ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

133000259 - Forest Resilience

DEGREE PROGRAMME

13AD - Master Universitario En Ingenieria De Montes

ACADEMIC YEAR & SEMESTER

2025/26 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	133000259 - Forest Resilience
No of credits	6 ECTS
Type	Optional/elective
Academic year ot the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	13AD - Master Universitario en Ingenieria de Montes
Centre	13 - E.T.S.I. Montes, Forestal Y Medio Natur.
Academic year	2025-26

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
M Pilar Pita Andreu (Subject coordinator)		pilar.pita@upm.es	- -
Roberto Luis Salomon Moreno		roberto.salomon@upm.es	Sin horario.
Jesus Rodriguez Calcerrada		jesus.rcalcerrada@upm.es	Sin horario.
Juan Antonio Martin Garcia		juan.martin.garcia@upm.es	Sin horario.

Rosa Ana Lopez Rodriguez		rosana.lopez@upm.es	Sin horario.
Martin David Venturas		martin.venturas@upm.es	Sin horario.
Jose Carlos Miranda Garcia-Roves		jc.miranda@upm.es	Sin horario.

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Skills and learning outcomes *

3.1. Skills to be learned

CB06 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o apl0icación de ideas, a menudo en un contexto de investigación

CB09 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CE 6.2 - Conocimientos y habilidades para la mejora ambiental del medio

CT04 - Capacidad crítica para el análisis, la síntesis y el aprendizaje mediante el intercambio de opiniones, presentando argumentos sólidos y estructurados

CT06 - Búsqueda bibliográfica, análisis de documentación y tratamiento de la información procedente de diversas fuentes y de su análisis y síntesis aplicándola a la resolución de problemas complejos

CT07 - Perfeccionar el conocimiento oral y escrito de la lengua inglesa

3.2. Learning outcomes

RA134 - Capacidad para realizar búsquedas bibliográficas, consultar y utilizar con criterio bases de datos y otras fuentes de información, para llevar a cabo simulaciones con el objetivo de realizar investigaciones sobre temas complejos de su especialidad

RA156 - Analizar el efecto del incremento de CO2 atmosférico y los fenómenos meteorológicos extremos en especies arbóreasl

RA155 - Valorar el efecto de las principales enfermedades y plagas que afectan a árboles forestales en el contexto del cambio global

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

This course offers a chance to gain a better understanding on how trees respond to several kinds of stress, both biotic (pathogens and pests) and abiotic (mainly those related to climate change: global warming, heat waves, drought, increased carbon dioxide in the atmosphere). Special attention will be given to ageing and regeneration, two key processes in forest dynamics and forest resilience.
The course will combine lectures given by specialists in their fields with laboratory practices, field trips and collaborative sessions, where recently published results on different topics will be discussed. Specific goals for this course are: Offer up-to-date information on tree and forest responses to Global Change, develop ecological indicators to assess the resilience of forest systems, integrate resilience into sustainable forest management, identify biotic threats to forests and management measures to increase resilience.

4.2. Syllabus

1. Introduction to Forest Resilience
2. CO2 exchange between forest ecosystems and the atmosphere
   2.1. Tree Physiological responses to increased atmospheric CO2
   2.2. CO2 effects on stress tolerance
3. Tree responses to climate change and extreme meteorological events
   3.1. Water deficit
   3.2. Global Warming and Heat Waves
   3.3. Using tree ring analysis to investigate the impact of climate change on trees
   3.4. Modelling forest responses to climate change
4. The effects of ageing on tree responses to stress
5. Forest resilience to pathogens and pests in the context of global change
6. Case studies: Management of Tablas de Daimiel National Park for improving its resilience to climate change
7. Case studies: Adaptations to vulcanism in the Canary Island pine
8. Resprouting and coppice stands
9. Forest dynamics. Main threats to natural regeneration

5. Schedule

5.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**Lecture: Introduction to Forest Resilience** Duration: 01:30 Lecture			
2	**.CO2 exchange between forest ecosystems and the atmosphere** Duration: 03:30 Lecture **Lab practice** Duration: 01:00 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
3	**.CO2 exchange between forest ecosystems and the atmosphere** Duration: 03:30 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
4	**Tree responses to climate change and extreme meteorological events** Duration: 03:30 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
5	**Tree responses to climate change and extreme meteorological events** Duration: 03:30 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
6	**Tree responses to climate change and extreme meteorological events** Duration: 02:00 Lecture **The effects of ageing on tree responses to stress** Duration: 01:30 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00

7	**Forest resilience to pathogens and pests in the context of global change** Duration: 03:00 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
8	**Fiel trip** Duration: 04:00 Practice field trip			
9	**Management of Tablas de Daimiel National Park for improving its resilience to climate change** Duration: 02:00 Lecture **Adaptations to vulcanism in the Canary Island pine** Duration: 02:00 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
10	**Resprouting and coppice stands** Duration: 01:30 Lecture **Modelling forest responses responses to climate change** Duration: 01:30 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar** Written test Progressive assessment Presential Duration: 00:00
11	**. Forest dynamics. Main threats to natural regeneration** Duration: 01:30 Lecture **Modelling forest responses responses to climate change** Duration: 01:30 Lecture **Lab practice** Duration: 00:30 Laboratory assignments			**Short questions about the contents of each seminar : Average mark** Written test Progressive assessment Presential Duration: 00:00
12	**Field trip** Duration: 08:00 Practice field trip			**Questions about the field trip** Other assessment Progressive assessment Presential Duration: 00:00

13	**Lab practice** Duration: 02:00 Laboratory assignments			
14	**Lab practice** Duration: 02:00 Laboratory assignments			
15	**Presentations and debate** Duration: 04:00 Additional activities			**Presentations and debate** Individual presentation Progressive assessment Presential Duration: 00:00
16				
17				**Written test for those students who failed progressive examination** Written test Global examination Not Presential Duration: 01:15

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
3	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
4	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
5	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
6	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
7	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
9	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
10	Short questions about the contents of each seminar	Written test	Face-to-face	00:00	%	5 / 10	CT07 CE 6.2 CB10
11	Short questions about the contents of each seminar : Average mark	Written test	Face-to-face	00:00	60%	5 / 10	CE 6.2 CB10 CT07
12	Questions about the field trip	Other assessment	Face-to-face	00:00	20%	5 / 10	CE 6.2 CB06 CB10 CT04 CT07 CB09

15	Presentations and debate	Individual presentation	Face-to-face	00:00	20%	5 / 10	CB06 CT04 CT07 CT06 CB09

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Written test for those students who failed progressive examination	Written test	No Presential	01:15	100%	5 / 10	CB10 CT04 CT07 CT06 CB09 CE 6.2 CB06

6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

6.2. Assessment criteria

Continuous assessment:

At the end of each seminar, the students will have to answer a **questionnaire about the contents of the seminar**. Attendance to at least 70% of the seminars will be mandatory. This evaluation activity will account for **60%** of the mark obtained by continuous assessment.

The students will have to carry a **debate and/or oral presentation** about some topics related to the contents of the course. This activity will have a weight of **20% i**n the mark obtained by continuous assessment. The following items will be considered to evaluate this activity: The soundness of the scientific evidences that support the argumentation, oral expression, clarity and originality in data presentation.

The students will have to attend to a **field trip** to the beech forest at Montejo de la Sierra and discuss/answer some questions regarding the contents of the trip This activity will have a weight of **20%** in the mark obtained by continuous assessment.

Final Exam (Ordinary): Students who failed the continuous assessment or wish to improve the mark obtained by continuous assessment will take a written exam about the contents of the course (May-June).

Final Exam (Extraordinary): Students who failed the continuous assessment and the final exam will take a written exam about the contents of the course in July.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Technological equipment for measuring physiological parameters	Equipment	Equipment necessary for measuring stomatal conductance and chlorophyll fluorescence
Chen et al (2015). Roles of Climate, Vegetation and Soil in Regulating the Spatial Variations in Ecosystem Carbon Dioxide Fluxes in the Northern Hemisphere. PLoS ONE 10(4): e0125265. doi:10.1371/journal. pone.0125265	Bibliography	
Choat et al. 2018. Triggers of tree mortality under drought. Nature 558 (7711), 531	Bibliography	
Gill, R. M. A. (1992). A review of damage by mammals in north temperate forests: Impact on trees and forests. Forestry: An International Journal of Forest Research, 65(4), 363-388.	Bibliography	
Jiang et al. (2020) The fate of carbon in a mature forest under carbon dioxide enrichment. Nature 580: 227-231	Bibliography	

Leakeey et al. (2009).Elevated CO2 effects on plant carbon, nitrogen, and water relations: six important lessons from FACE . Journal of Experimental Botany, Vol. 60, No. 10, pp. 2859?2876	Bibliography	
Morellet, N., Gaillard, J. M., Hewison, A. M., Ballon, P., Boscardin, Y. V. E. S., et al. (2007). Indicators of ecological change: new tools for managing populations of large herbivores. Journal of Applied Ecology, 44(3), 634-643.	Bibliography	
Keeling et al (2017). Atmospheric evidence for a global secular increase in carbon isotopic discrimination of land photosynthesis. Proceedings of the National Academy of Sciences. 114. 201619240. 10.1073/pnas.1619240114	Bibliography	
Teskey R, et al 2015. Responses of tree species to heat waves and extreme heat events. Plant, Cell and Environment 38, 1699?1712	Bibliography	
Schuldt B, et al 2020. A first assessment of the impact of the extreme 2018 summer drought on Central European forests. Basic and Applied Ecology 45, 86-103	Bibliography	
Zhao DF, et al (2017) Environmental conditions regulate the impact of plants on cloud formation. Nature Communications. 8:14067 | DOI: 10.1038/ncomms14067	Bibliography	

8. Other information

8.1. Other information about the subject

Different seminars will be given by experts on the subject and illustrated with updated results from our Research Group and other authors, published in recognized scientific journals.

This course is connected with the Sustainable Development Goals established by UN, more specifically with Goal 13 'Climate action' and Goal 15 'Life on Land' through the analysis of CO2 effects on plants and the resilience of forest species to both biotic and abiotic stress

The skills to be learned have been defined in accordance to the document "Memoria de Verificación"