Ecosystem monitoring and adaptive management under climate change scenarios

Blended International course founded by ERASMUS+ KA131 - (BIP program)

Year 2024

Virtual component scheduled from March 15th to May 24th and mobility week in Italy from June 3rd to 7th

Partnership: teachers and students

University of **Valladolid** (SPAIN)

University **Complutense** of Madrid (SPAIN)

University of **Orlean** (FRANCE)

University of **Nitra** (SLOVAK REPUBLIC)

University of **Molise** (ITALY)

COURSE SYLLABUS

Aims and brief description

Adaptive management entails a solid understanding of ecosystems and their dynamics. Therefore, having standardized monitoring protocols is essential. Periodic standardized observations support a thorough understanding of ecosystem diversity and functioning, as well as the factors shaping them. Thus updated standardized monitoring are pivotal for adequate ecosystem modeling under different scenarios of global change.

In this course, students will learn the fundamentals of ecosystem monitoring and acquire specific methodological approaches and tools that focus on various ecological facets, including soils, wildlife, forest diversity, and habitats, both in natural and altered conditions. Moreover, students will learn the fundamentals of monitoring data analysis and modeling, with particular attention to information and tools supporting adaptive management

Meeting Time

Lectures (virtual): Friday 10:00 to 13:00 (see schedule below)
Mobility (Italy): all day (see schedule below)

Instructors

- Prof. Maria Laura Carranza (carranza@unimol.it); Anna Loy (a.loy@unimol.it); Michele Innangi (michele.innangi@unimol.it); Mirko Di Febbraro (mirko.difebbraro@unimol.it); Claudio Colombo (colombo@unimol.it); Erica Di Iorio (erika.diiorio@unimol.it) University of Molise
- Prof Celia Herrero de Aza (celia.herrero.aza@uva.es); Irene Ruano Benito (irene.ruano@uva.es), Universidad de Valladolid, Spain
- Prof. Domenico Morabito, Univeristy of Orleans, France (domenico.morabito@univ-orleans.fr)
- Prof. Peter Massányi, Univeristy of Nitra, Slovakia (peter.massanyi@uniag.sk)
- Prof. Rafael Barrientos Yuste, Complutense Univeristy of Madrid, Spain (rafabarr@ucm.es)

Description

This programme provides students with basic knowledge and practical activities on Ecosystem monitoring and adaptive management under climate change scenarios, emphasizing the following major topics:

- Ecosystem monitoring and adaptive management
- Global change ecology – main drivers of global change
- Forest monitoring modelling and management
- Soil monitoring modelling and management
- wildlife monitoring, threats assessment and global change
- Habitats monitoring modelling and management
- Global change, pollution reclamation and human health
- Data Science of Environment and Natural Resources
- Analysis of environmental data and modelling

Format

The BIP course comprises 24 hours of online lectures (synchronous) and 32 hours of in-person field and lab work for a total of **7 ECTS** (European Credit Transfer and Accumulation System). The applied component will take place during the mobility week in Italy.

Evaluation

Based on assignments and presence week activities project

Course structure and topics

Lectures

Date	Topics	Instructor	Assignment
March 15 (9:00 to 13:00)	**Title**: Course Presentation. Topics to be covered during online lessons and practical activities to be implemented throughout the mobility week. **Arguments**: Global change ecology a new discipline: principles, and key concepts. Research Approaches and tools for analyzing and modelling the Ecology of Global Change. Organization levels of life and global change effects. The importance of standardized ecosystem monitoring in identifying adaptive strategies to address global change. The Anthropocene – sustainability and USG Sustainability Goals: origin, impacts of Contemporary Human Civilizations on ecosystems (e.g. land use change, Pollution of air, water and soils). Effects on climate change on emerging risks for food and feed safety. Climate crisis and soils.	Maria Laura Carranza, (University of Molise)	questionary

	Interaction between Anthropogenic Stressors. Vulnerability to Global Change. Ecosystems response (Feedback, Collapse, Resilience) Elements of Adaptive Management. Climate Mitigation. Some study cases and instruments for monitoring (in situ and using remote sensing) the effects of global change and of restoration actions on ecosystems Suggested reading - Rosenblum, E. B. (2020) Global Change Biology. The Study of Life on a Rapidly Changing Planet. Oxford University Press. USA - Soil and Climate change https://www.eea.europa.eu/signals-archived/signals-2019-content-list/articles/soil-land-and-climate-change - EFSA (European Food Safety Authority), Maggiore A, Afonso A, Barrucci F, De Sanctis G, 2020. Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality. EFSA supporting publication https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2020.EN-1881		
March 22 (9:00 to 13:00)	**Title**: Wildlife vulnerability to climate change **Arguments:** Assessing species' vulnerability to climate change is a prerequisite for developing effective strategies to conserve them. The module will provide the fundamentals for assessing the climate change vulnerability of wildlife (CCVA), describing key concepts, terms, steps and considerations. The module will also describe how CCVAs can be used to inform IUCN Red List assessments of extinction risk. It will also include case studies from the literature and from our research team. Suggested reading - Foden, W.B. and Young, B.E. (eds.) (2016). IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change. Version 1.0. Occasional Paper of the IUCN Species Survival Commission No. 59. Cambridge, UK and Gland, Switzerland: IUCN Species Survival Commission. x+114pp. (https://portals.iucn.org/library/sites/library/files/documents/SSC-OP-059.pdf)	Anna Loy, (University of Molise)	Technical datasheet interpretation and comments
April 5 (9:00 to 13:00)	**Title**: The impact of land use change and new human infrastructures on wildlife: the importance of knowing the actual mortality. **Arguments**: The natural habitats encroachment by humans is experiencing unprecedented levels. One of the main impacts is the mortality that human infrastructures (mainly roads, railways, power lines or wind farms) cause on wildlife. Knowing the actual mortality without falling into biases and how it can affect the survival of impacted populations is an essential objective in monitoring ecosystems under global change. Suggested reading - Barrientos R, Martins RC, Ascensão F, D'Amico M, Moreira F, Borda-de-Água L (2018) A review of searcher efficiency and carcass persistency in infrastructure-driven mortality assessment studies. Biological Conservation 222: 146-153. - Borda-de-Água L, Barrientos R, Beja P, Pereira HM (2017) Railway Ecology. Springer. 320 pp. (https://link.springer.com/book/10.1007/978-3-319-57496-7) - van der Ree, R., Smith, D.J., Grilo, C. (Eds.), 2015. Handbook of Road Ecology. John Wiley and Sons, Hoboken https://transportecology.info/ https://www.iene.info/	Rafael Barrientos Yuste, Univeristy Complutense of Madrid	report on the topic in depth
April 12	**Title**: Dead wood inventory and monitoring for ecosystems management **Arguments**:	Celia Herrero Aza	report on the topic in depth

(9:00 to 13:00)	Dead wood is an important component of forest ecosystems with several crucial ecological functions, like carbon sequestration or contribution to energy flow and nutrient cycles s well as to provide habitat for a large proportion of forest species. As the importance of dead wood for biodiversity has become widely acknowledged several international schemes for Sustainable Forest Management (MCPFE in Europe, CIFOR in tropical forests) have included ''dead wood'' as indicators of biodiversity. Measures of dead wood are often incorporated in studies and protocols that monitor the health and biodiversity of forests, including national forest inventories, such as those of Canada or USA. The sampling design and estimation procedures have important consequences for the precision and accuracy of the estimators and for the effort required. In this module we will teach and train new researchers to implement a standardized sampling approach that assures a comparable knowledge on quantitative and qualitative patterns of dead wood in forests. Standardized updated data on dead wood is essential for ecosystem adaptive management at local, regional and global sale. Furthermore, a particular attention will be given to the variety of factors influencing the amount of dead wood such as climate, site productivity, tree species composition, disturbance regime (natural and/ or anthropogenic), time since last disturbance, characteristics of the previous cohort of trees, current forest management strategy and successional stage. Suggested reading: - Brin et al., 2008. Changes in quantitative patterns of dead wood in maritime pine plantations over time. Forest Ecology and Management, 256: 913-921, 10.1016/j.foreco.2008.05.042 - Herrero, C., Monleon, V.J., Gómez, N., Bravo, F. 2016. Distribution of dead wood volume and mass in mediterranean Fagus sylvatica L. forests in Northern Iberian Peninsula. Implications for field sampling inventory. Forest Systems 25 (3), e069-e081. DOI: http://dx.doi.org/10.5424/fs/2016252-09009.	(University of Valladolid)	
April 19 (9:00 to 13:00)	**Title:** Monitoring forest ecosystems for adaptive management in response to Global Change **Argument:** In this training session, we will explore ecosystem management in response to global change, highlighting the crucial role of data in effective decision-making. The field of forest science relies heavily on a wealth of data to draw accurate conclusions. Our session will explore the types of data required, strategies for obtaining personal data, and the availability of open data options. The format includes a practical exercise during the online class, linking to the on-site activities planned for the June week. The objective is to underscore the crucial link between sound management practices and robust data support within the context of global change. Suggested reading: - Kershaw, J.A, Ducey, M.J., Beers, T.W., Husch, B. 2016 Forest Mensuration, 5th Ed. Wiley - Duvemo, K., & Lämås, T. (2006). The influence of forest data quality on planning processes in forestry. Scandinavian Journal of Forest Research, 21(4), 327-339. https://forestexplorer.gsic.uva.es/es/index.html https://educawood.gsic.uva.es/	Irene Ruano Benito (University of Valladolid)	Report on the topic in depth
April 26	**Title**: Climate change and food and feed safety – Exploring the effects of environmental factors change on livestock reproduction.	Peter Massányi	report on the topic in depth

(9:00 to 13:00)	**Arguments**: Food chain of humans, historical issues in food intake, pollution of environment, contamination by medicines (e.g. hormones, antibiotics, painkillers) and poisons (e.g. herbicides, insecticides, anti-fungal), their transfer in environment, transfer to the food chain, foodstuffs of plant and animal origin, risks of contamination of food and feed, accumulation of contaminants in tissues and organs of humans and animals, disruption of animal systems, control mechanisms of food chain contamination in European Union. Standardized monitoring and assessment of food and feed quality. Producing of healthy and safe foods in the Anthropocene. Assessment of the effects of global change on the analyze information about pollution of the environment related to the transfer of contaminants into the food chain. European legislation- monitoring standards of quality. Suggested reading - EFSA (European Food Safety Authority), Maggiore A, Afonso A, Barrucci F, De Sanctis G, 2020. Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality. EFSA supporting publication https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2020.EN-1881	(Univeristy of Nitra)	
May 3 (9:00 to 13:00)	**Title**: Soils and climate change **Arguments:** Climate change significantly influences soil, and alterations in land use and soil conditions can either amplify or mitigate the effects of climate change. Addressing the climate crisis, ensuring sufficient food production, and adapting to a changing climate are impossible without healthier soils and sustainable land and soil management. A potential solution could involve preserving and restoring crucial ecosystems, allowing nature to capture carbon from the atmosphere. Our session will explore the pivotal role of soil in natural ecosystems, focusing on carbon sequestration and water infiltration. Moreover, the session will examine the interplay between declining soil quality and climate change, specifically addressing issues such as soil erosion and land degradation. The session will also delve into insights on the role of soil biological communities in mitigating the effects of climate change. Particular attention will be given to soil monitoring protocols and modelling approaches Suggested reading - Rosenblum, E. B. (2020) Global Change Biology. The Study of Life on a Rapidly Changing Planet. Oxford University Press. USA - Soil and Climate change https://www.eea.europa.eu/signals-archived/signals-2019-content-list/articles/soil-land-and-climate-change	Claudio Colombo, Erika Di Iorio, Michele Innangi (University of Molise)	report on the topic in depth
May 17 (9:00 to 13:00)	**Title**: Management of polluted sites using phyto-remediation **Arguments**: The pollution of soil gathered research attention due to its negative environmental and health impact. Mining activities and the associated wastes contribute to a large extent to environmental pollution, in particular through the release of trace elements (TMEs). The use of amendments alone or in combination with plants is an effective solution for stabilizing TMEs and improving the agronomic quality of techno-soils, this technique is known as phytoremediation. Insofar as the aim is to produce recoverable biomass, we call it phyto-management. It consists in planting vegetation to help reduce the spread of pollutants to the water table or neighboring areas. In this goal, plant selection and amendment must be efficiently selected. This seminar will focus on the phyto-stabilization of	Domenico Morabito (Univeristy of Orleans)	report on the topic in depth

	metal(loid) contaminated soils, with a focus on Salicaceae as potential phyto-stabilizor and the effects of diverse amendments, organic and inorganic, on the different components of the soil-plant continuum, i.e. soil, metal(loid)s, microorganisms, and plant, especially the physiological response of the plant roots to amendments. To do this, we will study a specific case involving a site polluted by arsenic and lead and which has been rehabilitated by phyto-management. Five years after the implementation of a phyto-management strategy using biochar on a parcel of the former Pontgibaud mine site in France, we show the development of vegetation on this site which was previously devoid of vegetation. This approach by assisted phytoremediation is an efficient solution to limit the propagation of pollutants by wind and percolating water from mining technosols. In addition, the low accumulation of TMEs found in the aerial parts of the willows planted on the site and the diversity of microorganisms observed in the new soil formed suggest a refunctionalization process. Suggested reading - Heavy metal toxicity and tolerance in plants (2023), Wiley Editor, ISBN: 978-1-119-90646-9,		

Mobility week

Date	Topics	Instructor	Assignm.
June 3, 4, 5 Giardino della Flora Appenninica di Capracotta	Field work in Alto Molise Landscape and on the garden of the Apennine flora of Capracotta (Molise Region – Italy) https://www.giardinocapracotta.unimol.it/en/home-2/ Visit to Protected Areas. With overnight stay at the structures of the Apennine Flora Garden. **Putting ecosystem monitoring into action**. Implementation of standardized field monitoring approaches in the field. All the data collected in the field will then be analyzed in a dedicated lab. -Dead wood monitoring. Field measurement of dead wood as a base for monitoring forest ecosystem health and biodiversity. The collected data will be sued for estimating several forest features as health, biomass, biodiversity, all aspects that support their sustainable and adaptive management (Prof. Celia Herrero de Aza) - Tree inventory (identification and mapping) of the garden of the Apennine flora using a standardized approach implemented in the app EducaWood. This app allows to find trees and annotate them. Identify tree species, measure heights and diameters, set tree statuses, upload tree photos. -Monitoring the impact of land use change and new human infrastructures on wildlife. Specifically, students will learn by field experience to test searcher efficiency of dead wildlife and the other carcass persistence monitored by camera-traps (Prof Rafael Barrientos) - Soil monitoring. Soil profile sampling. Interpretation of a soil profile and classification. How to identify signs of soil erosion? Elements of soil fauna sampling, and functional groups. Soil biodiviersity and functioning (Prof Caludio Colombo, Erica Di Iorio, Michele Innangi) - Habitat monitoring following the Habitats directive protocol. Vegetation plots, for monitoring habitat diversity, structure and	Rafael Barrientos Yuste, Univeristy Complutense of Madrid; Prof Celia Herrero de Aza, Universidad de Valladolid; Prof Irene Ruano Irene Ruano Benito, Universidad de Valladolid; Prof. Domenico Morabito, Univeristy of Orleans; Prof. Peter Massányi, Univeristy of Nitra; Prof M Laura Carranza, Michele Innangi, Mirko Di Febbraro; Claudio Colombo, Erica Di Iorio, and lab EnviXLab (Univeristy of Molise)	Projects

	functional features (Prof M Laura Carranza, Michele Innangi, Dott Marco Varricchione). - elements of citizen science. The role of CS as a monitoring tool. Field data collection on iNaturalist platform (Prof M Laura Carranza, Michele Innangi, Dott Federica Pontieri). .		
June 6, 7 (Pesche)	**Hands on data analysis and modelling** on computer lab (Dep Biosciences and Territory) Pesche Software Rstudio Desktop (https://posit.co/download/rstudio-desktop/) EducaWood (https://educawood.gsic.uva.es/) QGis (https://www.qgis.org/it/site/forusers/download.html) Past https://www.nhm.uio.no/english/research/resources/past/ iNaturalsit (https://www.inaturalist.org/) JavaClimateModel (https://jcm.chooseclimate.org/)	Rafael Barrientos Yuste, Univeristy Complutense of Madrid; Prof Celia Herrero de Aza, Universidad de Valladolid; Prof Irene Ruano Irene Ruano Benito, Universidad de Valladolid; Prof. Domenico Morabito, Univeristy of Orleans; Prof. Peter Massányi, Univeristy of Nitra; Prof M Laura Carranza, Michele Innangi, Mirko Di Febbraro; Claudio Colombo, Erica Di Iorio, and lab EnviXLab (Univeristy of Molise)	Projects

Readings

March 15

- Rosenblum, E. B. (2020) Global Change Biology. The Study of Life on a Rapidly Changing Planet. Oxford University Press. USA
- Soil and Climate change https://www.eea.europa.eu/signals-archived/signals-2019-content-list/articles/soil-land-and-climate-change
- EFSA (European Food Safety Authority), Maggiore A, Afonso A, Barrucci F, De Sanctis G, 2020. Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality. EFSA supporting publication https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2020.EN-1881

March 22

- Foden, W.B. and Young, B.E. (eds.) (2016). IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change. Version 1.0. Occasional Paper of the IUCN Species Survival Commission No. 59. Cambridge, UK and Gland, Switzerland: IUCN Species Survival Commission. x+114pp. (https://portals.iucn.org/library/sites/library/files/documents/SSC-OP-059.pdf

April 5

- Barrientos R, Martins RC, Ascensão F, D'Amico M, Moreira F, Borda-de-Água L (2018) A review of searcher efficiency and carcass persistency in infrastructure-driven mortality assessment studies. Biological Conservation 222: 146-153.
- Borda-de-Água L, Barrientos R, Beja P, Pereira HM (2017) Railway Ecology. Springer. 320 pp. (https://link.springer.com/book/10.1007/978-3-319-57496-7)
- van der Ree, R., Smith, D.J., Grilo, C. (Eds.), 2015. Handbook of Road Ecology. John Wiley and Sons, Hoboken

https://transportecology.info/

https://www.iene.info/

April 12

- Brin et al., 2008. Changes in quantitative patterns of dead wood in maritime pine plantations over time. Forest Ecology and Management, 256: 913-921, 10.1016/j.foreco.2008.05.042
- Herrero, C., Monleon, V.J., Gómez, N., Bravo, F. 2016. Distribution of dead wood volume and mass in mediterranean Fagus sylvatica L. forests in Northern Iberian Peninsula. Implications for field sampling inventory. Forest Systems 25 (3), e069-e081. DOI: http://dx.doi.org/10.5424/fs/2016252-09009.

April 19

- Kershaw, J.A, Ducey, M.J., Beers, T.W., Husch, B. 2016 Forest Mensuration, 5th Ed. Wiley
- Duvemo, K., & Lämås, T. (2006). The influence of forest data quality on planning processes in forestry. Scandinavian Journal of Forest Research, 21(4), 327-339.

https://forestexplorer.gsic.uva.es/es/index.html
https://educawood.gsic.uva.es/

April 26

- EFSA (European Food Safety Authority), Maggiore A, Afonso A, Barrucci F, De Sanctis G, 2020. Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality. EFSA supporting publication https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2020.EN-1881

May 3

- Soil and Climate change https://www.eea.europa.eu/signals-archived/signals-2019-content-list/articles/soil-land-and-climate-change

May 17

- Heavy metal toxicity and tolerance in plants (2023), Wiley Editor, ISBN: 978-1-119-90646-9,