



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



VAIA-FROM lessons LearNT to future option

FINAL REPORT

WP4

30.06.2022

WP4 - Forest SES Pilot Risk Assessment, Management and Governance

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1. Introduction to WP4 objectives, structure (tasks), resources and activities

Strengthening the resilience capacities of forest socio-ecological systems (SES) to wind disturbance is necessary to avoid major environmental, social and economic damages. Therefore, the overall aim of the WP4 is **to provide a preliminary integrated strategy to manage wind-related risks at local and regional level in North-East Italy**, in case future windstorm events, like Vaia, will occur in the future. Additionally, WP4 aimed at **understanding the role of the governance model in effective risk management**. To this, the risk management strategy that will be proposed as an output of the project will include both technical guidelines to increase the knowledge of forest-related practitioners on how to prevent and react to windstorm events and policy recommendations for decision-makers to support the implementation of proper prevention plans and adaptation strategies.

To create a comprehensive risk management framework, the WP4 research activities have been organized into four different Tasks (T) with specific objectives, as outlined in the following:

T4.1 - Understanding the governance structures in relation to forest SES risk management

- Analyse and describe the governance structures currently existing in the area affected by the windstorm to understand the legal framework for risk management and the current decision-making processes in relation to forest SES.
- Acquire information for the formulation of policy recommendations (Task 4.4) based on governance strengths and weaknesses.
- Verify the compliance of the existing legal framework for risk management with the international recommendations.

T4.2 – Preliminary test of forest risk assessment in relation to key ecosystem services (ES) in the pilot area

- Economic estimation of key ES by comparing their value change before and after the windstorm to identify damages and losses.
- Risk assessment through the evaluation of the vulnerability of ecosystem services (ES) to wind in order to identify the most appropriate forest management strategies to reduce the risks connected to future windstorm events.

T4.3 - Formulating technical guidelines for resistance and resilience of forest SES in the target area

- Set guidelines for forest resources management and planning interventions based on vulnerability assessment (from WP3) and Task 4.2 results.

T4.4 - Proposing a preliminary approach for integrated and systemic management of forest SES risk in the target region

- Develop a strategy suitable for local and regional authorities that encompasses governance instruments and approaches for increasing the resilience of forest SES in the targeted area.

The research methodologies adopted and an overview of the main results of the analysis conducted for each Task are described respectively in sections 2 and 3 of this report. While the report is intended to present what has been carried out in WP4 and provide evidence of the completion of the planned activities, the scientific results are only briefly summarized - as they will constitute the contents of some scientific papers which are currently under development and intend to be published in the next 18 months. The two main specific Deliverables expected as WP4 outputs will be completed in Italian, being mainly targeted to local and national policy makers, and presented at the public final event scheduled on the 28th of October 2022. These Deliverables will assume the form of technical reports with dissemination scopes, being titled D4.1) Preliminary technical guidelines for future SES vulnerabilities and risk management in the targeted area; and D4.2) Integrated and systemic management of forest SES wind-related risks: preliminary policy and governance solutions for resistance and resilience in the targeted area.

In general, it is worth to mention that most of the WP4 activities have been carried out during the second year of the project, involving various researchers. The advancements and effectiveness of many of the planned activities, initially designed for in presence face-to-face interviews and focus groups on the regions hit by the windstorm (typically applied in social and economic research), have been negatively affected by the restrictions due to the Covid-19 pandemic in 2020 and 2021. The Covid-related impediments required adjustments of the applied methodologies, and the need to request a 6-months postponement of the end of the project to complete what planned.

Through both internal meetings via Zoom, exchange of emails, individual work and in presence coordination meetings, the WP4 Leader (L. Secco) and other three members of the permanent staff of the TESAF Department actively contributed to the project development and its results. Staff members include professors and senior researchers with background on forest and rural development policy and economics (M. Masiero, D. Pettenella, T. Tempesta and D. Vecchiato). A strict collaboration has been established with one PhD student belonging to the “Young scientists for Vaia group” within the Land, Environment, Resource and Health (LERH) Doctoral School (F. Romagnoli, with socio-economic background and thesis focus); a student (F. Donà) of the MSc Local Development program has been supervised for a thesis on socio-economic impacts of Vaia storm in the affected regions. From 01/12/2020 to 28/02/2021 a 1-year Junior Research contract has been activated (G. Pagot) plus another 2021 a 1-year Junior Research contract has been assigned from 01/07/2021 to 30/06/2022 (A. Santini) thanks to the budget allocated (32% co-funding), with obligations connected to Tasks 4.1, 4.2 and 4.3. Finally, two surveys based on online and phone-call questionnaires for data collection on citizens and stakeholders’ attitudes in relation to ES and institutional and governance-related issues of the management of the windstorm emergency and post-emergency phases have been subcontracted to two different external agencies (i.e., Demetra for the survey on recreational ES and values; SdV Marketing for the other, broader analysis). All the allocated resources have been spent before the end of the project, by the 30.06.2022.

2. WP4 research methodology (by Task)

Section 2 describes the methodological steps carried out in each of the four Tasks.

Task 4.1 Understanding the governance structures in relation to forest SES risk management

In Task 4.1, we have analysed and described the governance processes to deal with windstorm and post-windstorm emergency in the areas affected. In particular, we have identified the decision-making process within the three phases of the emergency “response”, “recovery”, “preparedness” for all of the hit area (Veneto and Friuli-Venezia Giulia Regions, Autonomous Provinces of Bolzano and Trento) though the collection and systematisation of policy and governance-related information acquired with content analysis techniques. The information has been systematised into a matrix to visualize the role of each involved actor, focusing on the assigned specific competencies during the emergency, the legislative framework under which they have operated and the financial resources they have managed (Table 1).

Fase post-emergenza							
Veneto	Attori Coinvolti	Scala	Competenze/ Descrizione	Documenti, norme e piani	Risorse	Link	
Attori Coinvolti	Regione	Regionale	normalizzazione dei servizi definendo le tempistiche: 3 anni, da programmazione di spesa, con 2 anni al massimo di Stato di Emergenza	Dpcm del 27/02/19		https://www.regione.veneto.it/di/documenti_librari/get_file?uid=F3c742e7f4523-4440-b82b-1173c0981978&groupId=2596146	
		Regionale	Stima completa dei danni: 1.769.000.000€, stime fatte da Direzione Protezione Civile e Polizia				
	Commissario delegato	Regionale	E' il responsabile della firma del piano di utilizzo dei fondi statali e europei, che deve essere elaborato per ogni annualità (nel caso di Vaia 2019-2020-2021) dettagliando gli interventi da eseguire.	Piano del Commissario Post Vaia 2020			https://www.regione.veneto.it/article-detail?articleId=3321890 https://www.regione.veneto.it/web/veneto-in-giornocchio
		Regionale	Erogazione contributi ad attività produttive del settore agricolo, forestale e acquacoltura/pesca	Ordinanza n.20 del 19/11/19			
	AVEPA	Regionale	Erogazione dei fondi (privati ed attività economiche). I contributi ai privati vengono forniti in forma di finanziamenti agevolati (Ordinanza n.7/2020).	segue le indicazioni dell'ordinanza n.20 del 19/11/19.			
		Regionale	Stabilisce i criteri di assegnazione dei fondi	•Ordinanza n.7 del 24/9/19 (requisiti per nuclei familiari e attività produttive) •Ordinanza n.10 del 4/6/19 (percentuali e contributi per nuclei familiari e attività produttive) •Ordinanza n.11 del 9/7/19 (bandi assegnazione contributi a nuclei familiari e attività economiche non relative al settore agricolo/pesca) •Ordinanza n.7 del 13/9/2020 (istruzioni e criteri di assegnazione di fondi per privati e attività produttive con focus su beni mobili non registrati di privati, attrezzi, macchinari e scorte di attività produttive)			http://www.avepa.it/vaia-forestale-2018 https://rdv.app.box.com/s/p6q5i5w7ypcxv2okeqn7qzhljb2kqzklfile693842610614 https://rdv.app.box.com/s/p6q5i5w7ypcxv2okeqn7qzhljb2kqzklfile693842610614 https://rdv.app.box.com/s/33f7neuhfwy6ctjrgdp8zq30qatd0file693802624996
Risorse			Fondo foreste italiane	tramite art. 1, comma 665 della legge 145 del 2018	85.900,00	https://www.governo.it/PA/PA/2020_3063602_MPA/PA/2020_3063121_DM/Fondoforeste2019.pdf	
		Multiscala (fondi europei,nazionali, regionali o privati che vengono utilizzati per interventi a livello comunale)	fondi statali dalla legge di stabilità 2019		2019-232.588.417,11 2020-261.661.969,51 2021 - 261.661.969,51		
			state assegnate ulteriori risorse alla Regione Veneto per complessivi, per il solo anno 2019	pubblicato in G.U. n 115, serie generale, del 18 maggio 2019	149.635.484,42		
			imputati con i fondi europei devono essere utilizzati entro 18 mesi dall'erogazione (4 dicembre 2019) e sono sotto forma di sovvenzione (contributo finanziario)	Ordinanza commissariale n.14 29 settembre 2020.	68.620.678		
		Fondo Welfare e Identità territoriale Dolomiti			600.000	https://www.welfare.dolomiti.it/contributi-alle-famiglie-copite-da-vaia/	

Table 1 – Example of the matrix constructed with the information collected through policy content analysis
Source: own elaboration.

The use of the matrix allowed us to compare the decision-making process among the regions and to identify the main differences in terms of intervention priorities, financial resources and fund allocation and governance structures.

The following step implemented for reaching and in-depth understanding of the governance structures and actors involved in Vaia emergency management has been the **creation of a framework to evaluate governance** and its functioning in the three main phases of the emergency and in various regional contexts. The framework has been created based on indicators and variables developed by the most relevant Disaster Risk Reduction frameworks available at

international level. These are: i) the Sendai Framework, developed by the United Nations Office for Disaster Risk Reduction (UNDRR); and ii) the Build Back Better Framework, developed by the World Bank. These two frameworks represent the most outstanding references at global level to assess disaster preparedness, management and resilience (Hallegatte, Rentschler, & Walsh, 2018; Marzi et al., 2019; Nations Office for Disaster Risk Reduction, 2015). Based on the dimensions and indicators identified in these frameworks to measure the institutional capacity to deal with risk reduction, disaster management, and recovery processes, we selected and adjusted a set of variables suitable for the Vaia-Front study area. In particular, we have selected those dimensions and variables that are considered as more consistent and applicable in mountain and marginal regions (Table 2).

Table 2 – Extract of the indicators and dimension selected from international frameworks to measure the institutional capacity to deal with risk reduction

Reference Framework	Dimension	Subdimension	Description	Policy Analysis	Questions	Indicator	Notes
Sendai Framework; BBB	Foresight	Creation of risk culture	Include in post – disaster building reconstruction risk management and mitigation strategies		•2.4	Level of agreement with the sentence + number of sentences with agreement	
			Sensitize towards risk reduction and prevention with education and trainings, development of specific standards and risk mitigation policies		•3.3	Presence or absence of actions listed	
Sendai Framework IRDR REPORT		The creation of ad-hoc legislative framework	Review and adapt current legislative frameworks to include risk mitigation plans		•3.4b	Presence/ absence of of mitigation plans at different administrative levels	
			Introduction of specific institutional figures/ organs to manage and adequately formulate risk mitigation and prevention		•3.4c	Presence or absence for different administrative levels	
Sendai Framework; BBB; Recipe		Reestablishment of pre-disaster services, improvements of assets, infrastructures, and public services	Ensure continuity of previous services		•2.3 d./ e/ g	Presence/ absence (0/1) of actions listed	
Sendai Framework; BBB			improvement of existing assets: Introduction of new of services and infrastructures		•2.3 a/b/c/f	Presence/ absence (0/1) of actions listed	

Source: own elaboration.

Task 4.2 Preliminary test of forest risk assessment in relation to key ecosystem services in the pilot area

A preliminary test of forest risk assessment in relation to key ES in the pilot area (Rocca Pietore municipality, in Veneto Region) has been carried out starting with a **monetary evaluation of forest ES** before and after Vaia windstorm to identify the most vulnerable ES to windstorm events and the economic damages brought by these extreme events. First, we proceeded with the identification of the relevant ES in the affected area selecting timber production as a provisioning service, biodiversity conservation for supporting service, rockfall and avalanches protection for the regulation services and finally tourism activities together with mushroom and truffle collection as cultural services. As a starting point, we carried out a wide **literature review**, to identify indicators (biophysical and economic) that have been used in other contexts and research to describe ES. From the various options and the list of indicators, we selected the most appropriate and feasible to apply in the Vaia case-study, and we identified the most appropriate monetary valuation methods (Table 3).

Ecosystem Service	ES subcategory	Physical Variable	Value	Source	Economic Variable	Value	Source	Economic Value BT	Methodology
ALPINE AREA OF VENETO (PROVINCE OF BELLUNO)									
Supporting	Biodiversity Conservation	Natura 2000 areas (ha)							1. layer aree 2000 (ha) + superficie schianti (ha) -> calcolo danno fisico 2. Danno fisico viene moltiplicato per il valore economico delle aree natura 2000
		Windthrow area in Natura 2000 (ha)	3879 ha	Regione Veneto basato su dati Mipaf + ortofoto + immagini spot + dati LIDAR dove disponibili	Value of Natura 2000 ecosystems				
Provisioning	Timber production	Volume of harvest (m3) Ripresa annuale (m3)			Market price of timber (€/m3)			78,4/ha/yr	1. Ripresa annuale (m3) persa nelle aree schiantate (ha) 2. Dato moltiplicato poi per il prezzo medio del legno (10 anni prima) 3. BT value - vaia impacts
Regulating	Rockfall protection		4766 ha			simple palisade cutting terraces	Regional price-list	328€/ha/yr	1. protection forest area loss 2. loss (ha) multiplied by price of technologies in 2019 in veneto region according to regional price-list 3. BT value - cost of loss
	Avalanches protection	Forest areas protecting against natural hazards (ha) Windthrow area (ha)	1538 ha	Regione Veneto basato su dati Mipaf + ortofoto + immagini spot + dati LIDAR dove disponibili	Cost of bioengineering technologies		Regional price-list	13116047€/ha/yr	
Cultural	Tourism	Forest area (ha) Nr. Mushrooms permits (daily) per year Nr. of arrivals			Cost of mushroom permits (€)		Mean price calculated on the basis of different daily prices in the different unioni montane	277,423€/yr 6€ ha/yr	1. permits x cost of permit / forest area 2. BT value - our value

Table 3 - Extract of the ES variables and monetary valuation methodologies identify in literature

Source: own elaboration.

Then, considering the Vaia-Front selected case-study locations, two different levels of analysis have been applied:

1. One at provincial level, considering the province of Belluno. At this level the ES valuation has been based on primary and secondary data collected from the literature and regional databases accessed online. The value of timber production has been estimated using market price method; tourism value has been estimated using data on the annual revenues from touristic activities; truffle and mushroom picking value has been estimated considering the number of licences released and their price. Regulating services in the area has been valued with replacement cost method while the valuation on biodiversity conservation is still under

development. Additionally, a benchmark was set using a previous valuation study on Val di Fiemme (Benefit Transfer).

2. One at local level, considering the Rocca Pietore municipality. In this case, the ES valuation has been conducted with cash flow analysis using pre- and post-Vaia data on municipal revenues. This set of data was collected with the support of the Municipality staff (who was contacted via email and phone, and available in transmitting the data needed).

Finally, in collaboration with WP3, we investigated to what extent trees' susceptibility to wind affects forest ES. First, WP3 assessed forest susceptibility to wind damages using a physically based model (ForestGALES), then we combined the model outputs with spatial data about ES, to identify vulnerable areas in terms of possible negative changes of ES (i.e. reduction of the ES from the point of view of its biophysical characteristic). Finally, we estimated how the value of the ES is predicted to change according to the vulnerability map.

Because of its particular relevance in WP4-related socio-economic themes, an insight has been developed on the **Ecosystem Service "Recreation"**. The main objectives of this in-depth analysis have been: i) to identify landscape preferences; and ii) to evaluate the benefits of different forest structures for future «resilience» to extreme events. Two different methodological approaches have been applied. To fulfil the first objective, i.e. to identify landscape preferences, first an analytical matrix of analysis has been developed and photographic material about the landscapes of the hit regions, with a focus in Veneto, has been acquired (by means of both on-site evaluation and on-line search) (Figure 1).



Figure 1 – Photographic material acquired for the monetary evaluation of the ES Recreation in the target area

(source: Vecchiato and Tempesta, 2021)

To fulfil the second objective, i.e. to estimate the monetary value of the benefits of possible different forest structures for future resilience to extreme events, we applied a choice experiment methodology. This was based on the definition of a hypothetical scenario, the selection of attributes and levels and, finally, the elaboration of the experimental design. While for the first objective, we explored the perception of potential users of the forest-based recreational service associated to landscapes; for the second, we estimated the monetary value of the forest-based recreational service based on different possible combinations of options. In both cases, data have been collected by means of **an online survey** that included both the perceptual and monetary values. The welcome page of the online questionnaire, implemented in May-April 2022, is visible in Figure 2.

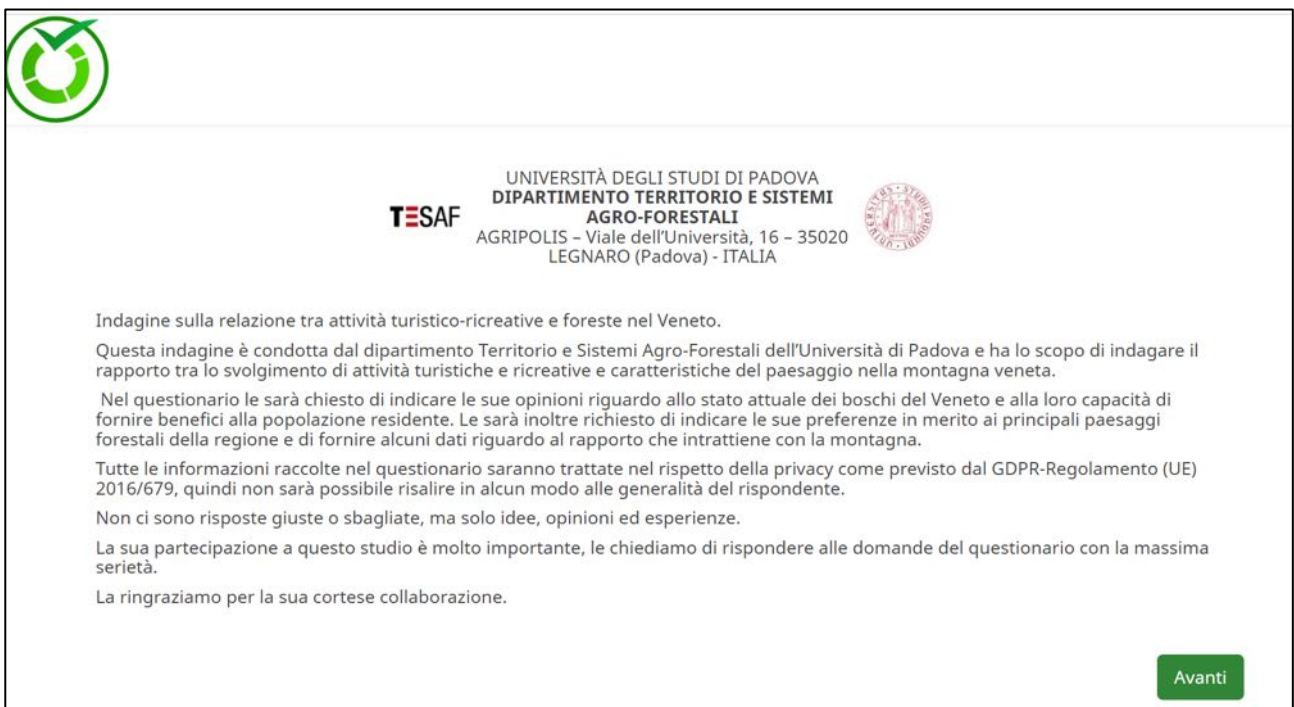


Figure 2 – The cover page of the online survey to deepen the understanding of the ES “Recreation” through monetary valuation based on choice experiment and landscape preferences (source: Vecchiato, 2021)

The survey, administrated by an external specialized company (Demetra) by means of CAWI (Computer Assisted Web Interviews), has reached up to **830 respondents**, stratified by age, gender, and province of residence. Despite the high number of participants, this sample cannot be considered fully representative of the resident population in Veneto: when the data are collected via web, as in this case, the educational level of respondents is typically higher than the average of the population. However, through the data collected it was possible to estimate that the total number of recreational events in 2021 was equal to 12.6 million. Furthermore, it was possible to verify that according to the interviewees, among the ecosystem services provided by the forest, the ones most damaged by the VAIA forest was the quality of the landscape, followed in order of importance by the prevention of hydrogeological instability and the conservation of biodiversity.

Task 4.3 Formulating technical guidelines for resistance and resilience of forest SES in the target area

To fulfil this Task, the research outputs of WP3 have been combined with the output of Task 4.2. Once, estimated ES vulnerability to windstorm events and their potential value change, we created **vulnerability maps** to identify the most vulnerable locations in terms of potential (negative) changes to key ES deriving from forests. To identify the most appropriate guidelines to maintain ES functioning, and thus to strength resilience, we created an ad-hoc matrix. The matrix returns a forest management recommendation considering the ES to maintain and a set of physical variables on forest structure such as the forest composition, the slope, the susceptibility to thrown and the exposition to wind (Table 4). The matrix will be integrated into the Deliverable D4.1, which provides technical guidelines to practitioners and policy makers of the target area.

Table 4 – Structure of the matrix to identify forest management options in relation to the maintenance of

Funzione prevalente	Tipologia forestale	Stadio strutturale	Pendenza	Suscettibilità agli schian	Esposizione al vento	Raccomandazione gestione forestale da parte di tecnici forestali
Funzione culturale - opportunità turistico-ricreati	Abieteto	Fustalia giovane	0°-20°	Alta	Media	

different Ecosystem Services in the target area

Source: own elaboration, in cooperation with WP3.

Task 4.4 Proposing a preliminary approach for integrated and systemic management of forest SES risk in the target region

The first step undertaken in this Task has been the development of a set of three surveys to investigate perceptions and attitudes towards the various ES deriving from forests as well as and of three different target groups within the communities of the hit regions. These target groups are: i) the public actors (institutional stakeholders), ii) the citizens; and iii) other key stakeholders (economic and social actors) regarding the overall management of the emergency and post-emergency phases of Vaia windstorm. The surveys also intended to analyze disaster and post-disaster management capacity of local and regional institutions and investigate stakeholders' perceptions towards post-windstorm local communities resilience and adaptive capacities.

The **online questionnaire targeted to public actors (institutional stakeholders)** in the target area has been developed based on the dimensions and variables identified as relevant for analysing the institutional and governance aspects of disaster risk management in Task 4.1 (Figures 1 and 2). This survey has been administered by the staff members of WP4 through the **LimeSurvey platform of the University of Padova**, aiming at examining the ability of local and regional institutions to implement a) an effective post-disaster management; b) a reconstruction process that strengths society ability to adapt and recover from natural disaster. The questionnaire was targeted and submitted to key public institutional and governance stakeholders of the four Italian regions most affected by the windstorm, as selected during the stakeholders' analysis. To identify the key public actors (institutional stakeholders) for this part of the analysis we used two criteria, i.e. we selected the actors who were: i) emerging as crucial stakeholders from the analysis of the regional governance structures at regional level (Table 1); ii) having a role

as “implementation agency-agent” assigned by the legal frameworks for disaster management at regional level. Examples of questions used in this survey are reported in Table 5.

Table 5 – Examples of questions included in the online survey targeted to public actors (institutional stakeholders) via the LimeSurvey platform (source: own elaboration)

*Quanto è d'accordo con le seguenti affermazioni in una scala da 1 a 7? (1 = in totale disaccordo; 7= in totale accordo)

	1 - Totale disaccordo	2	3	4	5	6	7 - Totale accordo
Le comunicazioni istituzionali fornite alla popolazione nella fase di pre- allerta erano chiare	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Le comunicazioni istituzionali fornite alla popolazione sui comportamenti da seguire nella fase di pre-allerta sono state date in modo uniforme sul territorio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Le comunicazioni istituzionali fornite alla popolazione nella fase di pre- allerta sui comportamenti da seguire sono state fornite in modo univoco	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Il sistema di allerta è stato efficace	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The list of public actors’ (institutional stakeholders) names and contacts cannot be shared, for privacy reasons. However, in total, we identified and found details of 140 contacts, who have been invited via email to participate into the survey; at the end, we gathered **37 full answered questionnaires** and **26 partially answered questionnaires**.

The **data collection targeted to the population** (citizens) in selected locations of the target area has been developed based on a selected set of dimensions and variables identified as relevant for analysing the institutional and social capacity of disaster risk management in Task 4.1 (Table 1 and 2), such as the readiness of institutions and local stakeholders’ in dealing with extreme weather events. Furthermore we explored other issues relevant for the project adding further questions concerning citizens’ perceptions and attitudes towards forest ES, changes in ES provisioning in relation to the effects of Vaia windstorm, future preferred choices related to damaged forests, and more.

More specifically, this questionnaire revolved around three main topics: a) citizens’ satisfaction concerning public institutions’ recovery actions implemented both in the emergency and the post-emergency phases; b) eventual changes perceived in ES and territorial management after the windstorm; c) key elements that have increased the community resilience and adaptability to climate weather events. The survey has been administered by an external society (SDVMarketing) specialized in CATI (Computer Assisted Telephone Interviews) interviews.

A totality of 372 questionnaires has been collected. These interviews have been targeted to a total amount of **304 citizens (residents) representative of the population** most severely affected by Vaia windstorm (severely affected = volume of windthrow $\geq 800.000 \text{ m}^3$; and $ha > 3.000$), i.e. Veneto and Friuli-Venezia Giulia Regions and the two Autonomous Provinces of Trento and Bolzano; and, within each region, those most affected municipalities and valleys (Table 7).

For what concerns CATI interviews to reflect the population characteristics of the valleys considered, the data collected have been weighted ex post based on: population size of each valley, gender percentage and age clusters.

Regions	Most affected locations (municipality)	Valley	Province
Autonomous Province of Trento	Predazzo, Grigno	Val di Fiemme	Trento
Autonomous Province of Bolzano	Nova Levante, Nova ponente	Val D'Ega - giardino del Sud Tirolo	Bolzano
Veneto	Livinallongo, Taibon, Rocca Pietore	Agordino	Belluno
Friuli-Venezia Giulia	Forni Avoltri, Sappada	Carnia	Udine

Table 7 – Regions, provinces, municipalities and valleys considered for the CATI survey to citizens

Source: own elaboration.

Finally, an **online questionnaire targeted to the stakeholders** (economic and social key actors) in selected locations of the target area has been developed and administered. Similarly, to the questionnaire targeted to citizens, questions for this part of the analysis have been developed to explore key issues relevant for the WP4 goals, such as stakeholders' perceptions and attitudes towards forest ES and their changes in relation to ES provisioning after Vaia windstorm, future preferred choices related to the damaged forests, and more. More specifically, this questionnaire revolved around three main topics: a) stakeholders' satisfaction concerning public institutions' recovery actions implemented both in the emergency and the post-emergency phases; b) eventual changes perceived in ES and territorial management after the windstorm; c) key elements that have increased the community resilience and adaptability to climate weather events. To ensure comparability between the questionnaires targeted to population and stakeholders the two questionnaires had the same structures and inspected the same topics. However, the survey administered to stakeholders included questions that addressed specifically issues related to the nature of the respondents (e.g. post windstorm economic repercussions or social networks and social capital characteristics). Some of the questions asked to stakeholders were the same used for the interviews to the public actors (institutional stakeholders), to allow comparison of results and, also in this case, data aggregation. As the previous one, this survey has been administered by an external society (SDVMarketing) specialized also in CAWI (Computer Assisted Web Interviews). A list of ca. 450 stakeholders has been initially developed by Vaia-Front staff members, with names, contacts, etc. of key actors in the target area. Four different stakeholders' categories have been identified, including: a) private sector (enterprises, trade associations, consortia, forest-related enterprises); b) local municipalities, emergency services, fire brigades and civil protection agencies; c) third sector (voluntary, cultural and environmental associations, foundations); d) operators and agencies of the tourism sector. In total, **68 stakeholders** accepted and participated into the online survey, in the same selected locations used for targeting the survey of the citizens (see Table 7). Collected data have been analysed implementing basic and descriptive statistics as well as multivariate statistical analysis.

3. Examples of scientific results

This section of the final report outlines some of the results obtained by each Task. As mentioned, not all the scientific results deriving from the implementation of the Tasks are included in this report, as they will be presented in scientific publications currently under development. Therefore, it reports examples of such results for some of the Tasks.

Examples of results for Task 4.1 - Understanding the governance structures in relation to forest SES risk management

The comparison of the governance processes process within the three phases of the emergency “response”, “recovery”, “preparedness” in the involved area shows that in the first phase of the emergency all the Regions and Autonomous Provinces adopted the same legislative framework but highlighted substantial differences in the recovery and preparedness phases. Afterward the windstorm event, the state of emergency has been declared by the Presidency of the council of ministers, following the proposal of the Prime Minister and the Presidents of the Regions and Autonomous Provinces involved. The emergency management was led by Civil Protection but followed the *principle of subsidiarity*: according to the scale of the impacts, local authorities intervened complying with the directions of Civil Protection. The head of Civil Protection, then transferred the decision-making authority during the emergency to the Deputy Commissionaire (OCDPC n.558/2018) that are presidents of the Region for Veneto and Friuli-Venezia Giulia and respectively the Presidents of the Autonomous Province of Trento and Bolzano according to Decree of the President of the Republic 31 August 1972, n. 670. All the local authorities followed this scheme leading the management of the emergency to the Civil Protection in the response phase. In the subsequent phases, local implementing actors, were identified in each locations and allowed to lead the implementation of the plans of intervention (Figure 3).

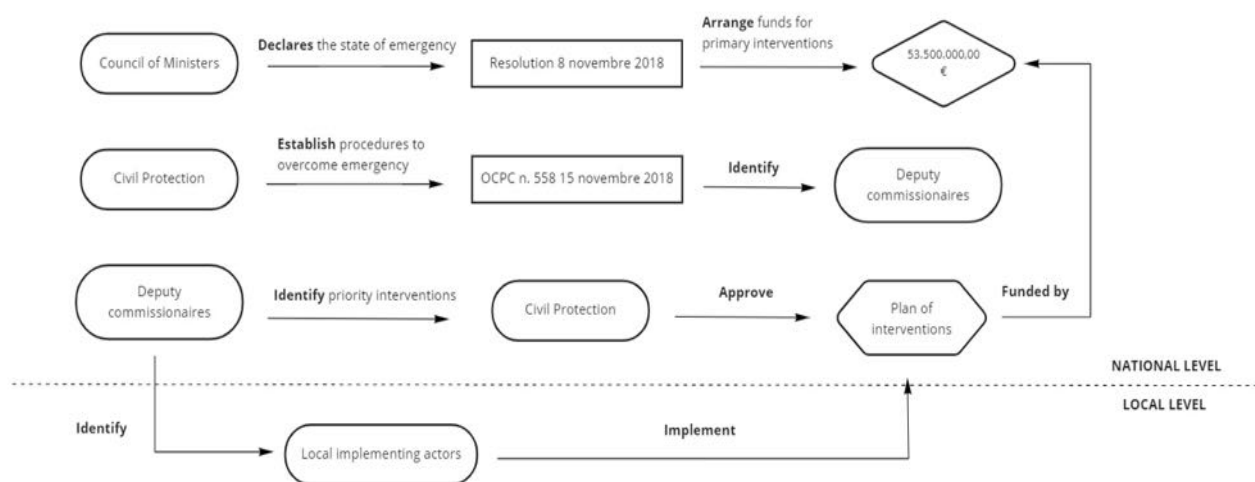


Figure 3 – Governance processes at national and local level during the response phase

The uniformity of governance response in the first phase of the emergency can be explained by the fact that the Civil Protection, which led most of the activities, has a complex but common

emergency management framework at national level. On the contrary, the governance processes during the recovery and the preparedness phases have been different for the four selected administrative locations due to the passage of power to regional and local authorities. Friuli-Venezia Giulia Region and the Autonomous Province of Bolzano have managed the two subsequent phases by establishing *ad-hoc* governance structures that coordinated all the interventions related to the emergency, including the implementation of new regulations and the management of funds. Veneto Region and the Autonomous Province of Trento instead relied on their existing regional and provincial structures empowering local implementing actors to implement recovery interventions. Additionally, we found that Regions chose different priorities on recovery interventions: while Veneto and Friuli-Venezia Giulia Regions dedicated more efforts and funds to infrastructure recovery, the two Autonomous Provinces committed more to recovering forest territories hardly damaged by the windstorm.

The results of this Task will serve as the basis for the project Deliverable D4.2 *“Integrated and systemic management of forest SES wind-related risks: preliminary policy and governance solutions for resistance and resilience in the targeted area”*, a technical report that will be targeted mainly to policy makers and practitioners. Moreover, the output will be valorised by means of scientific papers. In particular, one paper is under development, but the abstract has been accepted for the “International Mountain Conference 2022 – September 2022, Innsbruck, Austria” under the session “Adaptation strategies and pathways for resilience in mountain regions”.

Examples of results from Task 4.2 - Preliminary test of forest risk assessment in relation to key ecosystem services in the pilot location

The identification of potential vulnerabilities of forest ES to wind disturbances, and of related value change, allows us to formulate more appropriate risk management strategies for forest SES. In particular, the change in the monetary value of forest ES due to the impact of the windstorm is a signal to understand the magnitude of the event. The results at the provincial level (Belluno province) shows, as expected, a significant increase of the value of timber production pre- and post-Vaia and a substantial stability of the value of tourism. Among the cultural services, the value of truffle picking slightly increased after Vaia while the value of mushroom picking almost doubled with respect to the value before Vaia. However, this latter result is likely to be affected also by the changes in the use of natural environments such as forests during and after the Covid-19 pandemic. With respect to the regulation services, we have estimated the economic value for rockfall protection and avalanches protection through the replacement cost method. Replacement cost method is based on the principle that the value of an ES can be estimated considering the cost of replacing that service with a technology that acts as a substitute (Dixon et al., 1997). At local level we attempt to estimate the economic value of ES for the municipality of Rocca Pietore, one of the most damaged locations in the Veneto region. Using municipal revenues data, we estimated monetary values for selected ES before and after Vaia. We noticed, among other results, that while the mean revenues from wood sales increased significantly from ca. 23,200.00 to 226,000.00 € respectively before and after Vaia, the mean revenues from mushroom licence selling (a proxy for the forest recreational value driven by mushroom picking) decreased from 600.00 to ca. 430.00 € respectively before and after Vaia.

In line with the finding at provincial level, the increase in wood availability led to a major jump in the revenues from wood selling (Figure 4). On the contrary, cultural services registered a slightly decrease in the mean revenues from tourism and mushroom licences (Figure 5), probably due to the lower accessibility to forest locations in the first period after Vaia.

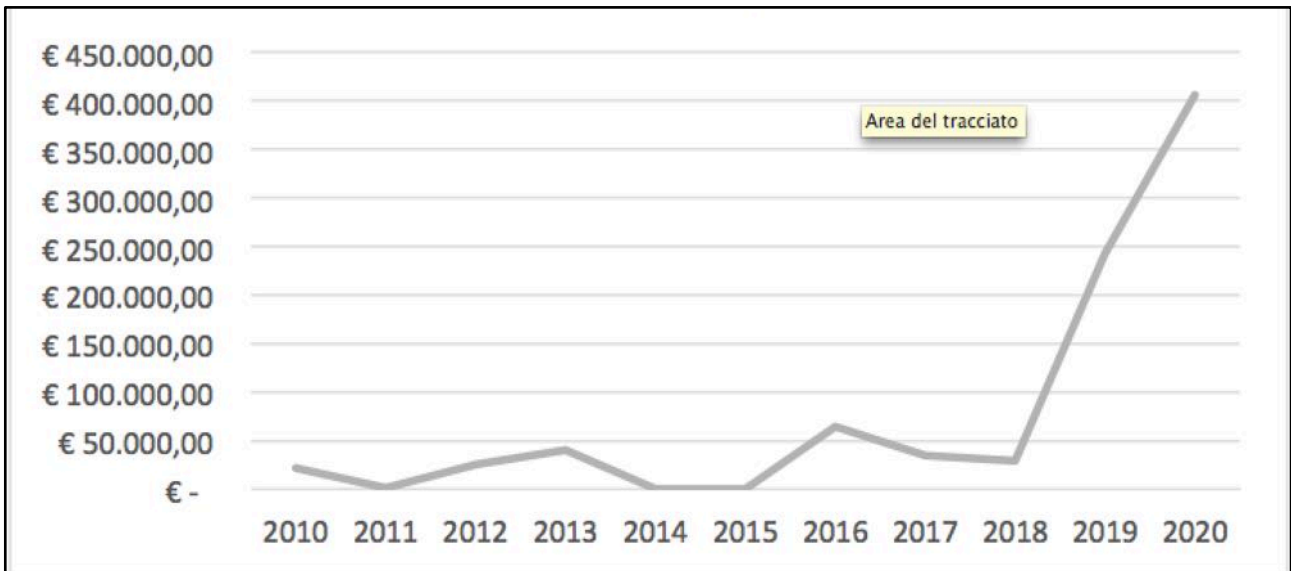


Figure 4 - Revenues from timber in the municipality of Rocca Pietore
(source: own elaboration on Rocca Pietore municipality's data)

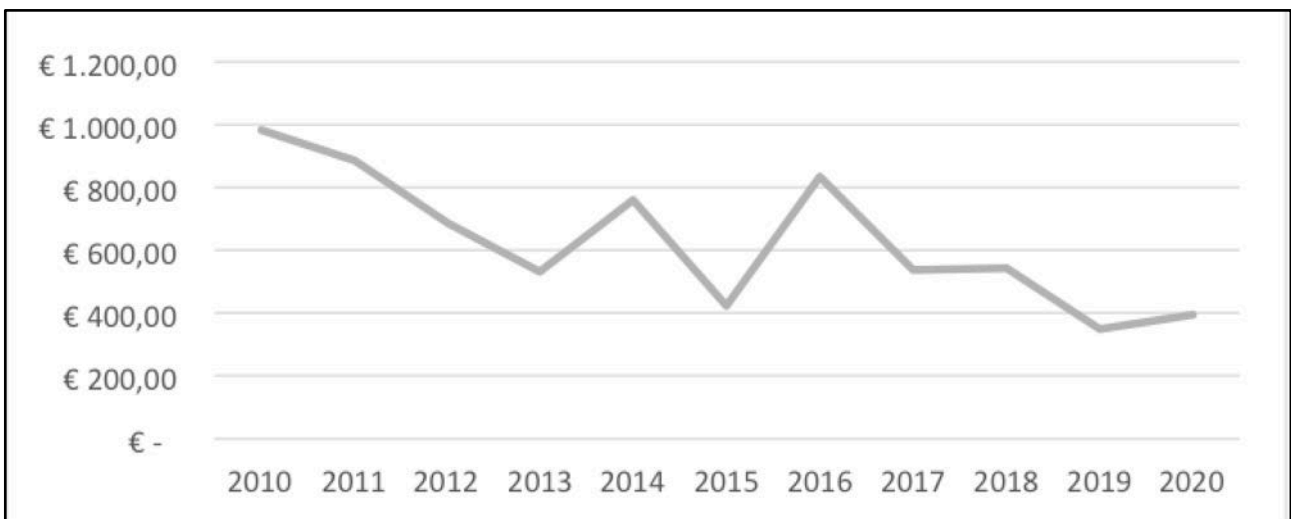


Figure 5 - Revenues from mushroom licence selling in the municipality of Rocca Pietore
(source: own elaboration on Rocca Pietore municipality's data)

Examples of results from Task 4.4 - Proposing a preliminary approach for integrated and systemic management of forest SES risk in the target region

To correctly identify a framework to manage forest SES risk in the target area is crucial firstly identify main source of risks, risk perceptions and attitudes of local population and key stakeholders. This preliminary step allows include local needs and populations and stakeholders'

preferences in a risk management framework. Concerning CAWI interviews to stakeholders, we have collected 68 interviews from a sample of ca. 480 stakeholders. We have a quite good survey participation for what concern Trentino (36.8%) and Veneto (32.4%), while Friuli (25.0%) and Alto Adige (4.4%) were less responsive. In relation to the sectors' responsiveness, we found that private and third sectors have been quite responsive (39,7% each), followed by local institutions (19.1%) and only a very few touristic sectors operators (1.5%). The data collected explored several aspects in relation to post- windstorm management, personal attitudes and perceptions concerning territorial changes and risk awareness. As an example, we can state that results on perceptions regarding the importance of forest ES at community level are very similar for both citizens and stakeholders. In both cases, the most relevant ES is "ensuring a nice landscape" (for citizens 4.68 and for stakeholders 4.40 on a scale from 1 = not important to 5 = extremely important), followed by "landslides and avalanche protection" (for citizens 4.54 and for stakeholders 4.21) and biodiversity conservation/wood production (which got 4.53/4.53 for citizens and 4.18/4.04 for stakeholders). Therefore, there is a strong concordance between community representatives (the general public, i.e. the citizens, and the key stakeholders, i.e. the interested groups, some of which experts of forest-related issues) in relation to the importance of ES at the community level.

With stakeholders, we have further investigated how much the provisioning of ES as changed after Vaia windstorm with respect to before (Figure 6).

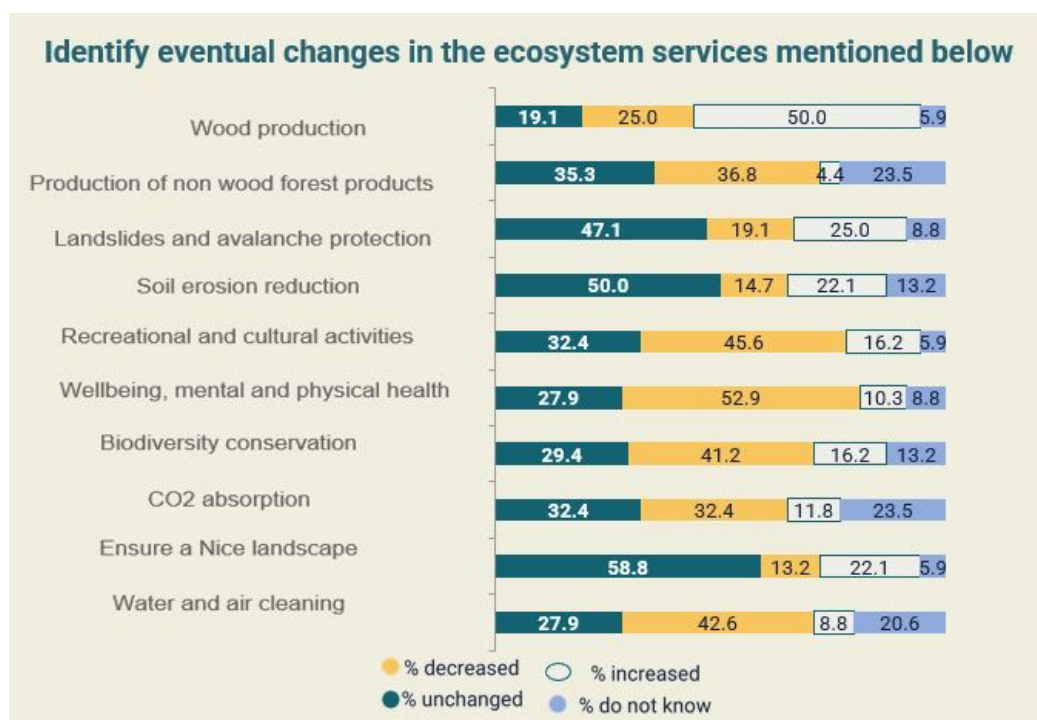


Figure 6 – Stakeholders' perception regarding changes to the provisioning of different ES (source: SDVMarketing, 2022 – mod.)

It is interesting to notice how the general perception is that the supplying of cultural and recreational services has strongly decreased, except for the provision of a nice landscape that

remained unvaried. As expected, wood production increased, while some key regulating services affected by the storm are actually perceived as unchanged (e.g. reduction of soil erosion and landslide and avalanche protection). In general terms, it is worth to notice also that there is a strong agreement if we examine the results focusing on the different geographical territories: regardless the region or municipality of residence, citizens and stakeholders assigned (almost) the same level of importance (and therefore the same ranking) to the same ES. If we focus on the single ES, we observe that values given by the citizens are averagely higher than the values given by the stakeholders. Nonetheless, all the ES presented are considered very important (values higher than 4 in a scale from 1 to 5), with one exception (production of non-wood forest products) that is considered relatively important (from 3 to 4 in the same scale).

Concerning preferences for post windstorms territorial management (Figure 7), the common perception of citizens regarding possible future strategies for forest management is that forest should be restored (e.g., planting young trees) and that carefully managed in a way that increase their resilience and resistance to future extreme weather events. Stakeholders expressed very similar positions, even if with less preferences. It is also valued extremely important increase information and divulgation of environmental issues in school and media to increase community awareness regarding the importance of forests. Similarly, both samples agree that Vaia has highlighted the vulnerability of forests and that is needed an active engagement of the community to improve their management and protection in future.

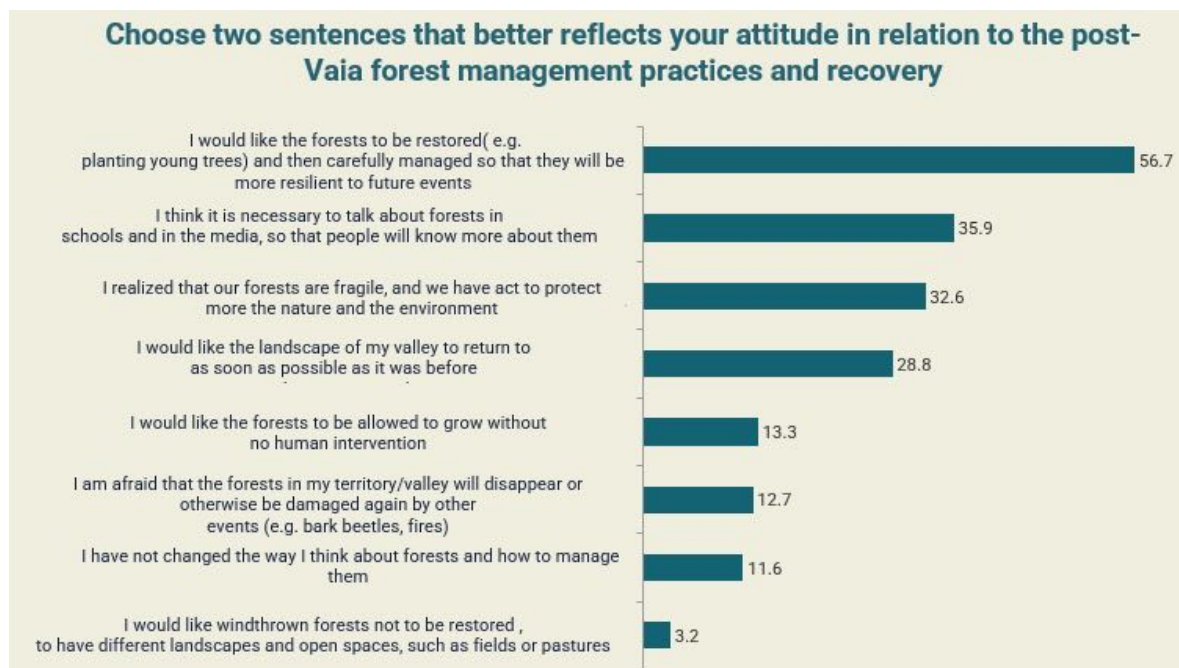


Figure 7 – Citizens’ perception regarding future strategies for forest management in the target area hit by Vaia (source: SDVMarketing, 2022 – mod.)

4. WP4 outputs

The outputs associated to WP4 activities so far are listed hereafter, following an inverse chronological order:

1. Abstract accepted at the International Mountain Conference 2022 (Innsbruck, September 2022)
Section: Adaptation strategies and pathways for resilience in mountain regions. *Analyzing institutional response strategies to Vaia windstorm in Italian Alpine region: lessons learnt and steps forward in natural disaster management* – Authors: Romagnoli, Santini, Masiero, Secco.
2. Romagnoli, F., Masiero, M., Secco, L. (2022). Windstorm Impacts on Forest-Related Socio-Ecological Systems: An Analysis from a Socio-Economic and Institutional Perspective, *Forests*, 13(6), 939;
<https://doi.org/10.3390/f13060939>
3. Donà, F. (2022). *Socio-economic local effects of extreme windstorms in Europe: the case of Vaia, in Italy*. MSc thesis in Local Development, Dept. DISSGEA and TESAF, University of Padova. Academic Year 2020-2021. Supervisor: prof. L. Secco; co-supervisor: F. Romagnoli. Completed: 30.06.2022; to be discussed: 14.07.2022.
4. Secco, Pettenella (2022). Vaia. Capitolo divulgativo sulla resilienza delle comunità rurali post-eventi climatici estremi nel libro fotografico "After/Dopo" sulla tempesta Vaia, edito da ArteSella (TN).
5. Presentazione orale: Angelini, Da Re, Romagnoli (2022) – "Quale futuro per la montagna bellunese?" in "Aree Fragili 2022" - Sessione organizzata "Foreste mentori" (Secco)
6. Masiero, Pettenella, Secco, Romagnoli – "Dealing with extreme events and forest management: can Universities have a role? The case of Vaia storm in Italy. In: Schmidt, P., Lewark, S., Weber, N., (eds). Proceedings of the SILVANetwork annual conference: Twenty years after the Bologna Declaration – challenges for higher forestry education. Dresden (Germany), 19-21 June 2019:
7. Pettenella D., M.Marchetti, R.Motta, G.Vacchiano (2021). Neanche Vaia resiste all'insostenibile leggerezza delle statistiche forestali. *Forest@ - Rivista di Selvicoltura ed Ecologia Forestale*, 2021, Volume 18, p.1 <https://doi.org/10.3832/efor3733-017>
8. Secco L. (2021), How social innovation contributes to just transitions to carbon neutrality: example from Italy - invited speaker and co-organizer at the COP26 Glasgow (10.11.2021) (Green Zone Event, The James Hutton Institute, UK);
9. Pra A., D.Pettenella (2020). La lezione di Vaia. *Montagne360* (7), 14-17
10. Pettenella D. (2020). I cambiamenti nella comunicazione sulle foreste: contenuti informativi e ruoli dei mass media. In: V.Ferrario e M.Marzo, *La montagna che produce / Productive mountains*, a cura di Mimesis Edizioni, Sesto San Giovanni (MI) , p.53-68. ISBN: 9788857573564.
11. Angelini A., D.Cason, D.Pettenella (2020). Una gestione attiva e consapevole dopo Vaia? *Ecoscienza 2000* (4), p. 50-51 https://www.arpae.it/dettaglio_documento.asp?id=8031&idlivello=1177
12. Romagnoli F. et al. (2020). *An eye on the Vaia storm: investigating windstorm impacts*. *EFI News*, September 28, 2020. https://medforest.net/2020/09/28/an-eye-on-the-vaia-storm-investigating-windstorm-impacts/?utm_campaign=campaign_code&utm_content=category&utm_medium=email&utm_source=efi_newsletter
13. Four oral presentations + one organized session in various public events: 9th AIEAA Conference "Mediterranean agriculture facing climate change: Challenges and policies", 10-12/06/2020

(Romagnoli F. et al.); Fiera&Festival delle Foreste, Longarone, BL – 12/09/2020 (MasieroM. et al.); Aree fragili Rovigo 2020 conference, Rovigo - 24/10/2020 Reazioni sociali al cambiamenti climatici in aree fragili (Secco L., D.Pettenella et al.)

Apart from the two technical reports (Deliverables D4.1 and D4.2) that will be developed in Italian, targeted to the national and local practitioners and policy makers and presented at the public event scheduled on the 28th of October 2022, WP4 planned outputs include the following papers, to be published in the next 18 months (i.e., by the end of 2023):

paper 1:

Secco, Santini, Romagnoli, Masiero, Pagot, Pettenella - "Forest governance and risk management: the case of Vaia wind storm in the North-East of Italy"; possibili riviste: *Forest Policy and Economics, Environmental Policy and Governance Journal?*

paper 2:

Santini, Masiero, Costa - "Extreme events and the loss of ecosystem services: the case of windstorm in north-eastern Italy" (Bozza); possibili riviste: *Forests, Forest Policy and Economics, Ecosystem Services?*

paper 3:

Vecchiato, Tempesta - "Valuing the landscape benefits of different reforestation options after catastrophic events: the case study of the VAIA wind storm in Italy" (bozza); possibili riviste: *Forest Policy & Economics, Forests, Journal of Environmental Management?*

paper 4:

Masiero, Santini, Secco, Pettenella - "Assessing windstorm direct and indirect economic impacts via an ecosystem-service-based approach: an application to selected provisioning and regulating services after Vaia windstorm (Italy)"; possibili riviste: *Forest policy and Economics, Forests*

paper 5: Romagnoli, Santini, Masiero, Secco - "Analyzing institutional response strategies to Vaia windstorm in Italian Alpine region: lessons learnt and steps forward in natural disaster management"; rivista target: *Forest Policy and Economics, Environmental Policy and Governance Journal?*

Finally, two abstract have been submitted to the EURAC conference EURAC 03-04.10.2022 *Global Mountain Sustainability Forum*:

1. Session: Resilience-building and adaptation strategies in mountain regions. Title of the abstract: *"Comparative analysis of post-windstorm mountain community resilience: comparison among four Italian regions"*; authors: Romagnoli, Santini, Masiero and Secco (results of the abstract evaluation are not yet available).
2. Session: Managing environmental challenges in mountain areas. Title of the abstract: *Addressing the vulnerability of forest ecosystem services to windstorm events: a case study in the Italian Alps*. Authors: Santini, Costa, Lingua, Masiero, Secco, Romagnoli, Vecchiato