

Restoration of degraded areas for flood risk mitigation

The Greek Forest Service have been successfully restoring degraded areas, to mitigate the risk of flooding and the damages caused by hundreds of torrents across the country.



The location of Metsovo in Greece and the restoration project area.

Author: Gavriil Xanthopoulos – Annotation on Google Maps & Google Earth images
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A 1960 photo showing the extremely poor condition of the Metsovitikos catchment.

Author: Greek Forest Service | © Greek Forest Service

/// Context ///

In the steep terrain of many mountainous areas of Greece, the combination of heavy overgrazing with repeated fires (especially during the 2nd World War and the civil war that followed) led to loss of forest vegetation and soil. As a result, in the 1950s, it became evident that hundreds of torrents across the country were causing flooding on a regular basis, destroying agricultural areas in the plains and damaging settlements. At that time the Greek Forest Service (GFS) undertook the task to restore many water catchments where such torrents originated through soil retention measures, including reforestation, and creation of water flow control infrastructure. Many such projects were executed in the following decades with impressive results, substantially mitigating the flooding damage problems.

An example of the restoration projects carried out by the GFS was the one aiming at the heavily degraded catchment area of the Metsovitikos torrent, near the town of Metsovo, on the Pindos mountain range. The total area of the catchment is 2696 hectares, elevation ranges from 720 to 1830 m and the average yearly rainfall is 1400-1550 mm. In 1955, a comprehensive project was initiated, constructing over 1000 check-dams, 70 gabions walls, and numerous other phytotechnical works, followed by reforestation with 1.8 million seedlings in over 500

Restoration projects in degraded mountainous water catchments by the Greek Forest Service (GFS) offer valuable examples of revegetation, water retention and flood mitigation.

hectares. The project's success and its results are evident today, showcasing its environmental value in preventing erosion, fostering vegetation growth, mitigating flooding and associated damages. In light of the climate crisis, such programs are crucial to counter desertification, particularly in the Mediterranean region.

Unfortunately, in the 1990's priorities and funding for the GFS changed, and by the beginning of the 2000's such efforts were abandoned. Furthermore, there was no provision for maintenance of the works that had been completed. The Mediterranean tropical-like cyclones that occur in the last few years with increased frequency, bringing storms such as "Ianos" in September 2020, "Daniel" and "Elias" in September 2023 that poured extreme amounts of rain in a short time and resulted in unprecedented flooding in the central part of Greece, brought in mind the value of those restoration works on Pindos, the mountainous backbone of the country.

Restoration projects in degraded water catchments by the Greek Forest Service offer valuable example.

Destructive flooding in central Greece in the last few years, linked to climate change, shows how short-sighted has been the abandonment of the restoration projects by the GFS.

/// Solution for a Resilient Future ///

Soil erosion has negative impacts on fertile soil and natural habitats. Its intensity is influenced by factors like lithology, slope, erosive forces (e.g., rainfall), and the presence of protective vegetation. In steep mountainous terrain, lack of vegetation results in unobstructed flow of rain water, increased erosion, and ultimately the development of torrents that carry silt, rocks and other materials to the plains, resulting in flooding and causing damages. Greece is a mountainous country, with many tall mountains skirted by small plains around their base. The historical heavy use of vegetation for grazing by sheep and goats, often combined with the use of fire by shepherds, resulted in large areas denuded of plant cover and the development of many damaging torrents across the country. The situation became worse with repeated fires during the 2nd World War and the civil war that followed.

In the 1950s, it became evident that hundreds of torrents across the country were causing flooding on a regular basis, destroying agricultural areas in the plains and damaging settlements. This created the need for damage mitigation works in mountains and in the plains. The Greek Forest Service (GFS) undertook the task to restore selected mountainous water catchments where such torrents originated, through soil retention measures, including reforestation, and creation of water flow control infrastructure.

One of the restoration projects carried out by the GFS focused on Metsovitikos torrent, near the town of Metsovo, on the Pindos mountain range which has a catchment area of 2696 hectares. Elevation ranges from 720 to 1830 m and the average yearly rainfall is 1400-1550 mm. The slopes are very steep and in the 1950s the catchment was heavily degraded. Erosion was exacerbated due to unstable flysch deposits, sparse forest cover, steep slopes, intense rainfall, logging, and grazing, causing landslides that threatened nearby settlements and infrastructure. In 1955, a comprehensive restoration project was conceived and planning started. The final plan was approved in 1960 and works were initiated, constructing over 1000 check-dams, 70 gabions, and numerous other phytotechnical works, followed by reforestation with 1.8 million seedlings in over 500 hectares.

A demanding restoration project of a heavily degraded area in the Metsovitikos torrent watershed on Pindos mountain.



A 1960 photo showing a series of water flow control dams. A proudly standing forest guard on the dam shows the scale.

Author: Greek Forest Service | © Greek Forest Service

Heavy use of vegetation for grazing, often combined with the use of fire by shepherds, resulted in large areas denuded of plant cover and the development of many damaging torrents across Greece.

By the 1980s there was clear evidence of improvement. Vegetation cover had increased substantially. Water retention had increased, water outflow peaks had been reduced and downstream flooding had been mitigated. A series of photos in 1960 documented the degraded condition at the time the works were being constructed. The same places were revisited and photographed in the 1980s illustrating the tremendous improvement. A scientific study published in 2004, evaluated the effectiveness of the project and verified the reduction of the destructive phenomena. The study also recognized the limitations of phytotechnical works regarding complete protection.

In retrospect, this project was carried-out successfully due to the heavy manual work invested by the local population who were employed as workers by the GFS, and the GFS foresters and other personnel who planned the activities and oversaw their application, in steep terrain and under very demanding conditions. The need for employment was only one side of the availability and performance of those workers. The stamina of all those people, temporary workers and GFS employees, but also the pride for their achievement, as evidenced in multiple photographs, were also remarkable.

One of the restoration projects carried out by the GFS focused on Metsovitikos torrent, near the town of Metsovo, on the Pindos mountain range.



A 1985 photo of the same series of dams. The same forest guard, from the previous photo, on the same dam.
Author: Greek Forest Service | © Greek Forest Service

Works were initiated in 1960, constructing over 1000 check-dams, 70 gabions, and numerous other phytotechnical works, followed by reforestation with 1.8 million seedlings in over 500 hectares.

Unfortunately, according to a later report of the Forest Service office in Metsovo, the project was completed to about 90% of what was originally planned. Most important, with dwindling funding for the Forest Service from 2000 on, little if any maintenance was carried out, as a follow-up. The same happened in many other places in Greece where similar projects had been executed.

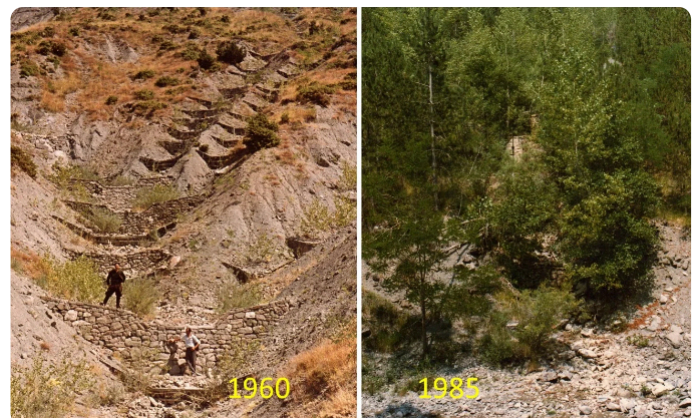
/// Always Moving Forward ///

The experience of the Metsovitikos restoration effort and other similar projects in Greece, has illustrated beyond any doubt the effectiveness of the type of activities that were carried out. The project's success and its results are evident today, showcasing its environmental value in preventing erosion, fostering vegetation growth, mitigating flooding and associated damages. Furthermore, such programs are crucial to counter desertification, particularly in the Mediterranean region. Unfortunately, the abandonment of further works of this type and the lack of a maintenance program, gradually led to loss of the expertise that had been developed within the GFS, ranging from the temporary workers and the forest guards to the local foresters and the head unit at the GFS headquarters in Athens. All this at a time that the "bells are ringing" as the climate is modified.

Climate change, by increasing temperature increases the amount of water vapor in the air due to more evaporation from water bodies but also maintains relative humidity below saturation since warmer air can hold more water vapor before it is saturated. On one hand, this leads to lack of rainfall and drought, but when the air cools suddenly (e.g. with a passage of a cold front) the amount of vapor that condenses can result in rainfall much like the one experienced in the tropics. There are signs that this is already happening. The Mediterranean tropical-like cyclones that occur in the last few years with increased frequency, bringing storms such as "Ianos" in September 2020, "Daniel" and "Elias" in September 2023, in Greece,

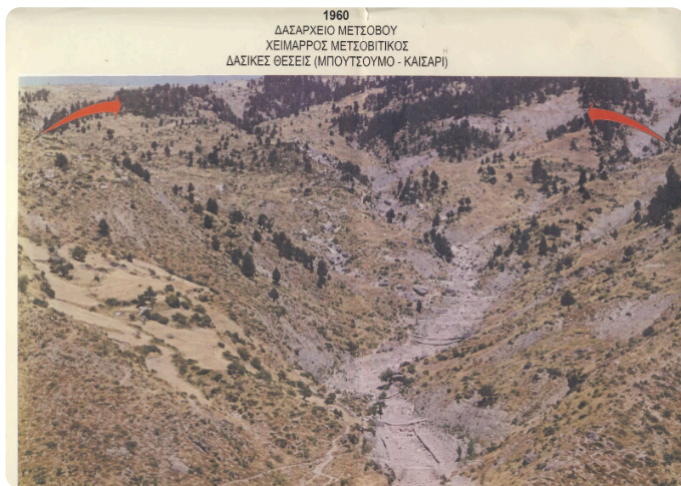
The Metsovitikos restoration effort and other similar projects in Greece, illustrated beyond any doubt the effectiveness of the type of activities that were carried out.

that poured extreme amounts of rain in a short time and resulted in unprecedented flooding in the central part of Greece have rung a warning bell. Whereas, after the disaster, big technical companies are planning large scale dams and other water management projects in the plains of Thessaly, the proven value of the restoration projects in the mountains should be kept in mind and they should be revisited. Smoothing water flow peaks in the mountains and retaining significant amounts there, can contribute substantially to avoidance of future disasters in the plains.



Small dams and reforestation on rugged terrain in 1960 (left) and the results observed in 1985 (right).
Author: Greek Forest Service | © Greek Forest Service

Restoration projects such as the Metsovitikos one should be restarted in view of the challenges of climate change.



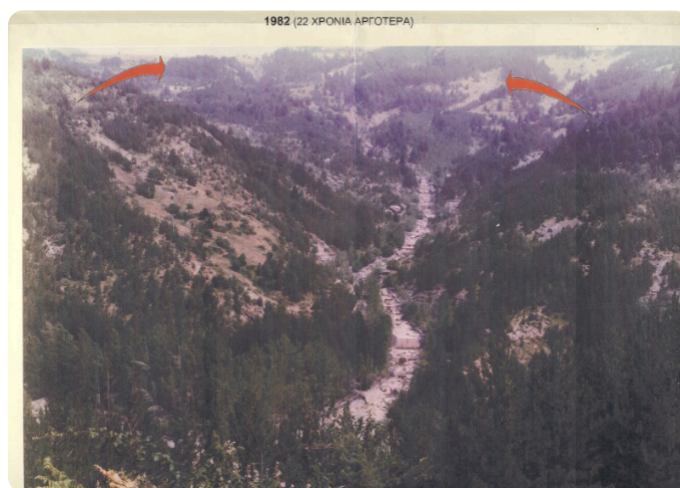
Currently, documentation of these time-honored techniques is publicized in Greece and across the Mediterranean with projects such as ResAlliance, hoping to contribute towards the development of timely restoration initiatives before flooding disasters become even worse. The expertise will have to be redeveloped, personnel will have to be trained and methods may have to be modified to make use of new knowledge, techniques and equipment and probably to cater to new needs. For example, as the forest fire problem is worsening and is expanding to areas previously thought as immune, such as the high-elevation forests, it might make sense to create taller dams and develop small lakes in appropriately located places. These lakes could be available for water pick-up by firefighting helicopters in

Following the flooding disasters in central Greece the proven value of the restoration projects in the mountains should be kept in mind and they should be revisited.

A series of restoration demonstration projects across the Mediterranean funded by programs such as LIFE+ or INTERREG, could be the solution for the reintroduction of these techniques.

Part of the Metsovitikos watershed in 1960.
Author: Greek Forest Service | ©Greek Forest Service

case of fire, in addition to serving for holding peak water flows in case of heavy rains. Such initiatives could achieve both effectiveness and efficiency. A series of restoration demonstration projects across the Mediterranean, similar to the Metsovitikos one, with funding from a European source such as LIFE+ or INTERREG, could be the solution for the reintroduction of these techniques. However, any such effort should be accompanied by a long-term monitoring effort to gauge effectiveness and propose refinements, if needed.



The same part of the Metsovitikos watershed in 1982.
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Further information

- Sioutas, E. 2001. Report on the restoration of Metsovitikos torrent. Forest Service Office of Metsovo (in Greek). 4 p.
- Goulas, K., Stathis, D., Sapountzis, M. 2004. The phytotechnical works in the catchment area of the Metsovitikos torrent of Metsovo. Scientific yearbook – Department of Forestry and Natural Environment, vol. 42/1 pp. 69-84 (in Greek). <https://ikee.lib.auth.gr/record/233652/?ln=e>
- Mastoridou, E., 2017. Long-term erosion study in the North Pindos National Park. M.Sc. Thesis, Democritus University of Thrace, Department of Forestry and Management of the Environment and Natural Resources. 99 p (in Greek). https://repo.lib.duth.gr/jspui/bitstream/123456789/12731/1/MastoridouE_2014.pdf
- Mavroulis, S., Mavrouli, M., Lekkas, E., Tsakris, A. 2024. Impact of the September 2023 Storm Daniel and Subsequent Flooding in Thessaly (Greece) on the Natural and Built Environment and on Infectious Disease Emergence. Environments, 11(8), 163. <https://doi.org/10.3390/environments11080163>

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