DEALING WITH EXTREME EVENTS AND FOREST MANAGEMENT: CAN UNIVERSITIES HAVE A ROLE? THE CASE OF THE VAIA STORM IN ITALY

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Abstract

Forest disturbances associated with extreme events and natural disasters are expected to increase continually in intensity, quantity, and frequency in the coming years, posing severe threats to the world's forests. This challenges many actors to cooperate in developing innovative and effective solutions to increase resilience of socio-ecological systems. Higher education institutions, including universities, are called to contribute to these solutions. An interesting case-study is provided by Vaia storm, an unprecedentedly extreme event that hit North-East Italy between October and November 2018. Post-event activities and reactions by Italian universities are reported and analysed in this paper, with a focus on the Department of Land, Environment, Agriculture and Forestry (in the Italian short version, TESAF) at the University of Padova. An overview of activities is provided, distinguishing among five main categories: (1) research initiatives by senior university staff, (2) PhD research activities, (3) education initiatives for students, (4) communication and dissemination activities and (5) side initiatives developed in cooperation with partner organizations. Though mainly focused on a single university Department, the overview confirms that higher education/research institutions had a key role in the post-Vaia phases and supports the idea that they could have a more active role in developing and delivering knowledge and skills that can help moving closer to more resilient socio-ecological systems.

Keywords: forest disturbances, windstorm, resilience, research, education

Introduction

Forests can contribute to climate change mitigation by conserving and enhancing the carbon sink, through reducing greenhouse gas emissions from forest degradation and by producing bio-based energy and materials to replace fossil fuels (Grassi *et al.*, 2017). At the same time climate change can have long-term effects on forests (e.g., through higher temperatures, altered precipitation patterns etc.) and meanwhile lead to an increased occurrence of extreme events and disturbances directly/indirectly affecting the contribution of forests to mitigate climate change and forest resources as well (Lidskog and Sjödin, 2015). Windstorms, prolonged droughts, heat waves, wildfires, pest infestations etc. have increasingly occurred in the last decades and their impacts grew, together with the growing stock and average age of forest stands across Europe (Seneviratne *et al.*, 2012; Gardiner *et al.*, 2013; de Rigo *et al.*, 2017; Gregow

et al., 2017). Besides damaging forest resources in environmental and ecological terms, extreme events have also socio-economic impacts, affecting (among others) timber markets, management/investment choices, and ecosystem services, not mentioning damage costs, and losses of human lives and public goods. Coping with them needs a multidisciplinary and cross-sectorial approach, calling for new management models, both in terms of technical forest management solutions, and specific policy and governance mechanisms/approaches favouring resilience and adaptation capacity. While extreme events and natural disasters are perceived among the most likely and impacting global risks (World Economic Forum, 2018), the overall increase in their frequency and associated economic costs emphasises the importance of society adapting its future planning to deal with these new extremes (EASAC, 2018).

Actions for adaptation and resilience challenge many actors, stakeholders, and social groups. These include research and higher education institutions, in particular those dealing with forestry, that are called to provide students and future professionals with appropriate knowledge and skills vis-à-vis the emerging threats for forests and consequent societal needs. Besides adapting curricula across a diverse range of disciplines, this should also call for providing cutting-edge research results in natural and social sciences and collaborating with local communities and experts to identify innovative and effective solutions aiming to increase forest and social resilience. How are higher education programmes in forestry dealing with extreme events? How can university networks contribute to the identification/implementation of effective solutions for preventing, mitigating and managing them?

The paper addresses these questions with a specific reference to the Italian context and a specific focus on the Department of Land, Environment, Agriculture and Forestry (in Italian Dipartimento Territorio e Sistemi Agro-Forestali, TESAF) at the University of Padova (North-Eastern Italy). Reasons behind this focus are explained within section 2 below. In the last years extreme events have occurred in Italy at an intensity regime unseen before. 2017 has been the worst year ever for forest fires in Europe and Italy was heavily affected as well. On October 29th 2018, the Vaia storm hit five regions/autonomous provinces in the North-East of Italy, causing windfalls totalling several millions m3 of timber and exceptional impacts from an environmental, social and economic point of view. Wind is by far the most prominent among disturbances affecting European forests, being responsible for about 51% of all recorded damage (Schelhaas, 2008) and totalling some 900 million m3 windthrows since 1950s (Gardiner *et al.*, 2103). However, while windstorms are relatively common in Central and Northern Europe, in Southern European countries, like Italy, they mainly occur under the form of minor events. Due to its intensity, Vaia storm represented an unprecedented event, being the single largest natural disturbance event affecting forests in the modern history of the country. It shed light on the forestry sector and marginalised areas, calling research and education institutions (among others) to reaction. Building on this case, the paper presents examples of initiatives

currently under development in terms of applied research, training and technology transfer and discusses the possible role higher education and research programmes can have within this domain.

Methodology

This paper is not aimed to perform a systematic and exhaustive review of all Vaia-related initiatives developed by Italian universities, rather to provide an overview of different initiatives by TESAF, a leading forestry department that is located close-by affected areas and is actively involved in the post-event management. This is also driven by convenience sampling as, to our best knowledge, the TESAF Department is the only forestry university department in Italy that developed a collection of Vaia-related materials. While limiting the focus to a single department implies the exclusion of initiatives by other research organizations, likely resulting in an underestimation of the general picture, it still allows to get a preliminary idea of how academia reacted to an extreme event like Vaia.

The paper builds on two methodical components:
- a literature-based summary overview of the Vaia storm main impacts, and
- data mining, to collect and analyze data on post-Vaia initiatives developed by Italian higher education institutions specialized in forestry. In particular reference has been made to the dedicated public-available repository hosted by the official TESAF website (TESAF, 2021).

Although several Italian research and education institutions have developed initiatives in the wake of Vaia windstorm, the focus on the TESAF Department is justified by the fact that this is the largest university department with a focus on forestry-related matters within the area hit by the storm. It is also the only department offering a full programme (i.e., Bachelor, Master and Doctorate courses) in forestry within the same area and the most popular forestry programme at the national scale with a total number of 634 enrolled students as per the 2017-18 academic year (about 21% of forestry students enrolled in Italy) (MIUR, 2019). It also hosts, since early 1990s, the largest among the local Forestry Students Associations in Italy (AUSF Padova, 2021).

Last but not least, in 2018 TESAF Department has been officially requested by the Regional Implementing Authority for Planning Operations in Veneto[1] – appointed within the framework of extraordinary measures adopted in the post-Vaia phase – to provide technical and scientific support to all regional Implementing authorities and the Regional Emergency Support Unit for the management of the post-event phase.

The Vaia storm: a summary overview

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[1] Veneto, in the North-East of Italy, is the administrative region (NUT 1) where Padova is located.

On the night between the 28th and 29th of October 2018, the Northeast of Italy was hit by a storm with wind speeds higher than 190 km/h, affecting four out of the five regions in the area (from West to East, Lombardy, Trentino and South Tyrol, Veneto and Friuli-Venezia Giulia) (Figure 1).
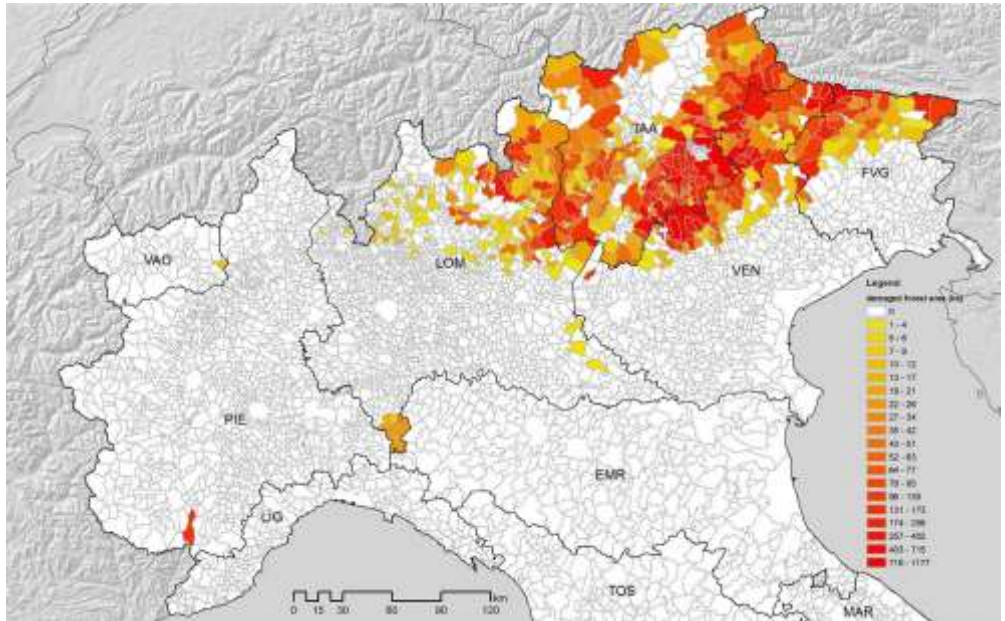

Figure 1: Forest areas damaged by Vaia, per municipality (Nomenclature of territorial units for statistics, NUTS 3). Note: LOM – Lombardy, TAA – Trentino-Alto Adige/South Tyrol, VEN – Veneto, FVG – Friuli-Venezia Giulia. Source: Chirici *et al.* (2018)

More than 41,000 hectares of forest were destroyed, about 10 million m3 of timber were windthrown and damages totaling more than 3 billion € were caused to both grey and green infrastructures (Chirici *et al.*, 2018). The Vaia windstorm has shattered the Italian forest sector but has also had many severe direct and indirect environmental as well as socio-economic impacts on mountainous areas. About 20,000 ha of forests within protected areas - i.e., natural and national parks, including Natura 2000 sites – were heavily damaged (Provincia Autonoma di Bolzano, 2020; Provincia Autonoma di Trento, 2020; Sitzia and Campagnaro, 2019). Several green and grey infrastructures were heavily damaged, including power and mobile lines, water facilities, roads, forest road networks, hiking and bike paths, protection infrastructures (e.g., against rockfalls, avalanches), riverbanks, urban green areas and facilities, protection forests etc. The assessment of timber trade data on pre- and post-Vaia timber sales via different sources shows that the increase in the supply of timber after the storm created market saturation conditions. This reflects on a decreasing trend of standing tree prices for industrial logs that diminished from an average pre-Vaia value of about 80 €/m3 to 10-25 €/m3 few weeks after the storm, with some slight recovery (40-45 €/m3) after a few months. The downturn in prices was associated to the increase in the number of

timber auctions with no bids, which reflects the decreasing number of logging operators actively participating to large auctions due to the financial risks associated to them. The increase in timber supply posed additional problems in terms of processing capacity by local sawmills: although the primary processing industry performs differently across regions and autonomous provinces in the North-East of Italy, local sawmills were not able to process such an amount of timber in the short-medium term. The ultimate consequence was the need to export towards traditional (Austria) and new (China) markets a large proportion of the harvested timber at low prices, losing the added value potential associated with the processing of low-cost raw material in the local territory (Romagnoli *et al.*, 2020).

Due to the huge total impact of the storm, two years after the event, forest and mountain communities are still striving to recover and find a new equilibrium.

Post-event initiatives by research and education organizations: the case of the TESAF Department at the University of Padova

Initiatives and actions undertaken by the TESAF Department are distinguished into five main groups: (1) research initiatives by senior university staff, (2) PhD research activities, (3) education initiatives for students, (4) communication and dissemination activities and (5) side initiatives developed in cooperation with partner organizations. Some information and details for each of these groups are provided below.

Research initiatives by senior permanent university staff
Research activities led by senior permanent university staff have been implemented in the wake of Vaia windstorm. In some cases, existing research activities were re-shaped and adapted to take into consideration the storm impacts and effects. For example, post-event forest regeneration and ecological dynamics have been targeted by a research project focused on a public forest area in the Dolomites (Malgonera forest) damaged by the storm. About 500 seedlings have been planted in a test plot and are being monitored within a larger network of pilot sites hit by the storm across Northern Italy. Other research activities that have been developed with regard to a broad range of post-event topics focussed on soil conditions and management, impacts on the timber market and prices, hydraulic risks in mountainous streams etc.

In addition to spot initiatives by single (or groups of) researchers, mainly addressing the topic from a monodisciplinary perspective, a two-year multidisciplinary research project developed by TESAF staff has started in October 2019. The project, titled VAIA - FRONT (FROm lessons learNT to future options), is funded by the TESAF Department and aims to analyse present and future vulnerabilities of forest socio-ecological systems to wind-related threats in the target area of North-East of Italy, and to preliminarily test a risk assessment procedure for selected ecosystem services in one pilot case study in Veneto region. To this end, the project includes four main actions: i) to collect and organise data on storm events and on their impacts in the

European and Alpine areas, included the area affected by Vaia; ii) to review current approaches to wind–related hazard, vulnerability and risk assessment, and governance analysis for forest socioecological systems; iii) to adapt existing frameworks for wind-related hazard and vulnerability assessment to one selected pilot area in the target region; iv) to implement a preliminary risk assessment and management for key forest ecosystem services in the selected pilot area. The ultimate ambition of VAIA - FRONT project is to identify key lessons to be learned from the Vaia event, both for planning and management practices and for policy interventions, to enhance the resistance and resilience of forest socioecological systems in the Italian Alps as well as in other Alpine regions (TESAF, 2019). The project is organised into five work-packages (Figure 2) and counts on the scientific support of an Advisory Board made-up of four highly qualified scientists from European universities and research centres, who assess project progress and provide guidance.
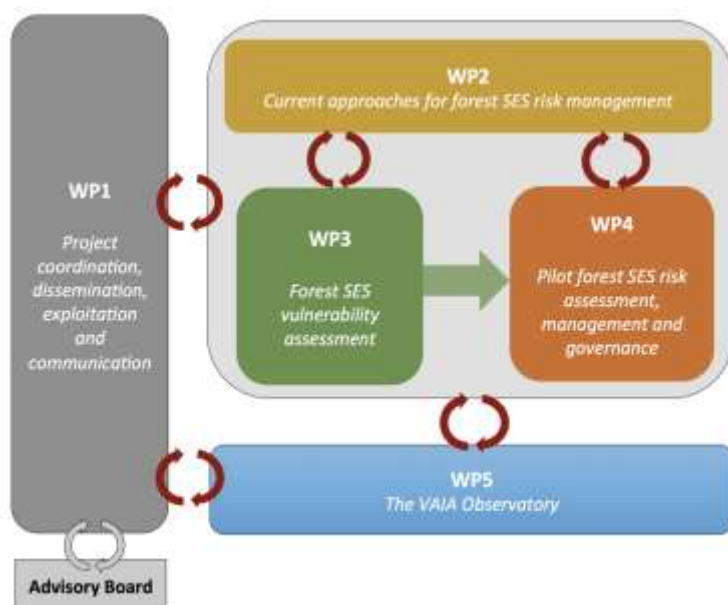

Figure 2: Structure of the VAIA FRONT project. WP = work package; SES = socio-ecological system. Source: TESAF (2019a).

The role of young researchers: PhD research activities

Research activities developed within the framework of VAIA - FRONT project are complemented by those implemented by Young Scientists for Vaia, i.e., a group of PhD candidates currently developing their PhD projects within the Land, Environment, Resources and Health (LERH) PhD programme at the TESAF Department. Four thematic areas have been identified for PhD candidates who applied to the LERH programme in 2019 and five research projects have been funded via three-year long scholarships and are currently ongoing under the guidance of a multidisciplinary group of scientific supervisors (Table 1). An additional, sixth, PhD

research project is being developed within the Crop Science PhD programme offered by the Department of Agronomy, Food, Natural Resources, Animals and the Environment (DAFNAE) of the University of Padova. DAFNAE Department is a twin Department to TESAF, focused on crop and animal science, hosted on the same campus where TESAF is based. All the above-mentioned PhD research projects are expected to be finalised by 2022.

Table 1: PhD research projects being developed by Young Scientists for Vaia within the LERH PhD programme at (a) TESAF and (b) DAFNAE Departments, University of Padova. Source: own elaborations based on data retrieved from LERH (2021) and DAFNAE (2021).

Main thematic Areas and issues	Research projects
TESAF Department, LERH PhD programme	
1. Forest policy and economics, governance of natural resources Addressed issues: risk perception, total economic value of damages and impacts, social attitudes towards mitigation programmes	Adaptive strategies and community resilience after extreme climatic events: the case of the Vaia storm in Italy
2. Forest ecology and silviculture Addressed issues: protection forests and hazards, ecosystem services, forest regeneration, deadwood manipulation	Impact of windstorm events on the ecosystem services of Alpine forests Short-term regeneration dynamics and influence of coarse woody debris on regeneration patterns after the Vaia storm in north-east of Italy
3. Mechanics and logistics Addressed issues: salvage logging, road networks, wood logistics	The eco-efficiency of salvage logging and wood transportation logistics in complex scenarios and the rule of the primary and secondary road network
4. Hydrology Addressed issues: gravitational hazards, hydrological risks	The Vaia flood event: observations and prediction of sediment and large wood dynamics
DAFNAE Department, Crop Science PhD programme	
5. Crop science Entomology, pest attacks and diseases, pathology	The VAIA windstorm: understanding outcomes and future trends on forest biodiversity through a DNA metabarcoding approach

Initiatives for students

Forest disturbances and their associated impacts, post-event activities and preventive management choices to improve forest resilience became topics increasingly addressed within forestry programmes. While field activities are traditionally part of learning curricula in forestry, visits to sites damaged by the Vaia storm provided tremendous learning opportunities. Before limitations imposed by anti-Covid measures starting from Spring 2020, many of these sites have been used as open-air labs for teaching, training and research activities since early spring 2019. Within the framework of forestry courses - in particular Master Degree (MSc) ones - offered at the university of Padova, field visits have been organized to damaged areas, to identify and estimate damages by the storm as well as encourage discussions around post-event management activities, including regeneration options and planting, observe skidding operations and logistics, consider safety aspects associated with windthrows removals, meet local experts, professionals and operators, etc.

Besides field visits, indoor learning activities were integrated with additional teaching activities inspired by Vaia and further complemented by seminars, workshops and conferences organized as integrative learning opportunities offered to forestry students at the University of Padova. This included a round table with experts from the regional Forestry Departments of the five administrative regions/autonomous provinces hit by the storm. Some of these events were organized in cooperation with the local university-based Forestry Student Association.

Vaia also became a topic for thesis research by students: by querying the University of Padova online public thesis repository using "Vaia" as a keyword within both the title and abstract fields, six Master theses were identified, five of which developed at the TESAF Department (ecology and silviculture) and one at the Department of statistics (climate physics and statistics). No Bachelor thesis was found instead.

Ad hoc activities have been organized within the framework of courses delivered outside standard forestry curricula. For example, the 55th edition of the "Ecology culture" course (June 2019), a week-long event organized by the TESAF Department every year at the Centre for Studies on Alpine Environment located in the Dolomites and targeted at national and international PhD students, was fully dedicated to storm damages to forests (TESAF, 2019b). Learning activities and a field module were offered to students attending the short specialization course in Prevention and emergency in the mountains and high altitude, organized by the Department of Cardiac Thoracic and Vascular Sciences and Public Health of the University of Padova (Gruppo operazioni forestali Università degli Studi di Padova, 2020). The focus, in this case, was on risk assessment of the work activities in mountain areas hit by the storm. Finally, the annual Summer School of the Erasmus Mundus MSc Programme on Mediterranean Forestry and Natural Resources (MEDfOR) (July 2019) hosted a seminar on "Dealing with extreme climatic events: the challenges after the windstorm Vaia" delivered by TESAF staff. The seminar followed a field trip to areas damaged by the storm (MEDfOR, 2019).

Communication and dissemination activities
Given the magnitude of the event, Vaia gained momentum in media and high visibility among both experts (researchers, practitioners, public administrations) and the public at large, exposing the national forest sector to an unprecedented visibility within the Italian audience[2].

As reported in Table 2, the TESAF Department staff was involved in several communication and dissemination activities, targeting a broad and diverse audience.

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[2] As an empirical confirmation of this, the docu-reality programme Undercut was broadcast by the Italian TV channel DMAX between June and July 2019. The programme showed activities by lumberjack teams from four different forestry enterprises engaged in removing windthrown caused by Vaia windstorm in Trentino area. Given the success achieved by the first season, a second (December 2019) and third (July 2020) editions have been produced and broadcast.

Most of these activities concentrated in 2019, although the number of communication initiatives per month was much higher in late 2018 (18 initiatives/month), just after the event (October-November 2018), than during other periods reported here. While this figures and trends may reflect the general interest for the topic and its visibility, they might have influenced by restrictions imposed by Covid-19 pandemic since February 2020 that limited to some extent both research and communication activities, in particular with reference to conferences. On the other hand, figures presented are likely underestimated as they do not cover some minor initiatives or activities that were not made publicly available through the TESAF website and communication channels.

Table 2: Media and dissemination activities on Vaia involving TESAF research staff. Source: own elaborations based on data retrieved from TESAF (2021).

Years	Online and offline media interviews		Online and offline media articles		Workshops, seminars and conferences		Video interviews		Total		
	N.	%	N.	%	N.	%	N.	%	N.	%	Average N. per month
2018	16	23.9	4	25.0	7	24.1	9	25.7	35	23.6	18
2019	39	58.2	11	68.8	18	62.1	22	62.9	89	60.1	7.5
2020	12	17.9	1	6.3	4	13.8	4	11.4	21	14.2	1.8
Total	67	100.0	16	100.0	29	100.0	35	100.0	148	100.0	5.8

A bunch of conferences/workshops were directly organised by the TESAF Department, including, among others, the kick-off meeting of the VAIA – FRONT project (Padova, October 2019), a joint webinar of the VAIA – FRONT project and the Young Scientists for Vaia group (online, July 2020) and a conference on the role of the University of Padova in developing research activities with reference to the Vaia storm (Belluno area, September 2020). Besides above-mentioned initiatives directly organised or co-organised by the TESAF Department, staff members were invited as speakers to a number of additional events among those referred to in Table 2, organised by other institutions, including Alpine Clubs, cultural and industrial associations, scientific bodies etc. About 45% of these events took place in Padova and close-by areas (not directly hit by the storm) taking advantage of the proximity to university staff and facilities, while another 35% took place in areas that were directly affected by the storm, both within and outside Veneto.

TESAF staff proactively cooperated with many media by providing information and materials for articles and being available for interviews. About 60 interviews (90% of total media interviews) were published by newspapers, mainly local ones (89%), while an additional 10% were published by national newspapers, thus reaching a broader audience. Additionally, 35 video interviews involving TESAF staff were recorded. Of this, about 60% were made via country-wide television or radio

programmes, while the remaining 40% were performed by regional media (29%) and Padova university media and communication channels (11%).

Communication and dissemination activities on Vaia were organised also by other academic and non-academic organizations. For example, the Italian Society of Silviculture and Forest Ecology co-organised several events, including conferences and a thematic exposition, as well as coordinated ad hoc technical and dissemination reports and publications. Some of these initiatives were supported by non-academic actors, like local foundations, regional administrations, specialised media and the National Federation of Wood-working and Trading Industries.

Side initiatives developed in cooperation with partner organizations
Additional initiatives were developed in cooperation with partner organizations. As an example, in late 2018 Etifor, a spin-off of Padova University, launched the WOWnature platform[3] that allows single citizens and private sector organizations to contribute to nature-restoration and forest development projects in various areas. At present there are projects running on about 70 different sites, both in Italy and abroad: 12 of these refer to areas damaged by the Vaia storm. The platform allows fundraising to support projects aimed to generate positive impacts by either improving existing forests or creating new forest areas. Positive impacts in terms of ecosystem services generation are independently verified and monitored according to the Ecosystem Service Procedure developed by the Forest Stewardship Council (FSC®) and all forest areas are committed to be managed in compliance with (and become certified according to) FSC forest management standards. Projects are (co)funded by private citizens, who are directly involved in planting operations, and private sector organizations that can take advantage of benefits generated by these projects to compensate negative environmental impacts they cannot avoid, reduce or mitigate. Among the most prominent initiatives it is worth mentioning the case of Arte Sella (Sella Valley, Trentino), a large and famous permanent land-art exposition that was damaged by the storm and restored with the support of Levico Acque, a local mineral water company committed to become plastic-free and climate positive (WOWwnature, 2021), and the case of Agordo (Belluno area, within the Dolomites), where Luxottica - a leading company in premium, luxury and sports eyewear, controlling over 80% of the world's leading eyewear brands (Luxottica, 2021) - invested in the restoration of a large forest located just behind the company's headquarter.

Etifor and the TESAF Department are also providing scientific and technical support to the Angelini Foundation for Mountainous Areas in the organisation of an online and public available collection[4] of studies, reports, documents and video on Vaia as well as other windstorm events that occurred in Alpine areas in the past (Fondazione Angelini, 2021).

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[3] www.wownature.eu
[4] www.angelini-fondazione.it/vaia-per-approfondire/

Another relevant initiative – Oltre Vaia (i.e., Beyond Vaia) – was launched in 2020 as a collaboration between the TESAF Department, FSC Italy – the FSC national office for Italy - and Treedom, an online platform promoting tree-planting activities worldwide. The initiative aims to restore forests destroyed by the Vaia storm in Asiago municipality (Asiago Plateau, Veneto) by supporting both tree planting and natural regeneration dynamics. The areas targeted by the initiative will also provide opportunities for developing on-site research activities on post extreme event forest dynamics.

Some final considerations

Forest disturbances associated with extreme events and natural disasters are expected to continue to increase in intensity, quantity and frequency in the coming years, posing increasing threats to the world's forests (Moore and Allard, 2011). Effective preventive measures aimed to increase forest resilience as well as rapid response to such disorganizing, catastrophic, psychologically shocking events rarely produces good results unless there is already a deep understanding of forest ecology and governance firmly embedded in management rules and culture (Vallauri, 2005).

In the case of the Vaia storm, institutional and voluntary bodies promptly reacted on emergency issues (safety, basic services and infrastructures), while in the management of post-emergency issues different reactions by regional/provincial Public Administration bodies were observed in terms of timing, implemented mechanisms, effectiveness etc. (Romagnoli *et al.*, 2020). On the other hand, civil society organizations, the private sector, mayors and institutions at the local level as well as education institutions (schools and universities) proved to be more reactive. Though mainly focused on a single university department, and although many of the above-mentioned initiatives are still ongoing or just terminated so it is not possible to draw general conclusions on their impacts/effectiveness, the overview provided within this paper confirms that higher education/research institutions had a key role in the post-Vaia phases and supports the idea that they could have a more active role in developing and delivering knowledge and skills that can help moving closer to more resilient socio-ecological forest systems. If making these systems more resilient implies change, education or research institutions, and in particular universities, should be and shall be part of such a change and actively promote and guide transformation. A high-quality research and education system is a prerequisite to sustainable and transformational efforts by increasing competencies available within society and facilitating their responsible use via a transparent, participative processes and a close dialogue across multiple disciplines, sectors and actors (Herget, 2018). As suggested by TESAF experience, University's three missions seem to fit very well this role:

- The first mission, i.e. education, should qualify human capital by continuously and effectively incorporating research results on how to cope with extreme events

and improve resilience of forest socio-ecological systems into learning programmes. This may be done for example by making research results available via teaching materials, seminars, etc. as well as by making research on these topics part of the education process, e.g., via thesis development.

- The second mission, i.e. research programmes and activities, including those involving or promoted by young researchers and conducted in cooperation with other universities and research centres around the world, should ensure the production of new knowledge to cope with extreme events and improve resilience to rapidly changing conditions. The adaptation of ongoing research activities, the development of new research projects and the sharing and capitalization of results may serve this purpose.
- The third mission should encourage cooperation with non-academic bodies – private sector, public administration and civil society – in order to address societal needs and catalyse innovation. Applied research and activities developed in cooperation with organizations outside the university can favour the transfer of knowledge into real-world solutions and help dissemination of good practices.

Extreme events like Vaia have a huge impact on media and can give unusual visibility to the forest sector, however inappropriate, partial or misrepresented perceptions can also be passed to the public: universities may therefore also have a role in rethinking how to communicate forests and forestry, to bring them closer to people and reinforcing educational and cultural role at a broad spectrum.

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