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Abstract	This deliverable reports about the activities of the international Science Schools of 2018 of the ECOPOTENTIAL project.
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Table of Contents

1. Executive summary 4
2. La Palma Science School 5
2.1. General description 5
2.2. Participation 5
2.3. Projects developed during the Science School 6
3. Gran Paradiso Summer School 7
3.1. General description 7
3.2. Participation 7
3.3. Projects developed during the Science School 9

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1. Executive summary

The present document is a deliverable of the ECOPOTENTIAL project, which is funded by the European Union's Horizon 2020 Programme under Grant Agreement #641762.

In this deliverable, we describe the ECOPOTENTIAL La Palma Science School 2018 'Application of Remote Sensing for Protected Areas and Biodiversity'. Furthermore, we report about the Gran Paradiso summer school 2018 'Critical Zone and Ecosystem Dynamics' organised and funded in cooperation by ECOPOTENTIAL and other scientific institutions.

The La Palma science school 2018 was held by the University of Bayreuth (UBT). The whole island of La Palma (Canary Islands, Spain) is protected and is one of the sites of interest of the project. The participants designed own studies and developed hypotheses as well as data sampling designs for a two-week field period. Following the time on La Palma, the students analysed their data and presented their results as both, a manuscript and a presentation. Five lecturers supervised the students during the school and in the post processing. During the school, several issues concerning the application of remote sensing to assess and monitor biodiversity as well as ecosystem functions and services have been touched. Studies focused on linking in-situ data with remote sensing data by analysing fire damage in La Palma's Canary Pine (*Pinus canariensis*) forest or by analysing leaf colouration along an elevational gradient.

The Gran Paradiso summer school was co-organised by CNR (Institute of Geosciences and Earth Resources and by the Institute of Atmospheric Sciences and Climate of the Italian National Research Council) and Pennsylvania State University (US), in collaboration with the Gran Paradiso National Park. The Gran Paradiso National Park is a protected area in the Italian Alps and a site of interest of the project. Doctoral students, post-docs and researchers who are working or intend to work on Critical Zone processes and ecosystem dynamics participated in the summer school. The participants gained a basic knowledge about the functioning of the Critical Zone and its relationships with ecosystem dynamics using in-situ data, laboratory analyses, remote sensing and numerical modelling. Field lectures, experimentation and excursions to study sites and Critical Zone observatories were conducted by a diverse array of lecturers. The participation of students and teachers from the US has been funded by the SAVI project of the US National Science Foundation (SAVI - NSF) and Pennsylvania University. Other research networks as LTER and the H2020 project CRESCENDO also endorsed the school.

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2. La Palma Science School

2.1. General description

The La Palma science school was held from March 6th to March 20th, 2018 by the University of Bayreuth (UBT). The whole island of La Palma (Canary Islands, Spain) is completely protected as a 'Man and the Biosphere' reserve, hosts a national park (Caldera de Taburiente) and several Natura 2000 sites. Moreover, it is one of the sites of interest of the project. The high-elevation island has very diverse climatic conditions and hosts large areas covered by natural Canary Pine forests and laurel forests. Moreover, the southern part of the island holds many young lava flows and vast lapilli fields making the island even more diverse. The school offers students the opportunity to get an exclusive view of the island's diverse ecosystems.

Before conducting field work, the students were divided into smaller groups and did an extensive literature review. Based on the current knowledge and the lack therein, each group prepared hypotheses and a data sampling design for a two-week field period on La Palma. The field experience challenged the students to address ecological issues while dealing with variable environmental conditions. Each group conducted their own research to answer their hypotheses. In turn, groups reported to the professors for feedback on the methodology applied and suggestions on the research. Additionally, fieldwork and teaching courses were combined to connect ecosystem management, in-situ data and remote sensing, preferably with the outcome of scientific manuscripts available for scientists and practitioners. Therefore, students were taught about the process of writing a scientific paper and got insights to the perspectives of a Journal editor during several seminars. Data gathered during the science school was analysed from April to June, with the constant supervision of the lecturers. Finally, each group presented their results in form of a presentation and a manuscript on the 6th of July in Bayreuth, Germany.

2.2. Participation

17 students, including Global Change Ecology M. Sc. Students, PhD and Master students from the ECOPOTENTIAL project and students from other relevant study programs, participated in the science school in La Palma.

The following lecturers were invited to the science school for their expertise in training young researches:

- Prof. Dr. Carl Beierkuhnlein (University of Bayreuth, Germany),
- Prof. Richard Field (University of Nottingham, UK),
- Prof. Alessandro Chiarucci (Università di Bologna, Italy),
- Prof. Dr. Ole R. Vetaas (University of Bergen, Norway),
- Dr. Severin Irl (University of Bayreuth, Germany)

Dr. Felix Medina from the Department Servicio de Medio Ambiente of the Cabildo Insular de La Palma supported the school as a local expert in ecology and conservation issues.

ECOPOTENTIAL partners participated as lecturers or local experts and taught students about outcomes and techniques from ECOPOTENTIAL. Furthermore, links to the storyline O7 (loss of endemic species and impacts on functioning) were mentioned in class and field and in the development of the different topics.

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Figure 1. One of the burnt Canary Pine (Pinus canariensis) forest study sites visited during the La Palma science school 2018.

2.3. Projects developed during the Science School

Students organized themselves in groups of three, and conducted research on their own about one of the following topics:

(a) Fire and fire-adaption, (b) leaf colouration along elevational gradients, (c) functional diversity of coastal habitats, (d) species co-occurrence and facilitation, (e) elevation-driven isolation and (f) geologic implications for plant growth.

One important topic of the science school was to assess the influence of a 2016 wildfire in the pine forest on species diversity. Fire magnitude and frequency can be mapped by Earth observation with existing ECOPOTENTIAL data. This may help to improve policy strategies to deal with the natural ecosystem processes fire on La Palma and improve decision making while extinguishing live fires and battling erosion afterwards. But fire remote sensing data can also be useful for ecologists. It allows to map fire and burn damage on a large scale without extensive fieldwork. During the science school, one group derived burn damage from Sentinel 2 images and subsequently linked the remote sensing data with sampled species numbers on the ground. Another topic of the science school was the analysis of leaf coloration along an elevational gradient. Therefore, one group measured leaf colour changes along an increasing elevation. The group is in the process of testing whether the pattern of leaf colour changes detected in the field can be identified with remote sensing products. Furthermore, two groups of students worked with endemic species. As an example, the endemic species Cheirolophus junonianus, so far only known on the phonolite

Roque Teneguía, was found at a second location in a very steep habitat. The local administration has a high responsibility for the occurrence of this species which occurs only on these two rocks of few square meters in the southern part of La Palma. In total, the science school covered several issues of biodiversity and ecosystem services which could be linked to remote sensing and conservation aspects of the unique local flora.

3. Gran Paradiso Summer School

3.1. General description

The Gran Paradiso summer school was held from July 10th to July 18th, 2018 by the Institute of Geosciences and Earth Resources and by the Institute of Atmospheric Sciences and Climate of the Italian National Research Council (CNR) and the US Pennsylvania State University, in collaboration with the Gran Paradiso National Park. The Gran Paradiso National Park is a protected area in the Italian Alps and a site of interest of the project. The park is characterized by environments that differ in remarkably in elevation, slope and aspect between valleys.

The summer school intended to provide basic knowledge about the functioning of the Earth Critical Zone (CZ) and its relationships with ecosystem dynamics, focusing on aspects related to hydrology, soil geochemistry and weathering, vegetation dynamics and distribution, microbiota, biodiversity, ecosystem processes, Critical Zone-relevant geological processes and the role of the Critical Zone for achieving sustainable development goals. The course considered in-situ data, long-term ecosystem research, remote sensing observations and numerical modelling.

3.2. Participation

Several Doctoral students, post-docs and researchers participated in the Summer School.

The directors of the course were:

- Timothy White, Pennsylvania State University, USA
- Antonello Provenzale, CNR, Pisa, Italy
- Scientific Secretary: Ilaria Baneschi, CNR, Pisa, Italy

Lectures were held by:

- Emma Aronson, University of California Riverside, USA
- Steven Banwart, University of Leed, UK
- Carl Beierkuhnlein, University of Bayreuth, Germany
- Asmeret Berhe, University of California Merced, USA
- Palma Blonda, CNR IIA, Bari, Italy
- Michael Mirtl, Environment Agency Austria
- Nikolaos Nikolaidis, Technical Univ. of Crete, Greece
- Daniele Penna, University of Florence, Italy

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- Pam Sullivan, University of Kansas, USA
- Timothy White, Pennsylvania State University, USA

Seminars and Tutorials were held by:

- Ilaria Baneschi, CNR, Pisa, Italy
- Ashlee Dere, University of Nebraska-Omaha, USA
- Jost von Hardenberg, CNR ISAC, Torino, Italy
- Silvia Giamberini, CNR, IGG, Pisa, Italy
- Pietro Mosca, CNR IGG, Torino, Italy
- Maddalena Pennisi, CNR IGG, Pisa, Italy
- Maria Adamo, CNR IIA, Bari, Italy
- Antonello Provenzale, CNR, Pisa, Italy

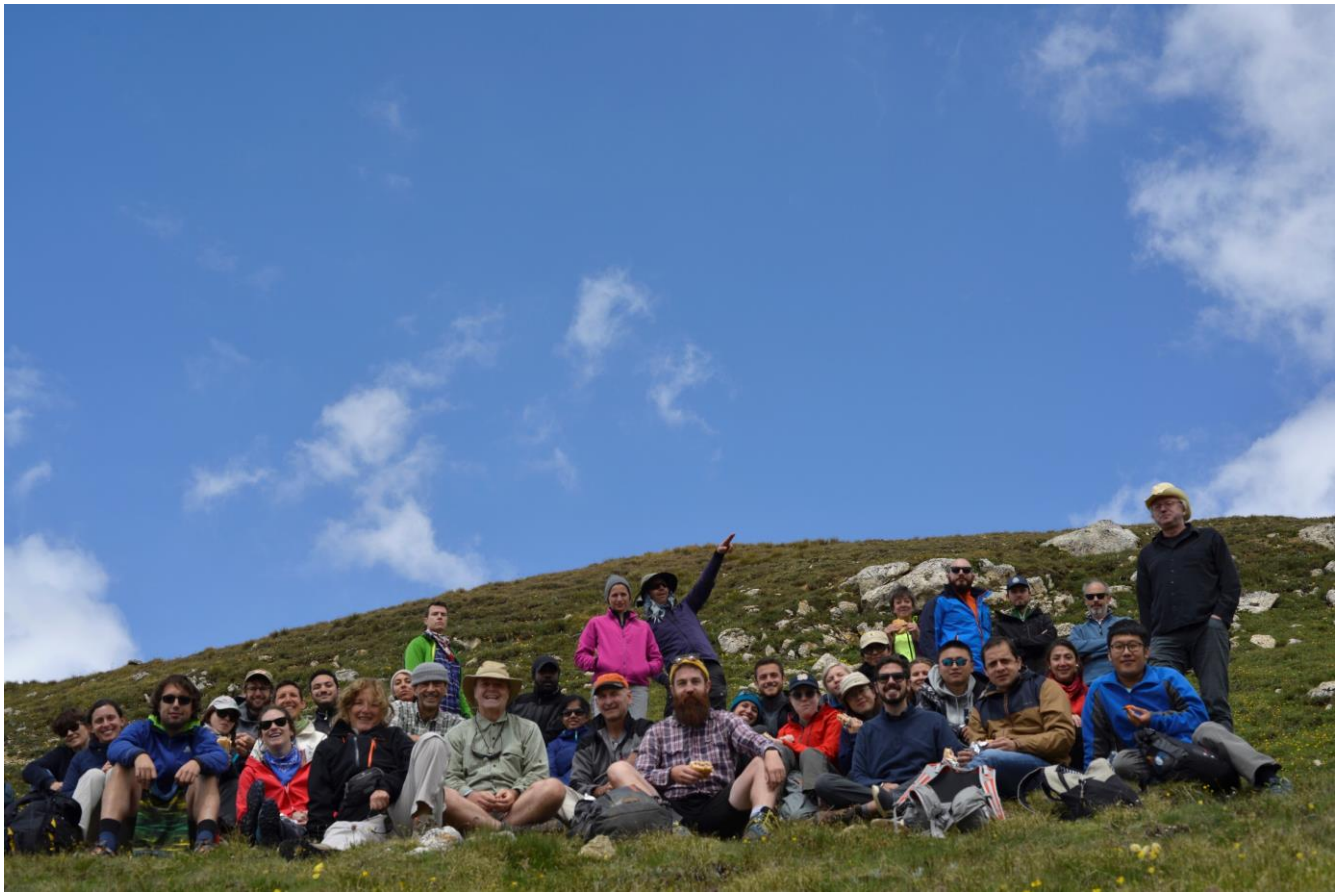

Figure 2. Participants and lecturers of the Gran Paradiso summer school 2018

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3.3. Projects developed during the Science School

During the school, different aspects of CZ were discussed by lectures and the students attended seminars and tutorials all together and also organizing themselves in different groups (the groups changed for different topics). In particular, regarding the use of Remote Sensing and In Situ data, students attended several tutorials and field lectures in order to learn how find, handle and use remote sensing data and about in situ surveys on several aspects of ecosystems dynamics, and lectures showed different applications of remote sensing products on CZ case studies. ECOPOTENTIAL partners participating as teachers gave lectures and tutorials in the class and in field explaining practical outcomes and techniques from the ECOPOTENTIAL project especially related to the Gran Paradiso National Park Storyline. The role of the eLTER infrastructure regarding the networking of research sites for long term ecological studies has also been explained.

Different groups of students were invited to read papers about CZ definition, modelling and long term monitoring and explained in few minutes and/or a presentation or a scheme the main object and their ideas. The field work was carried out all together with discussion and lectures give problems and questions to be asked by students in the field.