DMP title

Project Name DMP - Optimize climate-smart forest management to alleviate drought stress in temperate forest systems - DMP title
Project Identifier 1S16822N
Grant Title 1S16822N
Principal Investigator / Researcher Sanne Verdonck
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Description Droughts pose one of the largest threats to forest ecosystems and are expected to increase in frequency, duration, and intensity in the future. Increasing thinning intensity has been proposed as a drought alleviation strategy. However, the possible drawback of thinning on the forest microclimate is often overlooked, even though it is an ecosystem feature underlying forest biodiversity and many forest ecosystem processes. Therefore, this research aims at understanding the relationship between thinning intensity and the drought response of trees, while also investigating the negative feedbacks of management on the microclimate. The study will be executed at two spatial scales, (i) a forest stand scale with in situ measurements of tree growth, forest microclimate (temperature and soil moisture) and woodlice populations and (ii) a regional scale through remote sensing analysis and forest inventory data. We will focus on the tree species oak and beech.
Institution KU Leuven

1. General Information

Name applicant

Sanne Verdonck

FWO Project Number & Title

Number: 1S16822N
Title: Optimize climate-smart forest management to alleviate drought stress in temperate forest systems

Affiliation

- KU Leuven

2. Data description

Will you generate/collect new data and/or make use of existing data?

- Generate new data
- Reuse existing data

Describe in detail the origin, type and format of the data (per dataset) and its (estimated) volume. This may be easiest in a table (see example) or as a data flow and per WP or objective of the project. If you reuse existing data, specify the source of these data. Distinguish data types (the kind of content) from data formats (the technical format).

The data created and obtained throughout the PhD project are listed here per work package.

Work package 1: Past drought response of beech and oak in relation to stand structure

Data	Type of data	Format	Volume	Origin
1. Tree core samples	Physical	/	140 cores	Coring of selected centre trees from the north and west side
2. Tree-ring width time series	Numerical	.csv	500 MB	Measuring tree-ring width from tree cores with Lintab.
3. Tree-ring width time series UGent	Numerical	.csv	10 MB	Measuring tree-ring width from tree cores with X-ray. Data available through UGent.
4. BAI time series	Numerical	.csv	600 MB	Conversion of tree-ring width to basal area increments.
5. Management plans and logbooks	Text	.pdf (digital), books (non-digital)	100 MB (digital)	Official management plans of Sonian Forest and Meerdaal Forest • Meerdaalwoud: https://www.natuurenbos.be/sites/default/files/beheerplan_heverleebos_meerdaalwoud.pdf • Zoniënwoud Vlaanderen en Brussel: https://www.zonienwoud.be/documentatie/beheerplannen/ Additionally, information will be obtained through personal communication with forest managers (old non-digitized logbooks, personal notes...)
6. Wood sales data	Text and numerical	.csv (digital), books (non-digital)	200 MB (digital)	Agentschap Natuur en Bos (ANB), data obtained through official agreement
7. Weather data	Numerical	.csv	500 MB	Royal Meteorological Institute, data obtained through official agreement https://www.geo.be/catalog/details/RMI_DATASET_GRIDDEDOBS?l=en

The goal of this work package is to determine how trees have responded to drought in the past and whether this response varied based on forest management. To investigate this, tree cores (1) were taken to determine tree-ring widht time series (2, 3), which can be converted into basal area increment (BAI) data (4). This data will be linked to management information (5), wood sales data from ANB (6) and weather data (7).

Work package 2: Current drought response of beech and oak in relation to stand structure

Data	Type of data	Format	Volume	Origin
8. Radial changes time series	Numerical	.csv	1 GB	Dendrometer installed on centre trees provide information on the expansion and shrink of trees, resulting in radial changes time series.
9. Temperature time series	Numerical	.csv	500 MB	Dendrometer installed on centre trees measures temperature at installed height.
10. Plot inventory data	Text and numerical	.csv, access database	500 MB	FieldMap measurements containing information on stand structure (species, relative positions, DBH, height, stumps...)

The goal of this work package is to determine how trees currently respond to drought and whether this response varies based on forest management. To investigate this, radial changes time series (8) are obtained through the use of dendrometers. This data will be linked to information on the forest plot (10) and weather data (7) as well as temperature data (9).

Work package 3: The effect of stand structure on forest-related microclimate and biodiversity

Data	Type of data	Format	Volume	Origin
11. Temperature and soil moisture time series	Numerical	.csv	1 GB	Microclimate loggers measure temperature at three different heights and soil moisture
12. Insect specimens	Physical	/	300 pitfall samples	Pitfall traps, samples stored with ethanol
13. Observational activity-dependent abundance data of insects	Text and numerical	.csv	100 MB	Determination and counting of species in pitfall trap samples
14. Light measurements	Numerical	.csv	500 MB	Licor light measurements
15. Drone measurements	Binary imagery	.las, .laz	1 GB	LiDAR images from drone flights from which forest structural information can be defered.

The goal of this work package is to determine how the forest microclimate is affected by forest management and if this reflects itself in the insect populations on the soil (mainly woodlice). To investigate this, the forest microclimate is characterised by temperature and soil moisture data (11), which will be linked to the plot information (10) and to light measurements (14). Additionally, the insects in the pitfall traps (12) are sorted per species group and the species is determined, resulting in activity-dependent abundance data (13). This information is then linked to temperature and soil moisture data (11), plot information (10), light measurements (14) and processed LiDAR drone imagery (15).

Work package 4: Analyzing the drought response of oak and beech forests and the forest microclimate in Flanders through Landsat remote sensing

Data	Type of data	Format	Volume	Origin
16. Flemish forest inventory	Text and numerical	.csv, access database	50 MB	Agentschap Natuur en Bos (ANB), data obtained through official agreement
17. Management data	Numerical	.csv	10 MB	Derived from the Flemish forest inventory data of coupled plots
18. Harmonized Landsat Sentinel-2 (HLS) dataset	Numerical raster data	.csv	50 GB	Data freely available online: https://hls.gsfc.nasa.gov/
19. Vegetation index and land surface temperature time series	Numerical	.csv	500 MB	Conversion of raw HLS time series data into pre-defined indices
20. Soil data	Geometry with attributes of varying types (numerical, text...)	.shp	100 MB	Data freely available online: https://www.geopunt.be/catalogus/datasetfolder/a1547a01-b9fc-40fa-a2eb-009a39c02c7b
21. Digital terrain model	Raster	.tif	500 MB	Data freely available online: https://www.geopunt.be/catalogus/datasetfolder/f52b1a13-86bc-4b64-8256-88cc0d1a8735
22. Slope, elevation, northness, eastness, TWI	Raster	.tif	500 MB	Derived from the digital terrain model (19)

The goal of this work package is to scale up the results of previous work packages to the region of Flanders. The forest stands are described in the Flemish forest inventories (FFI) (16). Their growth response and microclimate response are captured through remote sensing data (18), which will be transformed to specific time series of useful indices (19). This response will be linked to management information (17) retrieved from the FFI's as well as environmental conditions (20, 21, 22).

Generated files during PhD

Data	Type of data	Format	Volume	Origin
23. R scripts, models and functions	Scripts	.R, .txt	500 MB	Created scripts, functions and models
25. Output models	Text and numerical	.R, .csv	500 MB	Output of models (p-values, significant model parameters, optimized results...)
26. Management optimisation tool	Tool	.xlsx	100 MB	Concrete user-friendly management advice using an Excel calculation tool

3. Legal and ethical issues

Will you use personal data? If so, shortly describe the kind of personal data you will use. Add the reference to your file in KU Leuven's Register of Data Processing for Research and Public Service Purposes (PRET application). Be aware that registering the fact that you process personal data is a legal obligation.

- No

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? If so, add the reference to the formal approval by the relevant ethical review committee(s)

- No

Does your work possibly result in research data with potential for tech transfer and valorisation? Will IP restrictions be claimed for the data you created? If so, for what data and which restrictions will be asserted?

- No

Do existing 3rd party agreements restrict dissemination or exploitation of the data you (re)use? If so, to what data do they relate and what restrictions are in place?

- Yes

The data regarding the Flemish forest inventory (Agentschap Natuur en Bos), the permanent forest reserve plots (Instituut voor Natuur- en Bosonderzoek) and the gridded observational database (Royal Meteorological Institute) are obtained through data contracts, which limit data use and (re)distribution. The use, management, and storage of the data will be described within these agreements. The rules set within the agreements will be respected. For example, the obtained data can only be used for and during my PhD research and cannot be distributed to other parties.

4. Documentation and metadata
What documentation will be provided to enable reuse of the data collected/generated in this project?

1. For each raw datafile, a README will be made containing information on the content of the dataset along with a description of the variables (what, which unit...).
2. The data collected through fieldwork are obtained through standardised procedures. The sampling methodologies will be described in detaill in protocols, which will be referred to in the README files of the raw data.
3. In scripts, explanatory comments will be included. A README file will also be made for each script, explaining the general goal of the script, which input is required, which output will be generated and which different steps are taken to create the output.
4. Physical data (tree cores, pitfall trap samples) will be stored and labeled. The samples' information will be inserted into a database at KU Leuven, describing what the sample is, when and where it was taken... to make sure the samples can be found easily in the future.

Will a metadata standard be used? If so, describe in detail which standard will be used. If no, state in detail which metadata will be created to make the data easy/easier to find and reuse.

- Yes

Data will be standardised according to data-type. The metadata standards considered for this project are:

1. Ecological Metadata Language (EML)
   This metadata standard is specific for ecological research and will be used for all data collected in the field (dendrometer data, tree core data, pitfall trap data, microclimate logger data). The Morpho application will be used to create, edit and search metadata files following EML. These files can be used to exchange information within and among research groups.
2. The Dublin Core metadata standard will be used to describe the remaining data and scripts. It is a general standard to describe resources and can form the base for my own standard if additional information has to be stored.

5. Data storage and backup during the FWO project
Where will the data be stored?
During the project, the data will be stored on the KU Leuven **OneDrive for Business**, allowing for files up to 100 GB to be stored. Each user is granted 2 TB of free storage.

How is backup of the data provided?
The data stored on the OneDrive for Business will be synced and backed-up automatically, reducing data loss risks and allowing version control.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely. If no or insufficient storage or backup capacities are available then explain how this will be taken care of.

- Yes

The available storage space will be enough for the gathered data. The OneDrive for Business provides 2 TB of storage.

What are the expected costs for data storage and back up during the project? How will these costs be covered?
The free storage capacity of 2 TB through OneDrive for Business will be sufficient. In case, extra storage be needed it can be increased to 5 TB. The cost will be covered from FWO annual bench fee.

Data security: how will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?
No sensitive data will be produced during the project. All data saved to the KU Leuven OneDrive for Business is password protected through the central KU Leuven login. KU Leuven obliges users to update passwords regularly. The folders will be locked and only accessible by the authorised staff. Only people with allocated rights can access data, for example, during collaborations.

6. Data preservation after the FWO project
Which data will be retained for the expected 5 year period after the end of the project? In case only a selection of the data can/will be preserved, clearly state the reasons for this (legal or contractual restrictions, physical preservation issues, ...).

1. All physical samples (tree cores, pitfall samples) will be stored for a non-specified amount of time.
2. All final datasets used for analyses for publications and PhD dissertations will be retained. Datasets will have been converted to standard file formats.
3. All codes and scripts will be stored.
4. Even after the 5 year period, the data and scripts will remain available for lab members of the forest, nature and landscape group.

Where will the data be archived (= stored for the longer term)?
After the project, long-term storage and storage of larger files is guaranteed through the Forest, Nature and Landscape **Archive drive** at KU Leuven, which has automatic back-up procedures.

What are the expected costs for data preservation during the retention period of 5 years? How will the costs be covered?

No extra cost are expected for long-term storage of the data. The data are estimated to be within the allowed limit of the FNL Archive server.

7. Data sharing and reuse

Are there any factors restricting or preventing the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)?

- Yes. Specify:

The data regarding the Flemish forest inventory (Agentschap Natuur en Bos), the permanent forest reserve plots (Instituut voor Natuur- en Bosonderzoek) and the gridded observational database (Royal Meteorological Institute) are obtained through data contracts and agreements, which limit data use and (re)distribution. The obtained data can only be used for and during my PhD research and cannot be distributed to other parties.

Which data will be made available after the end of the project?

All relevant data on which publications were based will be made available publicly in a standardised format. Data obtained through agreements with third parties will not be published openly. For this data, I will refer to the third party.

Where/how will the data be made available for reuse?

- In an Open Access repository

1. Relevant datasets will be uploaded in a standardised format in Zenodo.
2. The source code will be made available on GitHub.

When will the data be made available?

- Upon publication of the research results

The datasets not falling under an agreement which are used in the publication will be shared.

Who will be able to access the data and under what conditions?

The relevant datasets, which are not part of an agreement, will be uploaded in a standardised format in Zenodo as an open access dataset under a CC-BY license. Therefore, it will be available to anyone for any purpose, provided that they give appropriate credit to the creators. Published data will be available for everybody with access to the publication as per publisher's rules.

What are the expected costs for data sharing? How will the costs be covered?

There are no expected costs for data sharing.

8. Responsibilities

Who will be responsible for data documentation & metadata?

Sanne Verdonck (KU Leuven)
Bart Muys (KU Leuven)

Who will be responsible for data storage & back up during the project?

Sanne Verdonck (KU Leuven)
Bart Muys (KU Leuven)
ICTS

Who will be responsible for ensuring data preservation and reuse ?

Sanne Verdonck (KU Leuven)
Bart Muys (KU Leuven)
ICTS

Who bears the end responsibility for updating & implementing this DMP?

The PI bears the end responsibility of updating & implementing this DMP.