is much more present, the role of the herbaceous component is negligible with respect to the one played by the arboreal component, both live plants and dead wood (D'IPPOLITO and VELTRI, 2009).

With regards to the management of this type of vegetation, it has been demonstrated that silviculture is an instrument capable of mediating between social demands, first among all the minimization of the hydrological risk and the ecologic and economic demands, by finding a compromise between objectives often conflicting such as safety, ecological functionality, landscape conservation, recreational use and preservation of water resources (CALAMINI, 2009).

### 3. FORESTRY AND SOIL CONSERVATION TO COMBAT DESERTIFICATION

Soil degradation is a worldwide emergency. In Italy, about two thirds of the farmlands are by now degraded. The depletion in soils of the organic matter has brought a sharp decrease in the structural stability of soils that has determined a drastic reduction of water infiltration, with an increase of the surface run flows and, therefore, an increase in the erosion process or flooding events in the flat areas. This type of degradation is also becoming a concern for forest type soils in the case of forest fires and soil compression, as a consequence of logging operations or excessive load of livestock or the local fauna. The role of forestry is a correct management of soils and lands in order to prevent the degradation of this natural resource (PAGLIAI, 2009).

Adequate in depth examination and recent related studies, have dealt

with the soil management for the prevention of degradation, the desertification risk, the methods to quantify the vulnerability levels of forest areas and to identify the factors that determine those levels. The role forest management plays in the prevention and mitigation of the desertification risk and soil conservation through silviculture in the Apennine and Alpine forests has been discussed as well (CORONA *et al.*, 2006).

For the Apennine environment, the operational strategies with the aim of increasing the efficiency of forests on the hydrology and on the control of surface erosion and of making the use of forest resources compatible with soil conservation have been presented. In particular, the elements on which it is necessary to intervene for the realization of the reforestation of degraded areas, the silvicultural models, supporting the sustainable management of forests to adopt in the ecological recovery of high forests, the precautions to take to alleviate the impact of the exploitation of coppices and the forms of recovery to use in forests in the wake of a fire have been emphasized (IOVINO, 2009). The effects of an increase in the structural complexity of a beech forest (transformation to unevenaged stands of high forests, coppice selection treatment) could cause on slope stability have been assessed through an increase in root system development and the consequent positive influence on the apparent cohesion, which allows to significantly increase the safety factor (FAINI and GIANNINI, 2009).

As for silviculture in the protection forests of the Alpine environment, a protocol has been illustrated for the definition and the analysis of the ability of forest stands to carry out their protective function and to assess the priorities and the forms of treatment in order to maintain and promote this function, with particular attention to “direct protection”. The maintenance and the promotion is possible through the application of silvicultural treatments.

The map of forests that have a direct protective function (Valle d’Aosta and Piemonte regions) represents the first step for the definition of the territorial area of protection. The definition of some of the structural parameters (on a typological basis), which allow several forest populations to carry out their protection role efficiently, together with the Protection Forests Management Handbook represent the essential elements for the definition of the structural parameters forest populations need to have in order to carry out their protective function efficiently (depending on the natural hazard) and for the definition of the silvicultural treatments that maintain and/or improve the protective role of forest stands (BERRETTI *et al.*, 2009). Moreover, the lines of action adopted by the Piemonte region have been presented. These lines of action guarantee adequate levels of safety for the mountain communities through interventions aimed at controlling the fragility of the mountain slopes, at preserving and improving the levels of land stability and the functional

efficiency of drainage basins and of forest systems (CACCIABUE and DEBRANDO, 2009).

Therefore, a general overview has been presented of the role forest management plays in the prevention and mitigation of the desertification risk in the environmental and socioeconomic context of Italy by approaching systematically and constructively the related main operational problems: the management of woods in territories at risk of desertification and reforestation and the programmatic frame of reference. The highlighted perspectives concerned the furtherance of the knowledge in order to characterized the phenomena at a local level; the extension of disciplines that are similar to the conservation of forests located in areas affected by the hydrological risk to the management of forests located in areas at risk of desertification, the propagation of the technical knowledge on the potential of forestry treatments to combat desertification and the promotion of the reforestation of bare or degraded land sites and of abandoned farmlands susceptible to the degradation processes (CORONA, 2009). In addition, the results of a study intended to quantify the vulnerability levels of forested areas in Basilicata, and to identify the factors that determine them have been presented. The analysis allowed the identification of homogenous areas in relation to vulnerability levels of the Lucanian forests and the interpretation of the connections between these areas and the first level physiognomies of the Regional Forest Map. Successive elaborations permitted the identification of individual factors which determined the vulnerability levels for each forest physiognomy for areas ranging from 900m<sup>2</sup> to more extended areas such as towns, mountain communities, drainage basins, parks etc. (FERRARA *et al.*, 2009).

#### 4. CONCLUSIONS

Forests, which are an important element of both mountain and hilly territories, are part of an articulated system of factors that intervene in water regulation and control of erosion. The entity of the wooded area of a drainage basin and the efficiency state of forests define the level of effectiveness of soil conservation, considered in three interconnected aspects: water regulation, the management of water resources and the fight against desertification.

The precise definition of forestry treatments needs to be entrusted to forest planning tools that need to be developed for each territorial level and need to be continuous with the ones already provided by the water resources management and soil conservation regulations. In light of the Directive on Waters (2000/60/CE), which is part of a group of regulations for the safeguard, the protection and the improvement of the quality of the environment, Italy issued a legislative decree



in 2006 (152/2006), bearing regulations on the environment, which reorganized the previous environmental regulations, in particular those regarding soil conservation, the fight against desertification, the protection of waters against pollution and the management of water resources. In 2009, the L.13/09 law (Conversion into a law, with modifications, of the decree with the force of law n.208 of December 30<sup>th</sup> 2008) has been issued and contains extraordinary measures concerning water resources and the protection of the environment with the purpose of accelerating the redaction, within December 22<sup>nd</sup> 2009, of the Waters Management Plans. All the planning and programming tools, which regulate the relationship between the physical/environment system and its use, consider water as one of the most significant elements, while in the forest/water relationship this association has yet to be made (CORBELLI, 2009).

It is recommendable to further the investigation and the use of the data derived from great research efforts as well the emergence of new research trends aimed at the identification of the spaces and landscapes available for the expansion of forests to debate the functional role and the processes in progress, in order to contrast the dominant dichotomy of “abandonment/anthropization” which does not promote a balanced relationship between the eco systemic services and the exploitation of the territory in a country pervaded by the centuries-old influence of man on the rural landscape, in the past, lived with awareness in the custody and the defense of the reciprocal influence between the water cycle and the forest coverings.

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