Science of the Total Environment 628–629 (2018) 1369–1394

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Early stage litter decomposition across biomes

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https://doi.org/10.1016/j.scitotenv.2018.01.012

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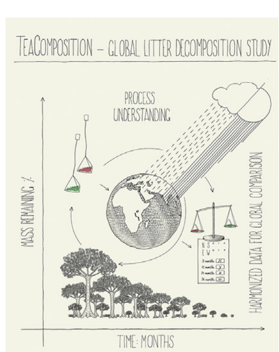
HIGHLIGHTS

- Litter quality is the key driver of initial litter decomposition at the global and regional scale.
- MAT has a low explanatory power on initial litter decomposition and is litter specific.
- MAP significantly affected litter decomposition but has low explanatory power.
- When data were aggregated at the biome scale, climate played a significant role on decomposition.
- The TeaComposition initiative is a low-cost standardized metric on litter decomposition.

GRAPHICAL ABSTRACT



A R T I C L E I N F O

Article history:
Received 31 August 2017
Received in revised form 20 December 2017
Accepted 2 January 2018
Available online 22 February 2018

Keywords:
Tea bag
Green tea
Rooibos tea
Carbon turnover
TeaComposition initiative

A B S T R A C T

Through litter decomposition enormous amounts of carbon is emitted to the atmosphere. Numerous large-scale decomposition experiments have been conducted focusing on this fundamental soil process in order to understand the controls on the terrestrial carbon transfer to the atmosphere. However, previous studies were mostly based on site-specific litter and methodologies, adding major uncertainty to syntheses, comparisons and meta-analyses across different experiments and sites. In the TeaComposition initiative, the potential litter decomposition is investigated by using standardized substrates (Rooibos and Green tea) for comparison of litter mass loss at 336 sites (ranging from −9 to +26 °C MAT and from 60 to 3113 mm MAP) across different ecosystems. In this study we tested the effect of climate (temperature and moisture), litter type and land-use on early stage decomposition (3 months) across nine biomes. We show that litter quality was the predominant controlling factor in early stage litter decomposition, which explained about 65% of the variability in litter decomposition at a global scale. The effect of climate, on the other hand, was not litter specific and explained <0.5% of the variation for Green tea and 5% for Rooibos tea, and was of significance only under unfavorable decomposition conditions (i.e. xeric versus mesic environments). When the data were aggregated at the biome scale, climate played a significant role on decomposition of both litter types (explaining 64% of the variation for Green tea and 72% for Rooibos tea). No significant effect of land-use on early stage litter decomposition was noted within the temperate biome. Our results indicate that multiple drivers are affecting early stage litter mass loss with litter quality being dominant. In order to be able to quantify the relative importance of the different drivers over time, long-term studies combined with experimental trials are needed.

1. Introduction

Through litter decomposition >50% of net primary production is returned to the soil (Wardle et al., 2004) and 60 Pg C year^{-1} is emitted to the atmosphere (Houghton, 2007). Depending on the type of ecosystem, the quantity of soil organic carbon (SOC) in the top 1-m depth range from 30 tons/ha in arid climates to 800 tons/ha in organic soils in cold regions, with a predominant range from 50 to 150 tons/ha (Lal, 2004). The amount of SOC is determined by the balance of carbon inputs from primary production and losses through the decomposition of organic matter over time (Olson, 1963). However, there is a large degree of variability in this balance and more research is needed for a better mechanistic understanding of decomposition processes at various scales and for a more accurate estimation of present and future global carbon budgets (Aerts, 2006).

Decomposition of plant litter may be divided into at least two stages (e.g. Berg and McClaugherty, 2008). The early stage of decomposition (ca. 0 to 40% mass loss) is characterized by leaching of soluble compounds and by decomposition of solubles and non-lignified cellulose and hemicellulose (Couteaux et al., 1995; Heim and Frey, 2004). The late stage (ca. 40–100% mass loss) encompasses the degradation of lignified tissue. In general, microbial decomposition of organic substrates is controlled by both biotic factors (substrate quality and microbial community composition) and abiotic factors (temperature and moisture; Gavazov, 2010). Research to understand the impact of global changes such as climate on decomposition processes has typically been conducted at individual sites and/or through cross-site observations and experiments (e.g. Emmett et al., 2004; Heim and Frey, 2004; García Palacios et al., 2013). This has sometimes lead to controversial conclusions since the observed decomposition may be dependent on local litter quality used in the study and the factors controlling decomposition may be influenced by the methodologies and experimental designs applied. Consequently, comparisons across observations and common conclusions may be hampered. For example, early stage decomposition (mainly microbial) has been reported to be primarily controlled by climate and major nutrients in pine needle litter (Berg and McClaugherty, 2008), by microbial and nematode communities in pine needle litter (García Palacios et al., 2016), by litter content of water soluble substances (Heim and Frey, 2004) and by soil temperature and soil pH for a maize straw-soil mixture (Djukic et al., 2012). At regional and global scales, litter decomposition has been reported to be controlled by climate and litter quality (explaining about 60–70% of litter decomposition rates; Parton et al., 2007) and by soil meso-and micro-fauna communities (explaining about 7%; Wall et al., 2008). However, at the biome scale the metadata-analysis by García Palacios et al. (2013) showed that the variables controlling decomposition vary with decomposition in cold and dry biomes being mostly controlled by climatic conditions while soil fauna seemed to have a more defining role in warm and wet biomes. Moreover, Bradford et al., (2014) showed that climate has a main control on decomposition only when local-scale variation is aggregated into mean values. In order to pinpoint the specific drivers of litter decomposition across various litter types with different decomposition rates and across multiple sites, standardized studies across sites and regions are needed (Wickings et al., 2012; Handa et al., 2014; Parsons et al., 2014).

Decomposition studies across multiple sites using standardized methods already exist within observational networks or experimental studies such as GLIDE (Global Litter Invertebrate Decomposition Experiment – Wall et al., 2008), LIDET (Long-term Intersite Decomposition Experiment Team – Adair et al., 2008), CIDET (Canadian Intersite Decomposition Experiment – Trofymow and CIDET Working Group, 1998), DIRT (Detrital Input and Removal Experiment – Nadelhoffer, 2004), BioCycle (Biodiversity and biogeochemical cycles: a search for mechanisms across ecosystems - Makkonen et al., 2012), DECO (European Decomposition project - Johansson et al., 1995), CANIF (Carbon and Nitrogen Cycling in Forest Ecosystems project – Persson et al., 2000), MICS (Decomposition of organic matter in terrestrial ecosystems: microbial communities in litter and soil – Cotrufo et al., 2000), VULCAN (Vulnerability assessment of shrubland ecosystems in Europe under climatic changes - Emmett et al., 2004), and VAMOS (Variation of soil organic matter reservoir – Cotrufo et al., 2000). Results from these have been used by predictive models such as Yasso07 (Tuomi et al., 2009) and in meta-analyses such as the ART-DECO project (Cornwell et al., 2008). These studies have all provided important information on the decomposition of litter, but have been limited to specific biomes or ecosystem types or have used site specific litter.

Therefore, despite the many efforts, a general understanding of the litter decomposition process and its driving factors is hampered by (1) use of site- or network/project-specific litters and methodologies (e.g. different study lengths, litter bag mesh sizes, incubation depths, litter type and litter mixes; García Palacios et al., 2013), and (2) the low number of global studies that go across all biomes

(Bradford et al., 2016). This study presents results from the TeaComposition initiative which uses standard litters (tea bags - Keuskamp et al., 2013) and a common protocol allowing global and long-term application to overcome these limitations by providing standardized litter decomposition measurements across broad spatial scales. This paramount importance of standardized methods has alo been emphasized by Haase et al., 2018 and Mollenhauer et al., 2018 in press. The study presents early stage litter mass loss across nine biomes with the aim to determine and compare globally the main drivers of decomposition at present climatic conditions. The early stage decomposition is generally expected to show greater mass loss rates and a dynamic response of mass loss to controlling factors (e.g. Heim and Frey, 2004; Pérez-Suárez et al., 2012). Therefore the specific objectives of the study were to estimate the variation in early stage mass loss of two litter types worldwide, to explore the linkage of early stage litter mass loss with key drivers (climate, litter type, land-use), and to explore whether the relative importance of the drivers differ between the litter types. Our research questions are (1) does early stage litter mass loss of Green tea and Rooibos tea vary at the global scale due to the different litter qualities (Didion et al., 2016; Keuskamp et al., 2013), (2) are abiotic drivers controlling the initial stage of mass loss (Bradford et al., 2016) with temperature being the main regulating factor in the cold biomes and precipitation in the warmer biomes (Adair et al., 2008), and (3) does early stage litter mass loss vary between land-use types due to changes in the microclimates (Fig. 1).

2. Material and methods

2.1. Background of the TeaComposition initiative

The TeaComposition initiative was started in summer 2016. The main objective is to investigate long-term litter decomposition and its key drivers at present as well as under different future climate scenarios using a common protocol and standard litter (tea) across nine terrestrial biomes. It is one of the first comprehensive global studies on litter decomposition focusing on the litter decomposition in the topsoil and the degradation of the main litter components (lignin, cellulose and hemicellulose) to carbon dioxide and soluble or leachable compounds. As a collaborative network the TeaComposition initiative has involved a large number of international research projects and networks with observational or experimental approaches, which are relevant for increasing our mechanistic understanding of decomposition processes as well as for improving the predictive power of process-based models.

2.2. Study sites

The TeaComposition initiative comprises 570 sites across nine terrestrial biomes (Fig. 2). Here "biome" is defined as a region with specific macroclimate and its classification was done according to Walter and Breckle (1999). In this study, data from 336 sites were used for analyses. Some of the sites included manipulation experiments (e.g. including treatment plots such as fertilizer addition or climate manipulation) in which case only the tea bags from the untreated control plots were used in the analyses. Sub-sites with different conditions (e.g. tree species diversity experiments or altitudinal gradients) were considered as single sites.

Overall, the sites represented all terrestrial biomes (Table 1) and each site provided information on location (i.e. coordinates), climate (averaged monthly or daily temperature (MAT) and cumulative precipitation (MAP)), vegetation type, and specific land-use (Table S2). Climate data were measured at the site or taken from nearby weather stations. In cases where no climate data were provided, data were extracted from WorldClim (Fick and Hijmans, 2017). The mean annual air temperature (MAT) in our dataset ranges from −9 to +26 °C and the mean annual precipitation (MAP) from 60 to 3113 mm (Table 1; Site specific data can be found in the Table S2). Since sites were assigned to different land-use categories from

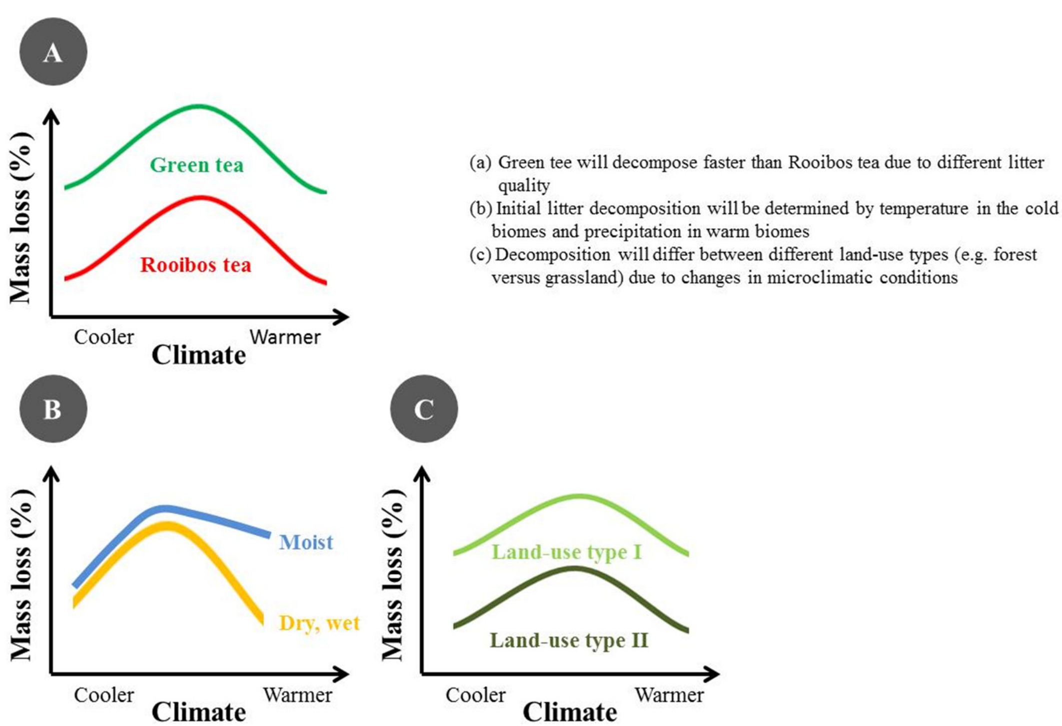


Fig. 1. Conceptual depiction of the main research questions. The temperature dependency across the temperature range (figure b) is arbitrary.

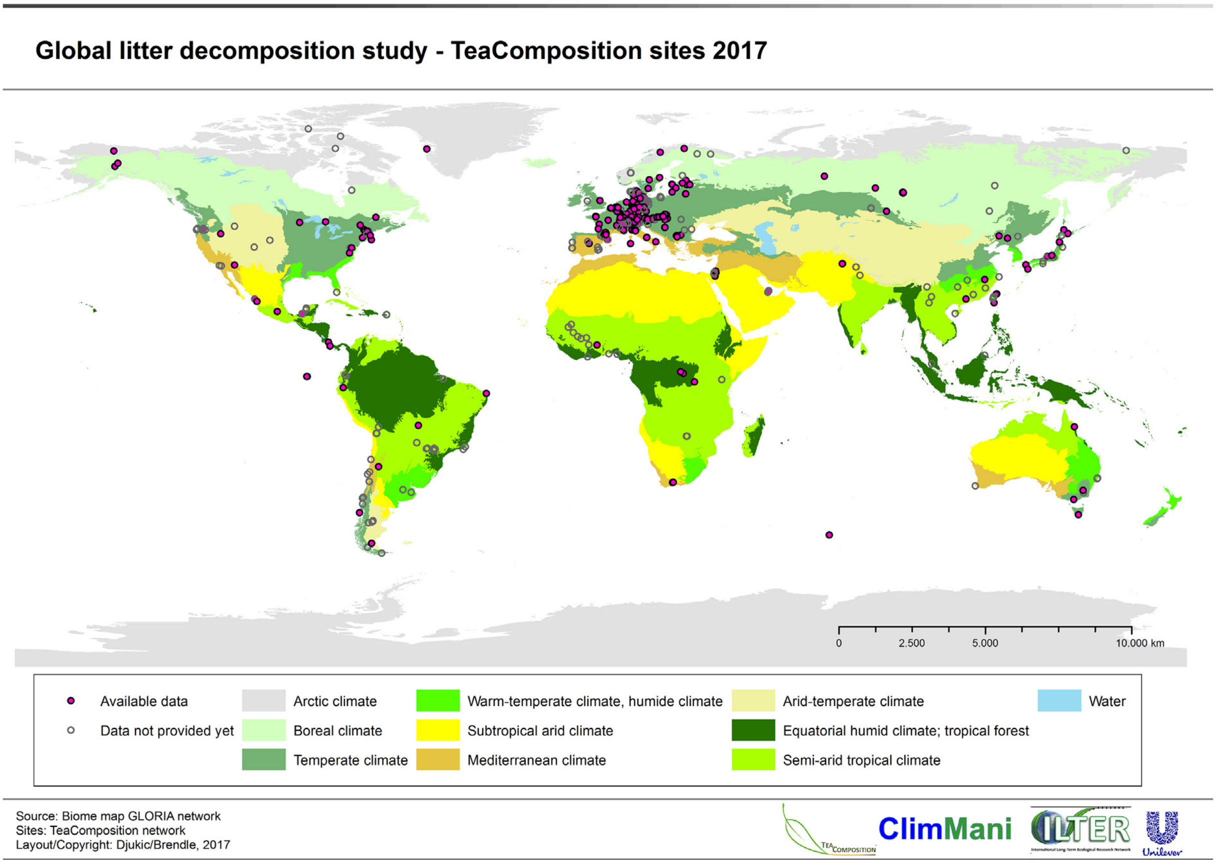


Fig. 2. Map showing the location of the 570 study sites involved in the TeaComposition initiative so far. Data from the sites with the red circles have been used in the present study. Data from Qatar come from Alsafran et al., 2017. See Tables 1 and S2 for more detailed information. Classification of the biomes was according to Walter and Breckle (1999).

different classification schemes, we reclassified them into five broader classes: arable, forest, grassland, shrubland and wetland based on the site description.

2.3. Method and study design

The TeaComposition initiative uses tea bags as a standardized metric for decomposition as proposed by Keuskamp et al. (2013), and applies a standardized protocol adapted to match global and long-term applications. The standardized protocol ensures: (i) use of the same batch of tea bags assuring the same substrate quality for all sites, (ii) harmonized start of the decomposition at the same season at the year for northern and southern hemisphere (i.e. start in summer; June–August in northern hemisphere and December–February in southern hemisphere), (iii) comparable incubation depth at the upper 5 cm of the soil relevant for litter decomposition, and (iv) standardized and comparable incubation times covering both short and long term dynamics with incubation times extending to three years (sampling points after 3, 12, 24, and 36 months).

Two types of tea material with distinct qualities are being used; the Green tea viz. green leaves (*Camellia sinensis*; EAN no.: 8 722700 055525) with high cellulose content and expected fast decomposition, and rooibos tea (*Aspalanthus linearis*; EAN no.: 8 722700 188438) with high lignin content and expected slow decomposition (Keuskamp et al., 2013). The bag material is made of

Table 1
Summarized general characteristics of the study sites used for the analysis within the TeaComposition initiative. Note: Detailed table on the single site characteristics can be found in the Supplementary material.

Biomes	Number of sites	Land use	Climate data (MAT / MAP)*
Arctic climate	4	Grassland	-9 to 5 / 237 to 709
Boreal climate	17	Boreal Forest, Shrubland, Grassland, Bog, Ecotone	-3 to 6 / 293 to 1015
Temperate climate	250	Agriculture, Forest, Shrubland, Grassland (Meadows), Wetland, Ecotone, alpine Grassland	-7 to 14 / 265 to 2140
Warm-temperate climate	13	Forest, Shrubland, Grassland, Wetland	6 to 21 / 955 to 3072
Arid-temperate climate	9	Desert, Shrubland, Grassland steppe, Ecotone	6 to 21 / 174 to 528
Mediterranean climate	13	Agriculture, Forest, Shrubland, Grassland, Wetland, Lake, Subalpine / Alpine Grassland	7 to 25 / 569 to 1627
Subtropical arid climate	15	Forest, Grassland, Wetland	15 to 24 / 60 to 412
Equatorial humid climate	6	Agriculture, Forest, Wetland (Mangrove, Freshwater Swamp), Ecotone	22 to 26 / 1298 to 3113
Semi-arid tropical climate	9	Agriculture, Forest, Shrubland, Grassland (Savanna), Wetland	11 to 26 / 636 to 1268

* MAT = Mean annual temperature; MAP = Mean annual precipitation.

woven nylon and has a mesh size of 0.25 mm allowing access of microfauna (Bradford et al., 2002) in addition to microbes and very fine roots. Before the start of the incubation all tea bags were oven-dried at 70 °C for 48 h and the initial weight was recorded (overall mean = 1.81 g, s.d. = 0.10). Each bag was identified with a unique number and was buried in the upper 5 cm of the top soil layer during summer seasons in both the northern and southern hemisphere. At least two homogenous areas (plots) were selected (at least 1 m apart) at each site. Two replicates of the two litter qualities (Green tea and Rooibos tea) were installed in each of the two blocks, resulting in minimum 4, maximum 250, and in average 8.33 bags of each tea type per site and sampling time. Tea bags were collected at all sites after a field incubation period of three months. The tea bags were cleaned from soil and roots, oven dried (70 °C for 48 h), and the weight of the remaining tea (without bag) was recorded. Instead of weighing incubated tea bags (as often damaged, tag dissolved or rope missing) an averaged bag weight (40 empty tea bags; 0.248 g per bag) was used to estimate the amount of the tea before the incubation. If the collected tea bags were visibly contaminated with soil, ash content (refers to the mineral residue after removal of organic matter by ignition) was determined by heating in a muffle oven at 500 °C for 16 h, in order to correct for the mineral part (Soil Survey Staff, 2004).

2.4. Data analyses

Because not all tea bags were incubated for exactly three months (overall mean = 92 days, s.d. = 13.2) we linearly standardized all mass loss data to a fixed period of 90 days prior to data analyses. As such, the reported mass loss data therefore represent a rate of mass loss over 90 days.

2.4.1. Differences in tea mass loss across biomes and between tea types

We quantified differences in remaining litter mass between biomes using linear mixed models with biome and tea type as fixed factors and site as a random factor accounting for the dependence in observations within site. Residual plots were visually inspected for deviations from model assumptions. If the interaction between biome and tea type was significant, multiple comparisons between biomes within each tea type were tested applying post hoc contrasts with P-values adjusted for multiplicity with the single-step method (Hothorn et al., 2008).

To quantify the different sources of variation in our data we used a linear mixed effect model with a nested structure (sites nested within biome). Biome and site were set as random factors and tea type as a fixed factor. We then ran separate analyses for each tea type to investigate whether biome, site and individual tea bags accounted differently for the variation for each tea type.

2.4.2. Effects of climate on the initial litter mass loss

To investigate the effects of climatic variables on remaining tea mass after three months of field incubation we applied linear mixed models with local climate as fixed factors and site as random factor. We used local climate data (average monthly air temperature and total precipitation) measured at nearby weather stations during the period of incubation when data were available (n = 124; Fig. 4; Table 2). For sites with no local climate data, we imputed the monthly averages of temperature and the total precipitation for the corresponding measurement period from WorldClim (Fick and Hijmans, 2017). Whereas local climate represent the weather conditions measured at the sites during the incubation period, WorldClim represents the average climate for the period 1970–2000. We assessed the congruency between the two types of climate data by also running models including only the sites where both types of data were available. The results were qualitatively similar to the model including all sites. Moreover, local and WorldClim climate data were highly correlated (precipitation: $r = 0.83$; $P < .01$; temperature: $r = 0.87$, $P < .01$, Pearson's product moment correlation).

We modeled the remaining mass as a function of tea type, temperature and precipitation. Differences between litter types were tested by including interaction terms for tea type with both climatic variables. We used backward selection for model simplification until only significant terms remained in the final model. When a significant interaction with tea type was found, we used post hoc contrasts to test for significant relationships between the climatic variable and each tea type (i.e. test for slope different from 0); P-values were adjusted for multiplicity using a single-step method based on the joint normal distribution. Goodness of fit for these models were calculated based on marginal and conditional R^2 (Nakagawa and Schielzeth, 2013). Because climatic effects on decomposition can depend on the spatial scale of the observation (Bradford et al., 2014) we conducted a separate analysis, using the average remaining mass, temperature and precipitation, aggregated at the biome level. We tested for effects of climate factors using simple linear models, with temperature, precipitation and their interaction as independent variables. Significant interactions were further tested as described above.

Table 2
Effects of climatic factors on the site level remaining mass of the two tea types (statistics relates to Fig. 4). Estimates obtained from mixed effect model with site as a random factor. R^2 marginal: 0.74; R^2 conditional = 0.88.

	Est.(SE)[a]	t	P
Green tea	45.81(1.79)	25.62	<.01
Rooibos tea	79.57(1.80)	44.31	<.01
PREC	−8.87(2.68)	−3.32	<.01
Green tea × TEMP	0.14(0.17)	0.88	.38
Rooibos tea × TEMP	−0.12(0.17)	−0.74	.82

[a] Models were fitted using precipitation/1000 to avoid very small estimates. Est. = estimates, SE = standard error.

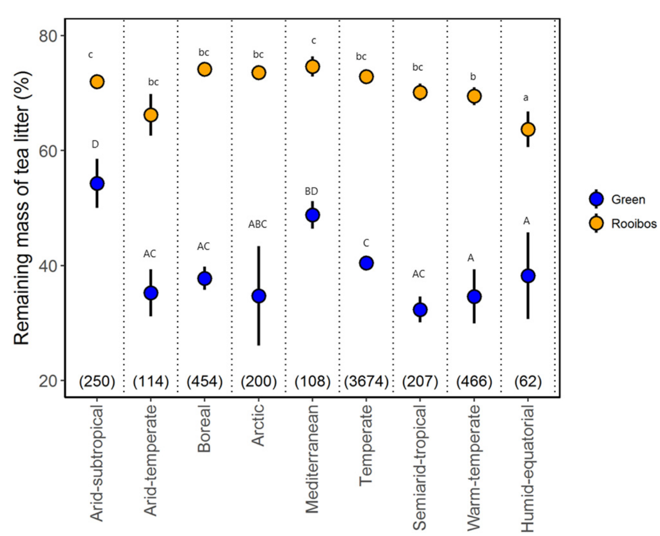


Fig. 3. Percentage remaining mass for Green and Rooibos teas across climatic biomes. The difference between Tea types was significant ($F = 9802$; $P < .01$). Blue and orange circles show the mean and the bars are the standard errors based on the total number of observations. Letters show pairwise comparisons within each tea type: lowercase for rooibos and uppercase for green. Numbers in parentheses are the total number of tea bags for each biome. Biomes are ordered by increasing mean annual precipitation.

2.4.3. Effects of land-use on the initial litter mass loss

We tested for differences in remaining tea mass between land-use types only for the temperate biome as this was the only biome with enough sites of the different land-use categories. We used a mixed model including land-use, tea type and their interaction as fixed factors and site as random factor. Separate models were used for each tea type to further explore differences. If the interaction between land-use type and tea type was significant, multiple comparisons among land-use types within each tea type were tested using post hoc contrasts with P-values adjusted for multiplicity with the single-step method.

All statistical analyses were conducted with R (version 3.1.2; R core team 2014). The level for detecting statistical differences was set at $P < .05$. The lme4 package (Bates et al., 2015) was used for fitting the mixed models and the multcomp package (Hothorn et al., 2008) was used for multiple comparisons. The percentage of variance explained by the fixed and the different random components was calculated using the "variancePartition" package in R (Hoffman and Schadt, 2016).

3. Results

3.1. Relative importance of litter quality on mass loss across biomes

Across all biomes, tea mass remaining after three months of field incubation (Fig. 3) was higher for Rooibos tea (78%, SD = 10.31) than for Green tea (38%, SD = 15.86). Overall, similar mass loss patterns were recorded for both tea types across biomes with tendencies or significantly higher mass loss at warm and humid climates compared to the dry and/or cold biomes. However, there was a significant interaction between biome and tea type ($F = 84$; $P < .01$) indicating that some differences between biomes depend on tea type. For Rooibos tea, significantly lower remaining mass was found at sites in equatorial-humid climate. For Green tea, we found the highest remaining mass at the sites from the arid-subtropical and Mediterranean climates, which were significantly different from the sites found in cooler and more humid biomes (Fig. 3).

The analysis of data variation showed that 65% of the variation in the remaining litter mass was related to tea type while 13% was related to biome (Fig. 3). The variation was 11% within biomes and 11% within sites.

3.2. Effects of climate on the initial litter mass loss

Our final model showed that climatic variables had different effects on early stage decomposition. Remaining mass loss decreased with increasing precipitation. This pattern was similar for both tea types as revealed by the not significant interaction between tea type and precipitation ($F = 0.01$, $P = .96$). We also found a significant interaction between tea type and temperature ($F = 64$, $P < .01$) indicating that the response of mass loss to temperature depends on tea type, i.e. litter quality. However, the analyses using post hoc contrasts showed that temperature did not have any significant effect on any of the tea types (Table 2; Fig. 4).

In contrast, the biome-scale analyses focusing on the mean values for the given biome revealed some variation in remaining litter mass loss from low (equatorial humid climate) to high (arid subtropical and Mediterranean climates) mass losses (Fig. 5a). In the linear models, we found a non-significant interaction between tea type and MAP ($F = 0.20$, $P = .66$); and between tea types and MAT ($F = 0.39$, $P = .54$). Whereas MAT had no effect ($F = 0.64$, $P = .43$), remaining mass decreased with increasing MAP for both tea types (Table 3).

3.3. Effects of land-use on the initial litter mass loss

We used the data set from the temperate biome (228 sites out of 250; Table 1) to test the effect of land-use on litter mass loss. The model for land-use effects showed a significant interaction between land-use and tea type ($F = 41$, $P < .01$). However, post hoc contrasts showed no differences among land-use types for either Green or Rooibos tea (all comparisons: $P > .05$).

4. Discussion

The early stage of litter decomposition is a highly dynamic phase and therefore important for the understanding of litter decay and the controlling factors across biomes and ecosystem types. Here we studied the early stage mass loss of two standardized litter types (Green tea and Rooibos tea) across 336 sites globally and found that the litter type (quality) was the

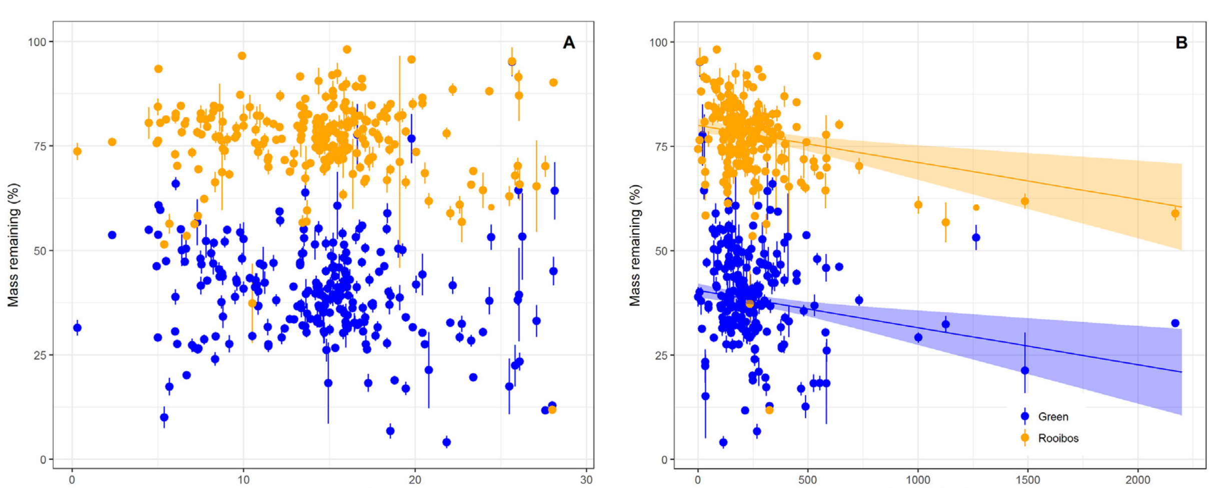


Fig. 4. Relationship between remaining mass of Green tea and Rooibos tea and temperature (A) and precipitation (B) after the 3-month incubation period. Climatic variables were obtained from local weather stations or from WorldClim for sites with no data. Circles show the mean values for each site and bars the standard errors. The regression line from the minimum adequate model is plotted only for the significant effects of precipitation and is obtained using only fixed factors. Band shows 95 confidence interval.

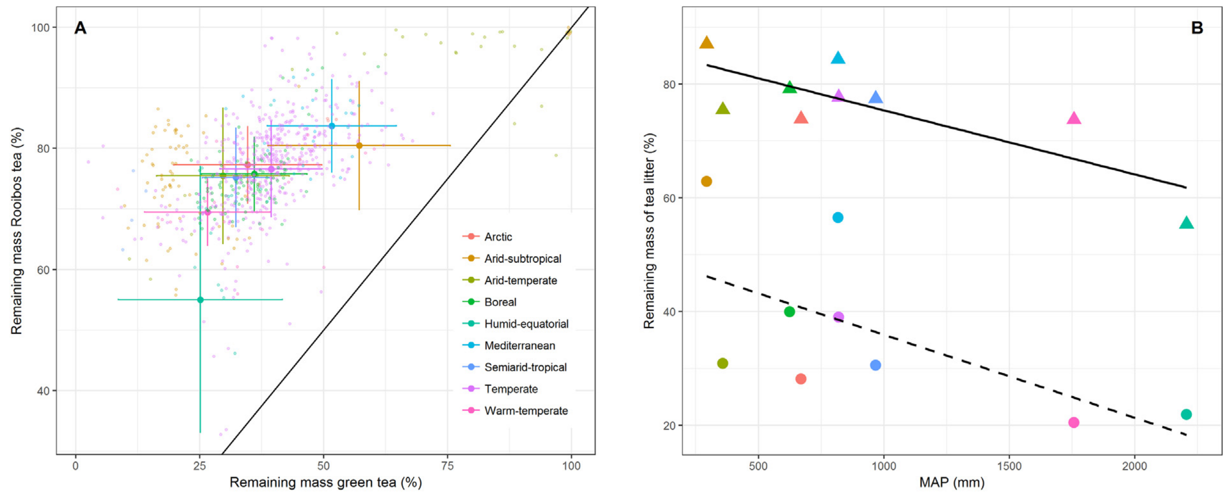


Fig. 5. A) Correlation between remaining mass of tea litter of different qualities (green and rooibos tea) after 3 month of incubation during the growing season. Symbols are arithmetic means for each biome and error bars indicate ± standard deviation. B) The average remaining mass aggregated by biome of Green tea (dashed line) and Rooibos tea (solid line) plotted against the mean annual precipitation for each biome (Table 1). The regression line is from a simple linear model showing significant effects for Green ($R^2 = 0.40$) and Rooibos ($R^2 = 0.64$).

main determinant of the mass loss while climate and land use had little effect.

4.1. Substrate quality effects on litter decomposition

The effect of initial litter quality (chemical and physical composition) has been reported to be one of the key drivers of litter decomposition (Bradford et al., 2016; Cornwell et al., 2008; Heim and Frey, 2004). In our study, the litter type also had a strong control on initial decomposition as Green tea consistently decomposed faster than Rooibos tea (Fig. 3). Faster initial decomposition of Green tea is expected due to its higher fraction of water-soluble compounds in contrast to the low content of soluble or hydrolysable compounds in Rooibos tea (Didion et al., 2016). The mass loss of the litter during this early stage may be more related to the leaching losses than to microbial mineralization of soil organic C at the early stage of decomposition. In a pilot study, we measured changes in the initial weight after 3–4 min of cooking (n = 332) and recorded a weight loss of 31% for Green tea compared to 17% for Rooibos tea. Similar observation was made within different urban soil habitats by Pouyat et al. (2017). Moreover, Green and Rooibos tea differ in their carbon and nutrient chemistry (Keuskamp et al., 2013) and physical features (Didion et al., 2016). In a meta-analysis of the factors influencing mass loss rates involving 70 published studies, Zhang et al. (2008) demonstrated, similar to our study, the direct influence of litter quality (C:N ratio and total nutrient content) on mass loss rates. The mass loss of both tea types decreased when precipitation increased (Table 2) which is in agreement with several studies showing a positive relationship between moisture availability and decomposition rates (Gholz et al., 2000; Prescott, 2010; García Palacios et al., 2016).

Overall, litter type explained 65% of the variability in litter mass loss at the global scale, which in turn implies that potential shifts in the relative abundance of vegetation types in the future caused by climatic changes could have large effects on global carbon budgets alone due to the differences in litter quality and consequently decomposition rates (Cornwell et al., 2008; Cornelissen et al., 2007).

Table 3
Effects of climatic factors on the biome level remaining mass of the two tea types for data aggregated by biome (statistics relates to Fig. 5). Estimates obtained from simple linear models after backward selection. R^2: 0.84.

	Est.(SE)[a]	t	P
Green tea	48.94(4.62)	10.60	<.01
Rooibos tea	88.23 (4.62)	19.10	<.01
PREC	−12.93(3.64)	−3.64	<.01

[a] Models were fitted using precipitation/1000 to avoid very small estimates. Est. = estimates, SE = standard error.

4.2. Climate effects on litter mass loss

Across biomes, climatic factors are assumed to have a significant influence on litter decomposition by affecting the activity of decomposer organisms (Bradford et al., 2014); namely for every 10 °C increase in temperature a doubling of microbial decomposition is anticipated ($Q_{10} = 2$; Friedlingstein et al., 2006). Here, processes in the topsoil deserve special attention since they are particularly exposed to dynamic changes in environmental conditions.

We analyzed the across-site variation in initial litter mass loss at the site and biome scales. In this study, investigated sites are spread across large temperature and moisture gradients. We observed an effect of precipitation on early stage litter mass loss, while temperature did not show any significant effects (Fig. 3). Mean annual temperatures of <10 °C and moisture contents of <30% or >80% have been suggested as inhibiting thresholds for litter decay (Prescott, 2010). The absence of any significant effect of temperature on litter mass loss in our study may be a consequence of the fact that all sites incubated the tea bags during the “summer” under relatively favorable conditions where temperature values were generally within the “optimal” decay range. Furthermore, large variation in litter mass loss was observed for both litter types within any given biome (Fig. 5a, Table 2) suggesting that local-scale factors (e.g. soil properties, soil water content, disturbances) other than climate had strong controls on regional litter mass loss dynamics (Cornwell et al., 2008). Similarly, Ise and Moorcroft (2006) reported a low temperature sensitivity of decomposition ($Q_{10} = 1.37$) at the global scale. On the other hand, when examined separately, climate explained 40%

of the variation for Green tea and 64% for Rooibos tea when the mean litter mass loss values were used for the given biome (Fig. 5b, Table 3). A similar finding was reported by Bradford et al. (2014), where the explanatory power of climate was increased to 84% when analyses were conducted on aggregated data.

Interestingly, early-stage litter mass loss of both litter types were comparable across all biomes (Fig. 3). The relative mass losses observed in the arctic sites may seem surprisingly high relative to the other warmer biomes. However, the study was carried out in the "summer season" where climatic conditions, even at the arctic sites are rather mild and warm and therefore favorable for decomposition (Couteaux et al., 1995). On the contrary, sites in the warmer biomes received less precipitation in the summer often being below potential evapotranspiration and leading to soil moisture deficit which again may result in lower mass losses. However, it has to be kept in mind that the results for arctic and arid-temperate biomes are based on a lower number of sites and should be interpreted with caution.

The data in this study collected during the growing season revealed that direct climatic control on early stage decomposition is of relatively minor importance. Instead, indirect climatic effects (e.g. plant community structure and associated microclimate, soil organic matter quality and structure of decomposer communities) may play a relatively stronger role in the early stage decomposition and may mask any importance of direct climatic controls (Aerts, 1997).

4.3. Land-use effects on litter mass loss

Long-term prevailing climatic conditions together with human activities define plant species composition and ecosystem structure, which in turn may affect decomposition rates. We did not observe any significant effects of land-use or management practices on the initial litter decomposition in the temperate biome. This may be caused by microbial decomposition not being limited by nutrients during the growing season. Another reason may be that in the early stage decomposition mineralization of labile C compounds is carried out by many groups of microorganisms while in the later stage of decomposition, decomposer groups may become more selected due to increased substrate complexity which in turn might lead to differences in litter mass loss between the land-use types (McGuire and Treseder, 2010). Hence, home-field advantage (Gholz et al., 2000) is expected to explain a fraction of the remaining variability at later and more advanced stages of decomposition. A detailed definition of different land-use categories would be necessary in order to be able to run more specific data analyses across all biomes.

5. Conclusions

Our study showed that litter type has the strongest influence on mass loss globally in the early stage of decomposition, while the effect of climate was only important under less favorable climatic conditions and when data were aggregated at the biome scale. This finding is particularly relevant for the general understanding of litter and carbon dynamics in relation to biosphere-atmosphere feedback, since the early stage litter decay is responsible for a significant fraction of the carbon loss from litter, and because the lack of site specific climate control for this decomposition phase should be reflected in soil carbon models. The short-term period of just three month incubations used in this study provides insight into the short mass loss dynamics of plant litter. On the other hand the results cannot be extrapolated to capture a reliable signal of the long term nature of the decomposition rates, because long term decomposition involves other litter components and the drivers are likely to vary at spatial and temporal scales (Couteaux et al., 1995; Berg, 2014). Therefore caution should be payed when extrapolating from short-term to long-term rates (Moore et al., 2017). Therefore, the TeaComposition initiative includes additional sampling points after 12, 24, and 36 months, which will provide long term litter decomposition dynamics globally. Repeated observations over time (medium to long-term data) are essential for improving our understanding of the long term decay process of plant litter. Further, in addition to the observational networks included in this study (e.g. ILTER – see Mirtl et al., this issue, in press), the TeaComposition initiative includes studies across collaborative experiments which are needed to identify and quantify the relative importance of multiple drivers (Verheyen et al., 2017; Borer et al., 2014).

Acknowledgements

This work was performed within the TeaComposition initiative, carried out by 190 institutions worldwide. We thank Gabrielle Drozdowski for her help with the packaging and shipping of tea, Zora Wessely and Johannes Spiegel for the creative implementation of the acknowledgement card, Josip Dusper for creative implementation of the graphical abstract, Christine Brendle for the GIS editing, and Marianne Debue for her help with the data cleaning. Further acknowledgements go to Adriana Principe, Melanie Köbel, Pedro Pinho, Thomas Parker, Steve Unger, Jon Gewirtzman and Margot McKleeven for the implementation of the study at their respective sites. We are very grateful to UNILEVER for sponsoring the Lipton tea bags and to the COST action ClimMani for scientific discussions, adoption and support to the idea of TeaComposition as a common metric. The initiative was supported by the following grants: ILTER Initiative Grant, ClimMani Short-Term Scientific Missions Grant (COST action ES1308; COST-STSM-ES1308-36004; COST-STM-ES1308-39006; ES1308-231015-068365), INTERACT (EU H2020 Grant No. 730938), and Austrian Environment Agency (UBA). Franz Zehetner acknowledges the support granted by the Prometeo Project of Ecuador's Secretariat of Higher Education, Science, Technology and Innovation (SENESCYT) as well as Charles Darwin Foundation for the Galapagos Islands (2190). Ana I. Sousa, Ana I. Lillebø and Marta Lopes thanks for the financial support to CESAM (UID/AMB/50017), to FCT/MEC through national funds (PIDDAC), and the co-funding by the FEDER, within the PT2020 Partnership Agreement and Compete 2020. The research was also funded by the Portuguese Foundation for Science and Technology, FCT, through SFRH/BPD/107823/2015 (A.I. Sousa), co-funded by POPH/FSE. Thomas Mozdzer thanks US National Science Foundation NSF DEB-1557009. Helena C. Serrano thanks Fundação para a Ciência e Tecnologia (UID/BIA/00329/2013). Milan Barna acknowledges Scientific Grant Agency VEGA (2/0101/18). Anzar A Khuroo acknowledges financial support under HIMADRI project from SAC-ISRO, India.

Authorship

ID designed and coordinated the study with extensive input from CB. IKS, SKR, KSL accomplished data collection and preparation. SKR conducted statistical analyses. KV and BB provided inputs for manuscript concept. ID wrote the manuscript with contribution from all authors. The TeaComposition team implemented the study and provided site specific and climatic data. The authors declare no conflict of interest.

Appendix A

Table 2s
General characteristics of the study sites within the TeaComposition initiative.

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
333	Patagonia	Argentina	-51.92	-70.41	165	6.40	202	Arid-temperate climate	Managed grassland	Pablo Peri
424	Facundo	Argentina	-45.11	-69.99	460	9.30	162	Arid-temperate climate	Shrubland	Laura Yahdjian
425	Aldea beleiro	Argentina	-45.58	-71.39	640	5.90	497	Arid-temperate climate	Grasland	Laura Yahdjian
426	Rio Mayo	Argentina	-45.39	-70.25	460	9.20	192	Arid-temperate climate	Shrub-grass steppe	Laura Yahdjian
427	Las Chilcas	Argentina	-36.28	-58.27	12	15.10	930	Warm-temperate, humid climate	Grassland	Laura Yahdjian
293	Cattai, NSW, Lilly	Australia	-31.83	152.64	5	14.50	799	Warm-temperate, humid climate	Restored swamp	Stacey Trevathan-Tackett
294	Cattai, NSW, Melaluca	Australia	-31.83	152.64	11	14.50	799	Warm-temperate, humid climate	Restored swamp	Stacey Trevathan-Tackett
295	Darawakh, NSW	Australia	-32.09	152.49	3	14.50	799	Warm-temperate, humid climate	Seasonal wetland	Stacey Trevathan-Tackett
296	Rhyll, Victoria	Australia	-38.46	145.29	0	14.30	832	Temperate climate	Grassland	Stacey Trevathan-Tackett
297	Rhyll, Victoria	Australia	-38.46	145.29	0	14.30	832	Temperate climate	Mangrove	Stacey Trevathan-Tackett
298	Rhyll, Victoria	Australia	-38.46	145.29	0	14.30	832	Temperate climate	Succulent saltmarsh	Stacey Trevathan-Tackett
411	Snowy Mountain_Mt Clarke	Australia	-36.42	148.28	2041	4.48	1979	Temperate climate	Alpine grassland	Ken Green
457	FNQ Rainforest SuperSite, Daintree, Cape Tribulation (Rainforest)	Australia	-16.10	145.45	56	24.40	5143	Wet tropical rainforest	Natural rainforest	Michael Liddell
458	Tumbarumba Wet Eucalypt SuperSite	Australia	-35.66	148.15	1100	9.60	1274	Temperate climate	Managed wet eucalypt forest	Jacqui Stol
459	Warra Tall Eucalypt SuperSite	Australia	-43.10	146.68	100	10.00	1379	Temperate climate	Natural tall eucalypt forest	Timothy Wardlaw
4.01	Zöbelboden-IP1	Austria	47.84	14.44	950	6.90	1061	Temperate climate	Spruce forest, initial Cardamino trifoliae-Fagetum sensu Willner 2002	Ika Djukic
4.02	Zöbelboden-IP2	Austria	47.84	14.44	950	6.90	1061	Temperate climate	Mixed beech, spruce, maple, ash forest. Potential naural vegetation:Adenostylo glabrae-Fagetum sensu Willner 2002	Ika Djukic
4.03	Zöbelboden-IP3	Austria	47.84	14.44	950	6.90	1061	Temperate climate	Mixed spruce-beech forest	Ika Djukic
4.04	Zöbelboden-nutrient addition	Austria	47.84	14.44	950	6.90	1061	Temperate climate	Spruce forest; initial carbonate spruce-fir-beech forest	Ika Djukic
6	Klausen-Leopoldsdorf	Austria	48.11	16.08	510	8.10	724	Temperate climate	Beech forest	Ferdinand Kristöfel
7	Mondsee	Austria	47.88	13.35	860	7.20	1353	Temperate climate	Mixed spruce-broadleaved forest	Ferdinand Kristöfel
8	Mürzzuschlag	Austria	47.63	15.66	715	5.20	978	Temperate climate	Spruce forest	Ferdinand Kristöfel
9	Murau	Austria	47.06	14.11	1540	3.30	1366	Temperate climate	Spruce forest	Ferdinand Kristöfel
10	Jochberg	Austria	47.33	12.41	1050	3.00	1143	Temperate climate	Spruce forest	Ferdinand Kristöfel
11	AREC Raumberg-Gumpenstein	Austria	47.50	14.15	720	9.10	1088	Temperate climate	Meadow	Andreas Bohner
12	Neustift im Stubaital	Austria	47.12	11.30	970	6.50	852	Temperate climate	Managed grassland	Georg Wohlfahrt
13	Illmitz	Austria	47.77	16.75	113	10.10	599	Temperate climate	Managed grassland	Thomas Zechmeister
14	Pürgschachen Moor	Austria	47.58	14.35	632	7.30	1248	Temperate climate	Peat bog	Simon Drollinger
15	Jamtalferner	Austria	46.85	10.15	2960	-4.43	1374	Temperate climate	High alpine	Andrea Fischer
275	Gossenköllesee	Austria	47.23	11.01	2417	3.20	1112	Temperate climate	High alpine	Birgit Sattler
16	Jalhay-La Robinette	Belgium	50.55	6.07	500	7.70	1134	Temperate climate	Forest	Monique Carnol
17	Waroneu	Belgium	50.57	6.10	420	7.70	1134	Temperate climate	Forest	Monique Carnol
18	Brasschaat	Belgium	51.31	4.52	14	10.00	785	Temperate climate	Scots pine forest	Arne Verstraeten
19	Zoniënwoud	Belgium	50.75	4.41	129	9.90	823	Temperate climate	Beech forest	Arne Verstraeten
20	Gontrode	Belgium	50.98	3.80	26	10.00	776	Temperate climate	Pedunculate oak - Beech forest	Arne Verstraeten
21	Ravels	Belgium	51.40	5.05	35	9.50	799	Temperate climate	Corsican pine forest	Arne Verstraeten
22	Wijnendale	Belgium	51.07	3.04	31	10.10	708	Temperate climate	Beech forest	Arne Verstraeten
351	Zedelgem (FORBIO)	Belgium	51.15	3.12	15	10.10	708	Temperate climate	Tree plantations	Kris Verheyen
352	Gedinne (FORBIO)	Belgium	49.99	4.98	397	10.40	670	Temperate climate	Tree plantations	Quentin Ponette
353	Hechtel-Eksel (FORBIO)	Belgium	51.16	5.31	56	8.60	1030	Temperate climate	Tree plantations	Bart Muys
346.01	BO-TUC-COP	Bolivia	-16.22	-68.27	4862	4.02	785	Semi-arid tropical climate	Tropical dry alpine (Subnival), Grassland (Xerophytic Puna)	Rosa Isela Meneses
346.02	BO-TUC-PAT	Bolivia	-16.21	-68.27	5058	3.58	799	Semi-arid tropical climate	Tropical dry alpine (Nival), Grassland (Mesic Puna)	Rosa Isela Meneses
346.03	BO-TUC-WAT	Bolivia	-16.23	-68.26	4650	5.33	749	Semi-arid tropical climate	Tropical dry alpine (subnival), Grassland (Mesic Puna)	Rosa Isela Meneses
347.01	BO-SAJ-HUI	Bolivia	-18.12	-68.96	4567	2.49	382	Semi-arid tropical climate	Semi-arid tropical, climate (Subnival),	Rosa Isela Meneses

(continued on next page)

Table 2s (*continued*)

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
									Shrubland and grassland (Xerophytic Puna)	
347.02	BO-SAJ-JAS	Bolivia	-18.16	-68.86	4931	4.30	373	Semi-arid tropical climate	Semi-arid tropical, climate (Nival), Shrubland and grassland (Xerophytic Puna)	Rosa Isela Meneses
347.03	BO-SAJ-PAC	Bolivia	-18.21	-68.97	4192	2.33	377	Semi-arid tropical climate	Semi-arid tropical climate (Alpin), Shrubland and grassland (Xerophytic Puna)	Rosa Isela Meneses
347.04	BO-SAJ-SUM	Bolivia	-18.13	-68.94	4759	5.60	344	Semi-arid tropical climate	Semi-arid tropical climate (Subnival), Shrubland and grassland (Xerophytic Puna)	Rosa Isela Meneses
28	Mata dos Godoy State Park	Brazil	-23.43	-51.23	620	20.60	1486	Equatorial humid climate; tropical rain forest	Forest fragment and restoration site	Jose Marcelo Torezan
29	Congonhas Farm	Brazil	-22.73	-51.18	340	22.20	1285	Equatorial humid climate; tropical rain forest	Forest fragment and restoration site	Jose Marcelo Torezan
30	Alvorada Farm	Brazil	-22.98	-50.93	340	22.00	1271	Equatorial humid climate; tropical rain forest	Forest fragment and restoration site	Jose Marcelo Torezan
31.01	Natal Restinga Forest	Brazil	-5.90	-35.17	40	25.70	1298	Equatorial humid climate; tropical rain forest	Restinga forest	Adriano Caliman
31.02	Natal Restinga Shrubs	Brazil	-5.91	-35.18	50	25.70	1298	Equatorial humid climate; tropical rain forest	Restinga shrubland	Adriano Caliman
32.01	Bodoquena	Brazil	-20.99	-56.52	378	22.40	1353	Subtropical arid	Savannah forested	Franco Leandro de Souza
32.02	Bodoquena	Brazil	-21.00	-56.51	367	22.40	1353	Subtropical arid	Savannah forested	Franco Leandro de Souza
32.03	Bodoquena	Brazil	-21.00	-56.51	358	22.40	1353	Subtropical arid	Riparian forest	Franco Leandro de Souza
33.01	Restinga de Jurubatiba - Forest	Brazil	-22.26	-41.61	20	25.70	1298	Equatorial humid climate	Restinga forest	Rodrigo Lemes Martins
33.02	Restinga de Jurubatiba - Shrubs	Brazil	-22.26	-41.61	30	25.70	1298	Equatorial humid climate	Restinga shrubland	Rodrigo Lemes Martins
34.01	Floodplain Paraná River	Brazil	-22.80	-53.54	250	22.80	1280	Semi-arid tropical climate	Atlantic forest	Evanilde Benedito
34.02	Floodplain Paraná River	Brazil	-22.86	-53.60	250	22.80	1280	Semi-arid tropical climate	Atlantic forest and grassland	Evanilde Benedito
34.03	Floodplain Paraná River	Brazil	-22.72	-53.30	250	22.80	1280	Semi-arid tropical climate	Shrubland	Evanilde Benedito
34.04	Floodplain Paraná River	Brazil	-22.71	-53.28	250	22.80	1280	Semi-arid tropical climate	Shrubland and grassland	Evanilde Benedito
34.05	Floodplain Paraná River	Brazil	-22.77	-53.33	250	22.80	1280	Semi-arid tropical climate	Shrubland	Evanilde Benedito
34.06	Floodplain Paraná River	Brazil	-22.72	-53.22	250	22.80	1280	Semi-arid tropical climate	Atlantic forest	Evanilde Benedito
35	Tijuca National Park	Brazil	-22.96	-42.27	350	23.00	1157	Equatorial humid climate; tropical rain forest	NA	Vinicius Farjalla
36	Fazenda Miranda	Brazil	-15.73	-56.07	184	26.00	1268	Semi-arid tropical climate	Native forest	Francisco Lobo
37	Baia das Pedras	Brazil	-28.37	-68.28	127	26.20	1245	Subtropical arid climate	Native forest	Francisco Lobo
38	Parque Estadual do Utinga	Brazil	-1.43	-48.42	18	26.80	2369	Equatorial humid climate; tropical rain forest	NA	Thaisa Sala Michelan
23	Beklemeto	Bulgaria	42.78	24.61	1420	7.50	682	Temperate climate	Beech forest	Miglena Zhiyanski
24	Sofia-FRI	Bulgaria	42.63	23.35	650	8.60	602	Temperate climate	Cedrus atlantica trees	Maria Glushkova
25	Sofia-FRI	Bulgaria	42.63	23.20	650	8.60	581	Temperate climate	Grassland	Maria Glushkova
26	Govedarci	Bulgaria	42.23	23.44	1310	5.90	658	Temperate climate	Spruce forest	Miglena Zhiyanski
27	Govedarci	Bulgaria	42.24	23.44	1320	5.60	658	Temperate climate	Grassland	Miglena Zhiyanski
414	Dinderesso Forest	Burkina Faso	11.21	-4.40	397	27.10	1014	Semi-arid tropical climate	Savanah shrub	Jean-Christophe Lata
39	Flashline Mars Arctic Research Station	Canada	75.43	-89.82	225	-17.30	131	Arctic climate	NA	Susan Holden Martin
320	Igloolik (Nunavut)	Canada	69.40	-81.54	15	-14.37	115	Arctic climate	Tundra	Nicolas Lecomte
362	IDENT-Sault Ste. Marie	Canada	46.87	-84.57	210	-0.80	327	Temperate climate	Plantation	Bill Parker
363	IDENT-Montreal	Canada	45.86	-73.93	39	6.20	976	Temperate climate	High input agriculture	Alain Paquette
364	IDENT-Auclair	Canada	48.23	-69.10	333	2.30	1015	Temperate climate	Low input abandoned agriculture	Alain Paquette
444	Bylot Island	Canada	73.16	-79.97	20	-15.40	175	Arctic climate	Tundra	Vincent Maire
445	Umiujaq	Canada	56.55	-76.55	5	-5.40	525	Arctic climate	Tundra	Vincent Maire
40	Pan de Azúcar, fog zone	Chile	-26.15	-70.65	814	18.00	16	Subtropical arid climate	Desert with fog influence	Rafaella Canessa
41	Pan de Azúcar, interior zone	Chile	-26.15	-70.65	533	18.00	16	Subtropical arid climate	Desert	Rafaella Canessa
42	Reserva Quebrada de Talca	Chile	-30.01	-71.04	648	13.50	92	Mediterranean climate	Shrubland	Rafaella Canessa
43	Parque Nacional La Campana	Chile	-32.92	-71.15	726	13.40	377	Mediterranean climate	Mediterranean Forest	Rafaella Canessa
44	Parque Nacional Nahuelbuta	Chile	-37.78	-72.98	1205	8.10	1525	Temperate climate	Temperate Rain Forest	Rafaella Canessa
45	Monumento Nacional Contulmo	Chile	-38.02	-73.23	350	11.00	1544	Temperate climate	Temperate Rain Forest	Rafaella Canessa

46	Fray Jorge National Park	Chile	-30.67	-71.67	450	15.70	134	Temperate climate	Temperate Fog Forest	Aurora Gaxiola
47	LTSER Senda Darwin Biological Station	Chile	-42.47	-74.12	200	8.40	2140	Temperate climate	NA	Aurora Gaxiola
48	Punta Arenas	Chile	-53.17	-71.62	100	4.90	795	Temperate climate	Native Forest	Aurora Gaxiola
49	Fundo San Martin, Valdivia	Chile	-39.82	-73.15	115	11.70	2011	Temperate climate	Native Forest	Aurora Gaxiola
50	Omora Biosphere Reserve	Chile	-54.93	-67.32	50	4.70	480	Subantartic climate	Native Forest	Aurora Gaxiola
51	Parque Nacional Nahuelbuta	Chile	-37.78	-72.98	1205	8.10	1525	Mediterranean climate	Temperate Rain Forest	Liesbeth van den Brink
52	Parque Nacional La Campana	Chile	-32.97	-71.08	721	13.40	377	Mediterranean climate	Mediterranean Forest	Liesbeth van den Brink
53	Reserva Quebrada de Talca	Chile	-30.01	-71.04	636	13.50	92	Mediterranean climate	Shrubland	Liesbeth van den Brink
54	Parque Nacional Pan de Azucar	Chile	-26.15	-70.65	511	18.00	16	Subtropical arid climate	Desert	Liesbeth van den Brink
55	Hulunbeier grassland, Inner Monglia	China	50.17	119.37	516	-1.80	374	Arid-temperate climate	Managed grassland	Wentao Luo
281	Xishuangbanna	China	22.01	100.80	556	21.70	1460	Semi-arid tropical climate	Primary forest	Wenjun Zhou
282	Yuanjiang	China	28.95	112.60	30	24.30	790	Warm-temperate, humid climate	Savannah forested	Wenjun Zhou
283	Ailao Mountain	China	23.83	101.57	1852	11.00	1980	Semi-arid tropical climate	Primary forest	Wenjun Zhou
284	Lijiang	China	26.87	100.23	2517	9.10	1160	Arid-temperate climate	Primary forest	Wenjun Zhou
285	Jilin	China	42.38	128.08	802	2.50	688	Temperate climate	Secondary forest and white brich plantation	Yalin Hu
286	Liaoning	China	41.85	124.93	597	4.80	885	Temperate climate	Laruch monoculture	Yalin Hu
287	Zhejiang	China	29.97	122.35	786	16.70	1249	Warm-temperate, humid climate	Secondary forest and chinese fir plantation	Yalin Hu
288	Fujian	China	26.56	118.11	360	18.70	1729	Semi-arid tropical climate (Subtropical climate)	Secondary forest and chinese fir plantation	Yalin Hu
289	Hainan	China	18.73	108.89	800	21.70	1523	Semi-arid tropical climate (Topical climate)	Secondary forest and chinese fir plantation	Yalin Hu
290	Jiangxi	China	24.56	114.43	550-600	18.50	1821	Semi-arid tropical climate (Subtropical climate)	Secondary forest and chinese fir plantation	Yalin Hu
291	Hunan	China	26.85	109.61	432	16.50	1280	Semi-arid tropical climate (Subtropical climate)	Secondary forest and chinese fir plantation	Yalin Hu
292	Inner Mongolia	China	42.50	122.32	120	7.60	506	Arid-temperate climate	Mongolian pine monoculture	Wentao Luo
359	BEF-China Main Experiment: Site A	China	29.12	117.91	180	17.10	1777	Warm-temperate, humid climate	Subtropical broadleaf forest	Heike Feldhaar
428	Dinghushan	China	23.17	112.17	200-350	21.85	1773	Humid-arid tropical climate	NA	Jiangming Mo
56.01	CATIE, Turrialba	Costa Rica	9.89	-83.65	600	22.40	3113	Equatorial humid climate; tropical rain forest	Mature secondary forest and mature disturbed forest	Geovana Carreno
56.02	CATIE, Turrialba	Costa Rica	9.90	-83.67	615	22.40	3113	Equatorial humid climate; tropical rain forest	Coffee agroforestry	Geovana Carreno
454	La Gamba	Costa Rica	8.70	-83.20	80	25.20	5748	Equatorial humid climate; tropical rain forest	Secondary forest	Florian Hofhansl
455	La Gamba	Costa Rica	8.70	-83.20	80	25.20	5748	Equatorial humid climate; tropical rain forest	Primary forest	Florian Hofhansl
57	Nature Reserve Červený kříž	Czech Republic	49.99	13.93	420	7.50	584	Temperate climate	Oak forest	Petr Petřík
418	Načetín	Czech Republic	50.59	13.25	775	5.40	789	Temperate climate	Spruce forest	Michal Ruzek
419	Načetín	Czech Republic	50.59	13.27	805	5.40	789	Temperate climate	Natural monocultural beech forest	Michal Ruzek
447	Kahuzi-Biega	Democratic Republic Congo	-2.32	28.75	1900	14.90	1796	Equatorial humid climate; tropical rain forest	Natural forest (montane)	Marijn Bauters
448	Yoko	Democratic Republic Congo	0.29	25.30	400	24.90	1779	Equatorial humid climate; tropical rain forest	Natural forest (lowland)	Marijn Bauters
449	Yangambi Arboretum	Democratic Republic Congo	0.79	24.49	400	24.50	1770	Equatorial humid climate; tropical rain forest	Forest plantation	Marijn Bauters
63	Mols	Denmark	56.39	10.96	57	7.80	573	Temperate climate	Grass, heath	Inger Kappel Schmidt
64	Brandbjerg	Denmark	55.26	11.27	5	8.30	591	Temperate climate	Grass, heath	Klaus Steenberg Larsen
66	Odsherred	Denmark	55.83	11.70	30	8.20	602	Temperate climate	Forest	Inger Kappel Schmidt
67	Mattrup	Denmark	55.16	10.04	110	7.20	796	Temperate climate	Forest	Inger Kappel Schmidt
68	Valloe	Denmark	55.42	12.05	46	8.30	596	Temperate climate	NA	Inger Kappel Schmidt
69	Nørholm	Denmark	56.13	9.02	52	7.50	803	Temperate climate	NA	Inger Kappel Schmidt
70	Kragelund	Denmark	56.17	9.42	85	7.30	748	Temperate climate	NA	Inger Kappel Schmidt
336	EC_ANT	Ecuador	-0.48	-78.14	5509	8.00	1336	Equatorial humid climate; Montane Grasslands and Shrublands	Grassland	Priscilla Muriel
337	EC_PIC	Ecuador	-0.18	-78.60	4676	10.60	1320	Equatorial humid climate; Montane Grasslands and Shrublands	Native grassland	Francisco Cuesta
339.01	EC_PNP1	Ecuador	-4.11	-79.16	3311	14.50	1163	Equatorial humid climate	Native shrubland	Marina Mazón

(continued on next page)

Table 2s (*continued*)

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
339.02	EC_PNP2	Ecuador	-4.11	-79.16	3352	14.50	1163	Equatorial humid climate	Native shrubland	Marina Mazón
339.03	EC_PNP3	Ecuador	-4.10	-79.16	3367	14.50	1163	Equatorial humid climate	Native shrubland	Marina Mazón
453.01	Galapagos WP169, Garrapatero - cinder cone	Ecuador	-0.70	-90.23	57	23.89	260	Subtropical arid climate	Semi-dry, deciduous vegetation	Heinke Jäger & Franz Zehetner
453.02	Galapagos WP171, Garrapatero - lava flow	Ecuador	-0.68	-90.22	47	23.91	276	Subtropical arid climate	Semi-dry, deciduous vegetation	Heinke Jäger & Franz Zehetner
453.03	Galapagos WP172, Garrapatero - cinder cone	Ecuador	-0.67	-90.25	210	22.99	302	Subtropical arid climate	Sub-tropical deciduous and evergreen shrubs and small trees	Heinke Jäger & Franz Zehetner
453.04	Galapagos WP180, Garrapatero - lava flow	Ecuador	-0.67	-90.25	231	22.62	315	Subtropical arid climate	Sub-tropical deciduous and evergreen shrubs and small trees	Heinke Jäger & Franz Zehetner
453.05	Galapagos WP174, Cerro Mesa - cinder cone	Ecuador	-0.64	-90.29	497	21.56	338	Subtropical arid climate	Mosaic of sub-tropical herb, evergreen shrub and tree vegetation, semi natural	Heinke Jäger & Franz Zehetner
453.06	Galapagos WP175, Cerro Mesa - lava flow	Ecuador	-0.64	-90.29	424	21.56	338	Subtropical arid climate	Mosaic of sub-tropical herb, evergreen shrub and tree vegetation, semi natural	Heinke Jäger & Franz Zehetner
453.07	Galapagos WP184, Cerro Crocker - cinder cone	Ecuador	-0.64	-90.33	866	19.87	398	Subtropical arid climate	Sub-tropical shrub and fern vegetation	Heinke Jäger & Franz Zehetner
453.08	Galapagos WP185, Cerro Crocker - lava flow	Ecuador	-0.65	-90.33	800	19.87	398	Subtropical arid climate	Sub-tropical shrub and fern vegetation	Heinke Jäger & Franz Zehetner
71	Saarejärve-1	Estonia	58.66	26.76	56	4.90	606	Temperate climate	Pine forest	Ivika Ostonen
72	Saarejärve-2	Estonia	58.65	26.76	45	4.90	606	Temperate climate	Spruce forest	Ivika Ostonen
73	Vilsandi	Estonia	58.39	21.84	2	6.00	586	Temperate climate	Pine forest	Ivika Ostonen
74	Tõravere	Estonia	58.28	26.46	67	5.00	598	Temperate climate	Spruce forest	Ivika Ostonen
75	Sagadi	Estonia	59.56	26.05	45	4.80	624	Temperate climate	Pine forest	Ivika Ostonen
76	Vihula	Estonia	59.58	26.13	14	4.80	624	Temperate climate	Pine forest	Ivika Ostonen
77	Vändra	Estonia	58.71	25.06	43	5.20	672	Temperate climate	Spruce forest	Ivika Ostonen
78	Kuusnõmme	Estonia	58.31	21.97	5	6.00	592	Temperate climate	Mixed pine and spruce forest	Ivika Ostonen
79	Järvselja-1	Estonia	58.31	27.33	33	5.00	604	Temperate climate	Drained pine forest, monoculture	Ivika Ostonen
80	Järvselja-2	Estonia	58.30	27.29	31	5.00	604	Temperate climate	Drained spruce forest, monoculture	Ivika Ostonen
81	Järvselja-3	Estonia	58.29	27.32	33	5.00	604	Temperate climate	Drained birch forest	Ivika Ostonen
82	Lammi Biological Station	Finland	61.05	25.04	112	3.70	645	Boreal climate	Native broad-leaf and spruce forests	John Loehr
446	Värriö	Finland	67.75	29.61	392	-1.30	537	Boreal climate	NA	Frank Berninger
83	83c - Landemarais	France	49.00	-1.18	145	10.60	636	Temperate climate	Restored peatland	André-Jean Francez
84	Arboretum Champenoux, 54	France	48.75	6.34	256	9.40	765	Temperate climate	Exotic and local trees	Marie-Noëlle Pons
85	La Bouzule, 54	France	48.74	6.32	225	9.40	765	Temperate climate	Grassland	Marie-Noëlle Pons
86	Garden 1, Fléville-devant-Nancy	France	48.63	6.21	236	9.40	775	Temperate climate	Vegetable garden	Marie-Noëlle Pons
87	GISFI station, Homécourt, 54	France	49.22	6.00	231	9.50	795	Temperate climate	Afforested grassland	Florence Maunoury-Danger
88	Temperate Forest 1, Hémilly, 57	France	49.03	6.50	280	9.20	789	Temperate climate	Mixedforest	Florence Maunoury-Danger
89	Riparian forest, Liverdun, 54	France	48.76	6.06	200	9.30	743	Temperate climate	Alluvial forest	Michael Danger
90	Settling pond 1, Pompey, 54	France	48.77	6.14	207	9.30	743	Temperate climate	Afforested settling pond	Florence Maunoury-Danger
91	Settling pond 2, Russange, 54	France	49.48	5.93	378	8.90	818	Temperate climate	Afforested settling pond	Florence Maunoury-Danger
92	Gravel pit 1, Corny, 57	France	49.01	6.05	167	9.60	736	Temperate climate	Alluvial forest	Michael Danger
93	Gravel pit 2, Dieulouard, 54	France	48.83	6.08	177	9.30	743	Temperate climate	Alluvial forest	Michael Danger
94	Chitelet Botanical Garden, 88	France	48.04	7.00	1225	9.30	1344	Temperate climate	Wetland	Sylvie Dousset
95	JM Pelt Botanical Garden, 54	France	48.87	6.18	245	11.10	618	Temperate climate	Botanical garden	Sylvie Dousset
96	Forest soil SBL, Haye Forest, 54	France	48.64	6.12	382	11.10	618	Temperate climate	Mixed forest	Sylvie Dousset
97	Forest soil Rendzine, Haye Forest, 54	France	48.64	6.10	402	11.10	618	Temperate climate	Mixed forest	Sylvie Dousset
98	Haut Jacques - Podzol, 88	France	48.28	6.86	600	9.30	1344	Temperate climate	Mixed forest	Sylvie Dousset
99	Haut Jacques - SBA, 88	France	48.28	6.86	600	9.30	1344	Temperate climate	Mixed forest	Sylvie Dousset
100	Rudlin - SOP, 88	France	48.12	7.04	600	9.30	1344	Temperate climate	Alpine grassland	Sylvie Dousset
101	Rudlin - SBA, 88	France	48.12	7.04	600	9.30	1344	Temperate climate	Alpine grassland	Sylvie Dousset
108	LTSERZAA_ORCHAMP_ CHAMROUSSE_1_CHAM1250	France	45.07	5.86	1249	7.50	1220	Temperate climate	Deciduous Broad-leaved Forest	Thomas Spiegelberger
109	LTSERZAA_ORCHAMP_ CHAMROUSSE_2_CHAM1470	France	45.09	5.86	1471	7.50	1220	Temperate climate	Mixed Forest	Thomas Spiegelberger
110	LTSERZAA_ORCHAMP_ CHAMROUSSE_3_CHAM1710	France	45.11	5.89	1713	6.20	1158	Temperate climate	Evergreen Coniferous Forest	Thomas Spiegelberger

111	LTSERZAA_ORCHAMP_CHAMROUSSE_4_CHAM1890	France	45.11	5.90	1887	4.70	1032	Temperate climate	Forest-grassland ecotone	Thomas Spiegelberger
112	LTSERZAA_ORCHAMP_CHAMROUSSE_5_CHAM2020	France	45.12	5.91	2021	4.70	1032	Temperate climate	Mountain Grassland	Thomas Spiegelberger
113	LTSERZAA_ORCHAMP_CHAMROUSSE_6_CHAM2180	France	45.12	5.91	2179	3.10	877	Temperate climate	Alpine meadow	Thomas Spiegelberger
118	LTSERZAA_ORCHAMP_RISTOLAS_1_RIS1870	France	44.75	7.00	1876	5.10	532	Temperate climate	Deciduous Coniferous Forest	Amélie Saillard
121	LTSERZAA_ORCHAMP_RISTOLAS_4_RIS2540	France	44.71	7.05	2555	1.75	403	Temperate climate	Alpine meadow	Amélie Saillard
125	FR AME CFE - Cime de Fer	France	44.33	6.94	2700	0.70	508	Temperate climate	Alpine meadow	Philippe Choler
129	FR AME LAU - Butte des Laussets	France	44.33	6.91	2508	2.50	674	Temperate climate	Subalpine grassland	Philippe Choler
132.01	Lyon (grasslands)	France	45.78	4.87	170	11.50	783	Temperate climate	Urban grassland	Pierre Marmonier
132.02	Lyon (undercover)	France	45.78	4.87	170	11.50	783	Temperate climate	Urban forest	Pierre Marmonier
133	Kerguelen Islands	France	-49.35	70.21	15	4.87	753	(Sub-)Arctic climate (Subantartic climate)	Grassland	Marc Lebouvier
134	Forêt de Chaux	France	47.10	5.73	260	10.50	943	Temperate climate	Forest	Eric Lucot
135	Zone Atelier Plaine et Val de Sèvre	France	46.14	-0.49	66	12.40	901	Temperate climate	Agriculture	Vincent Bretagnolle
136	Tourbière de la Guette	France	47.32	2.28	165	11.00	705	Temperate climate	Peatland	Sébastien Gogo
137	Vosges (88)	France	48.17	5.94	420	9.20	852	Temperate climate	Agriculture	Marie-Noëlle Pons
138	Experimental station Gardouch	France	43.37	1.67	180	12.80	751	Temperate climate	Forest	Joël Merlet
139	Toulouse (VCG)	France	43.60	1.44	333	12.70	698	Temperate climate	Semi-natural grassland	Annie Ouin
361	ORPHEE	France	44.74	-0.80	60	12.75	876	Temperate climate	Pine plantation	Hervé Jactel
367	LTSERZAA_ORCHAMP_LORIAZ_1_LORI1370	France	46.03	6.92	1359	7.10	1207	Temperate climate	Mixed forest	Amélie Saillard
368	LTSERZAA_ORCHAMP_LORIAZ_2_LORI1620	France	46.03	6.92	1606	6.00	1170	Temperate climate	Coniferous forest	Amélie Saillard
369	LTSERZAA_ORCHAMP_LORIAZ_3_LORI1800	France	46.04	6.92	1785	6.00	1170	Temperate climate	Coniferous forest	Amélie Saillard
370	LTSERZAA_ORCHAMP_LORIAZ_4_LORI1930	France	46.04	6.91	1923	4.30	1104	Temperate climate	Forest-grassland ecotone	Amélie Saillard
371	LTSERZAA_ORCHAMP_LORIAZ_5_LORI2130	France	46.04	6.92	2125	2.70	975	Temperate climate	Subalpine grassland	Amélie Saillard
372	LTSERZAA_ORCHAMP_LORIAZ_6_LORI2330	France	46.05	6.91	2324	2.70	975	Temperate climate	Alpine meadow	Amélie Saillard
373	FR AME CBA - Cime des Barbarottes	France	44.30	6.94	2792	0.70	508	Temperate climate	Alpine scree	Philippe Choler
403	ZA Armorique-Pleine Fougères	France	48.49	-1.57	93	10.60	636	Temperate climate	Forest and wetland	Romain Georges
404	ZA Armorique - Sougeal	France	48.51	-1.51	70	10.60	636	Temperate climate	Wet grassland	Romain Georges
405	ZA Armorique - Rimou	France	48.40	-1.51	26	10.60	636	Temperate climate	Grassland	Romain Georges
420.01	Toulouse-PYGAR-Auradé	France	43.56	1.06	157	12.40	730	Temperate climate	Agriculture (grass band along stream)	Jean-Luc Probst
420.02	Toulouse-PYGAR-Auradé	France	43.56	1.07	178	12.40	730	Temperate climate	Agriculture (fallow)	Jean-Luc Probst
420.03	Toulouse-PYGAR-Auradé	France	43.56	1.07	198	12.40	730	Temperate climate	Agriculture (grass fallow)	Jean-Luc Probst
421	Toulouse-PYGAR-Baget	France	42.96	1.03	522	9.30	964	Temperate climate	Grassland	Anne Probst
422.01	Toulouse-PYGAR-Bernadouze	France	42.80	1.42	1355	5.30	1191	Temperate climate	Peatland	Thierry Camboulive
422.02	Toulouse-PYGAR-Bernadouze	France	42.80	1.42	1433	7.20	952	Temperate climate	Forest	Thierry Camboulive
423	Toulouse-PYGAR-Météo	France	43.57	1.37	157	12.70	698	Temperate climate	Grassland	Christine Delire
58	Bad Lauchstädt	Germany	51.39	11.88	119	9.00	492	Temperate climate	Grassland	Jutta Stadler
59	Bayreuth	Germany	49.97	11.51	336	7.00	720	Temperate climate	Deciduous Forest	Jutta Stadler
60.01	Rhine-Main-Observatory	Germany	50.15	9.00	115	9.50	665	Temperate climate	Grassland, intensively use	Marlen Mährlein
60.02	Rhine-Main-Observatory	Germany	50.17	9.06	115	9.50	662	Temperate climate	Grassland, intensively use	Marlen Mährlein
60.03	Rhine-Main-Observatory	Germany	50.13	8.96	130	9.90	644	Temperate climate	Deciduous Forest	Marlen Mährlein
60.04	Rhine-Main-Observatory	Germany	50.18	9.08	135	9.50	662	Temperate climate	Deciduous Forest	Marlen Mährlein
61	Landau	Germany	49.25	7.96	200	8.70	644	Temperate climate	Plot forest: mixed beech forest; vineyard: vineyard; stream floodplain: alluvial stream floodplain	Stefan Stoll
62	Hiddensee	Germany	54.55	13.10	1	8.20	545	Temperate climate	Coastal heath	Andrey Malyshev
140	Lüss	Germany	52.84	10.27	109	8.80	835	Temperate climate	Deciduous Forest	Meesenburg, Henning
141.01	Lange Bramke, Kamm	Germany	51.86	10.42	659	5.90	1339	Temperate climate	Coniferous forest	Meesenburg, Henning
141.02	Lange Bramke, Nordhang	Germany	51.85	10.41	597	5.90	1339	Temperate climate	Coniferous forest	Meesenburg, Henning

(continued on next page)

Table 2s (*continued*)

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
141.03	Lange Bramke, Südhang	Germany	51.86	10.41	597	5.90	1339	Temperate climate	Coniferous forest	Meesenburg, Henning
142	Solling, Buche	Germany	51.76	9.58	504	6.90	1193	Temperate climate	Deciduous Forest	Meesenburg, Henning
143	Solling, Fichte	Germany	51.76	9.58	508	6.90	1193	Temperate climate	Coniferous forest	Meesenburg, Henning
144	Göttinger Wald	Germany	51.53	10.05	420	8.40	773	Temperate climate	Deciduous Forest	Meesenburg, Henning
145	Augustendorf	Germany	52.91	7.86	33	9.00	820	Temperate climate	Deciduous Forest	Meesenburg, Henning
146	Ehrhorn	Germany	53.18	9.90	115	9.00	785	Temperate climate	Deciduous Forest	Meesenburg, Henning
147	Schafstaedt	Germany	51.37	11.74	172	8.00	611	Temperate climate	Meadow	Mark Frenzel
148	Friedeburg	Germany	51.60	11.72	98	8.00	611	Temperate climate	Meadow	Mark Frenzel
149	Greifenhagen	Germany	51.63	11.46	265	7.80	614	Temperate climate	Meadow	Mark Frenzel
150	Siptenfelde	Germany	51.65	11.05	397	7.80	561	Temperate climate	Pasture	Mark Frenzel
151	Harsleben	Germany	51.84	11.06	152	7.80	561	Temperate climate	Meadow	Mark Frenzel
152	Wanzleben	Germany	52.08	11.44	98	8.80	513	Temperate climate	Mown meadow	Mark Frenzel
153	Mueggelsee	Germany	52.00	14.68	35	9.10	553	Temperate climate	NA	Rita Adrian
154	Hohes Holz	Germany	52.09	11.22	193	8.80	529	Temperate climate	Mixed beech forest	Corinna Rebmann
155.01	Biodiversity-Exploratories, Hainich	Germany	50.97	10.40	330	7.30	702	Temperate climate	Mown pasture	Ute Hamer
155.02	Biodiversity-Exploratories, Hainich	Germany	51.08	10.42	330	7.30	702	Temperate climate	Mown pasture	Ute Hamer
155.03	Biodiversity-Exploratories, Hainich	Germany	51.10	10.42	330	7.70	666	Temperate climate	Mown pasture	Ute Hamer
155.04	Biodiversity-Exploratories, Hainich	Germany	51.27	10.42	330	7.70	666	Temperate climate	Mown pasture	Ute Hamer
155.05	Biodiversity-Exploratories, Hainich	Germany	51.27	10.32	330	7.70	695	Temperate climate	Mown pasture	Ute Hamer
155.06	Biodiversity-Exploratories, Hainich	Germany	51.05	10.38	330	7.30	778	Temperate climate	Mown pasture	Ute Hamer
155.07	Biodiversity-Exploratories, Hainich	Germany	51.00	10.40	330	7.70	666	Temperate climate	Mown pasture	Ute Hamer
155.08	Biodiversity-Exploratories, Hainich	Germany	51.20	10.42	330	7.30	702	Temperate climate	Pasture	Ute Hamer
155.09	Biodiversity-Exploratories, Hainich	Germany	51.02	10.37	330	7.70	695	Temperate climate	Pasture	Ute Hamer
155.1	Biodiversity-Exploratories, Hainich	Germany	51.27	10.43	330	7.70	666	Temperate climate	Mown pasture	Ute Hamer
155.11	Biodiversity-Exploratories, Hainich	Germany	51.27	10.45	330	7.70	695	Temperate climate	Mown pasture	Ute Hamer
155.12	Biodiversity-Exploratories, Hainich	Germany	51.30	10.37	330	7.70	695	Temperate climate	Mown pasture	Ute Hamer
155.13	Biodiversity-Exploratories, Hainich	Germany	50.97	10.75	330	7.70	695	Temperate climate	Pasture	Ute Hamer
155.14	Biodiversity-Exploratories, Hainich	Germany	51.28	10.37	330	7.80	580	Temperate climate	Pasture	Ute Hamer
155.15	Biodiversity-Exploratories, Hainich	Germany	51.22	10.58	330	7.70	695	Temperate climate	Meadow	Ute Hamer
155.16	Biodiversity-Exploratories, Hainich	Germany	51.27	10.50	330	7.90	638	Temperate climate	Meadow	Ute Hamer
155.17	Biodiversity-Exploratories, Hainich	Germany	51.27	10.50	330	7.90	638	Temperate climate	Meadow	Ute Hamer
155.18	Biodiversity-Exploratories, Hainich	Germany	51.07	10.43	330	7.90	638	Temperate climate	Mountain grassland	Ute Hamer
155.19	Biodiversity-Exploratories, Hainich	Germany	51.18	10.45	330	7.70	666	Temperate climate	Pasture	Ute Hamer
155.2	Biodiversity-Exploratories, Hainich	Germany	51.20	10.43	330	7.70	695	Temperate climate	Pasture	Ute Hamer
155.21	Biodiversity-Exploratories, Hainich	Germany	51.22	10.47	330	7.70	695	Temperate climate	Mown pasture	Ute Hamer
155.22	Biodiversity-Exploratories, Hainich	Germany	50.98	10.37	330	7.70	695	Temperate climate	Pasture	Ute Hamer
155.23	Biodiversity-Exploratories, Hainich	Germany	51.20	10.42	330	7.30	702	Temperate climate	Mown pasture	Ute Hamer
156.01	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.08	13.97	50	8.60	560	Temperate climate	Mown pasture	Ute Hamer
156.02	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.09	13.97	50	8.60	560	Temperate climate	Mown pasture	Ute Hamer
156.03	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	13.98	50	8.60	560	Temperate climate	Mown pasture	Ute Hamer
156.04	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	14.00	50	8.70	547	Temperate climate	Mown pasture	Ute Hamer
156.05	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	14.00	50	8.70	547	Temperate climate	Mown pasture	Ute Hamer
156.06	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	13.62	50	8.50	569	Temperate climate	Mown pasture	Ute Hamer
156.07	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.09	13.97	50	8.60	560	Temperate climate	Pasture	Ute Hamer
156.08	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	14.02	50	8.70	547	Temperate climate	Mown pasture	Ute Hamer
156.09	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.08	13.60	50	8.50	569	Temperate climate	Pasture	Ute Hamer
156.1	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.14	13.87	50	8.60	560	Temperate climate	Meadow	Ute Hamer
156.11	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	13.97	50	8.60	560	Temperate climate	Meadow	Ute Hamer

156.12	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	14.02	50	8.70	547	Temperate climate	Meadow	Ute Hamer
156.13	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	13.62	50	8.50	569	Temperate climate	Meadow	Ute Hamer
156.14	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.12	13.70	50	8.50	567	Temperate climate	Meadow	Ute Hamer
156.15	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.13	13.83	50	8.60	560	Temperate climate	Meadow	Ute Hamer
156.16	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.15	13.82	50	8.50	567	Temperate climate	Meadow	Ute Hamer
156.17	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	52.98	13.83	50	8.70	554	Temperate climate	Pasture	Ute Hamer
156.18	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	52.97	13.83	50	8.70	554	Temperate climate	Mown pasture	Ute Hamer
156.19	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.13	13.87	50	8.60	560	Temperate climate	Pasture	Ute Hamer
156.2	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	53.10	13.67	50	8.50	567	Temperate climate	Mown pasture	Ute Hamer
156.21	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	52.97	13.82	50	8.60	562	Temperate climate	Mown pasture	Ute Hamer
156.22	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	52.87	13.97	50	8.70	554	Temperate climate	Pasture	Ute Hamer
156.23	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	52.87	13.97	50	8.70	554	Temperate climate	Pasture	Ute Hamer
156.24	Biodiversity-Exploratories, Schorfheide-Chorin	Germany	52.97	13.82	50	8.60	562	Temperate climate	Pasture	Ute Hamer
157.01	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.33	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.02	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.37	9.47	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.03	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.40	9.52	730	7.10	923	Temperate climate	Meadow	Ute Hamer
157.04	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.37	9.42	730	7.50	911	Temperate climate	Mown pasture	Ute Hamer
157.05	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.44	730	7.50	911	Temperate climate	Mown pasture	Ute Hamer
157.06	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.40	9.43	730	7.50	911	Temperate climate	Mown pasture	Ute Hamer
157.07	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.37	730	7.50	911	Temperate climate	Pasture	Ute Hamer
157.08	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.42	9.48	730	7.50	911	Temperate climate	Pasture	Ute Hamer
157.09	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.50	730	7.10	923	Temperate climate	Pasture	Ute Hamer
157.1	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.37	9.20	730	7.80	905	Temperate climate	Meadow	Ute Hamer
157.11	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.48	9.43	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.12	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.48	9.43	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.13	Biodiversity-Exploratories, Schwäbische Alb	Germany	44.37	9.52	730	9.70	942	Temperate climate	Mown pasture	Ute Hamer
157.14	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.40	9.50	730	7.10	923	Temperate climate	Mown pasture	Ute Hamer
157.15	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.40	730	7.50	911	Temperate climate	Pasture	Ute Hamer
157.16	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.45	9.45	730	7.50	911	Temperate climate	Mown pasture	Ute Hamer
157.17	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.45	9.45	730	7.50	911	Temperate climate	Mown pasture	Ute Hamer
157.18	Biodiversity-Exploratories,	Germany	48.45	9.48	730	7.50	911	Temperate climate	Pasture	Ute Hamer

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Table 2s (*continued*)

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
157.19	Schwäbische Alb Biodiversity-Exploratories, Schwäbische Alb	Germany	48.43	9.42	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.2	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.42	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.21	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.40	9.45	730	7.50	911	Temperate climate	Meadow	Ute Hamer
157.22	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.38	9.43	730	7.50	911	Temperate climate	Pasture	Ute Hamer
157.23	Biodiversity-Exploratories, Schwäbische Alb	Germany	48.45	9.50	730	7.10	923	Temperate climate	Pasture	Ute Hamer
303	Hiddensee	Germany	54.55	13.10	1	-0.90	536	Temperate climate	Heathland	Andrey Malyshev
305	Hanshagen	Germany	54.05	13.51	45	8.30	562	Temperate climate	Beech forest	Robert Weigel
321	Fendt	Germany	48.38	11.11	600	8.70	982	Temperate climate	Grassland	Ralf Kiese
322	Rottenbuch	Germany	48.18	11.64	750	8.40	1158	Temperate climate	Grassland	Ralf Kiese
323	Graswang	Germany	46.94	11.06	850	6.60	1359	Temperate climate	Grassland	Ralf Kiese
348	Rostock-ECOLINK-Salix	Germany	54.06	12.08	13	8.50	590	Temperate climate	Willow short rotation coppice	Christel Baum
349	Kaltenborn (BIOTREE)	Germany	50.78	10.22	330	7.80	650	Temperate climate	Tree plantations	Michael Scherer-Lorenzen
355	Kreinitz	Germany	51.39	13.26	115	8.40	575	Temperate climate	Tree plantations	Anja Schmidt
358	MyDiv	Germany	51.39	11.89	115	8.80	507	Temperate climate	Agriculture	Olga Ferlian and Nico Eisenhauer
412	Garmisch	Germany	47.47	11.06	720	8.00	964	Temperate climate	Grassland	Ralf Kiese
413	Esterberg	Germany	47.52	11.16	1265	6.20	1043	Temperate climate	Grassland	Ralf Kiese
456.01	Arctic station	Greenland	69.27	-53.46	89	-3.00	400	Arctic climate	Tundra	Regin Rønn
456.02	Arctic station	Greenland	69.27	-53.46	112	-3.00	400	Arctic climate	Tundra	Regin Rønn
158	Síkfőkút Project	Hungary	47.92	20.43	345	9.40	565	Temperate climate	Deciduous Forest	Zsolt Kotroczó and István Fekete
159	Kiskunság LTER - Fülöpháza	Hungary	47.45	19.70	108	10.60	522	Temperate climate	Grassland	Erzsébet Hornung
442	Rannsóknastöðin Rif (Rif Field Station)	Iceland	66.45	-15.95	NA	NA	650	Boreal climate	Peatlands, salt marshes, lichen rich heathlands	Jónína Sigríður Þorláksdóttir
325.01	IN-LAC, E-Ladakh/Changthang	India	33.01	78.42	5900	-7.80	250	Arid-temperate climate	Cold Himalyan Deserts, Subnival zone	Jiri Dolezal
325.02	IN-LAC, E-Ladakh/Changthang	India	32.98	78.36	5050	-3.50	150	Arid-temperate climate	Cold Himalyan Deserts, Alpine steppes	Jiri Dolezal
325.03	IN-LAC, E-Ladakh/Changthang	India	32.98	78.34	4720	-3.00	100	Arid-temperate climate	Cold Himalyan Deserts	Jiri Dolezal
329.01	IN-KJU-MGT	India	30.43	79.58	4254	3.10	1224	Subtropical arid climate	Alpine grassland	Sabyasachi Dasgupta
329.02	IN-KJU-GGT	India	30.46	79.58	3691	5.90	1472	Subtropical arid climate	Subalpin, Rhododendron scrub and grass land	Sabyasachi Dasgupta
329.03	IN-KJU_TBT	India	30.49	79.57	3286	5.60	1472	Subtropical arid climate	Treeline grassland	Sabyasachi Dasgupta
329.04	IN_KJU_MGT	India	30.42	79.59	4601	3.00	1224	Subtropical arid climate	Stony bryophyte and lichens	Sabyasachi Dasgupta
343.01	IN-KAS-GUL_1	India	34.02	74.21	3470	13.40	776	Temperate climate	Treeline of subalpine forest (dominated by Betula utilis)	Anzar A Khuroo
343.02	IN-KAS-GUL_2	India	34.02	74.20	3550	13.40	776	Temperate climate	Alpine scrub grassland (dominated by Rhododendron-Juniperus)	Anzar A Khuroo
343.03	IN-KAS-GUL_3	India	34.01	74.20	3640	13.40	776	Temperate climate	Alpine scrub grassland (dominated by Rhododendron-Juniperus)	Anzar A Khuroo
343.04	IN-KAS-GUL_4	India	34.01	74.20	3690	13.40	776	Temperate climate	Alpine scrub grassland (Rhododendron-Juniperus with Rock & Scree)	Anzar A Khuroo
160	Shita	Israel	30.15	35.12	250	19.40	207	Subtropical arid climate	Desert	Elli Groner
161	Ramon	Israel	31.25	35.37	440	21.30	60	Subtropical arid climate	Desert	Elli Groner
408	Lehavim LTER	Israel	31.36	34.85	460	18.70	318	Mediterranean climate	Rangeland	Marcelo Sternberg
409	Sde Boqer	Israel	30.87	34.77	475	18.80	90	Subtropical arid climate	Rangeland	Marcelo Sternberg
162.01	Matsch-Mazia	Italy	46.68	10.58	1000	1.60	528	Temperate climate	Dry pasture	Julia Seeber
162.02	Matsch-Mazia	Italy	46.68	10.59	1500	1.60	528	Temperate climate	Dry pasture	Julia Seeber
162.03	Matsch-Mazia	Italy	46.69	10.59	2000	1.60	528	Temperate climate	Dry pasture	Julia Seeber
162.04	Matsch-Mazia	Italy	46.70	10.60	2500	1.60	528	Temperate climate	Dry pasture	Julia Seeber
319	Mediterranean Shrublands	Italy	40.76	16.91	348	13.60	650	Mediterranean climate	Oak forests and shrubland	Roberto Cazzolla Gatti
334.01	IT_ADO_GRM	Italy	46.33	11.56	2199	3.30	956	Temperate climate	Grassland	Brigitta Erschbamer
334.02	IT_ADO_PNL	Italy	46.38	11.59	2463	2.00	1118	Temperate climate	Grassland	Brigitta Erschbamer
334.03	IT_ADO_RNK	Italy	46.38	11.61	2757	0.80	1177	Temperate climate	Grassland & scree vegetation	Brigitta Erschbamer

334.04	IT_ADO_MTS	Italy	46.52	11.81	2893	-0.20	1121	Temperate climate	scree vegetation	Brigitta Erschbamer
335.01	IT_MAV_CCR	Italy	45.69	7.56	2340	3.80	1250	Temperate climate	Grassland with occasional larch	Umberto Morra di Cella
335.02	IT_MAV_LBA	Italy	45.64	7.55	2584	1.50	1250	Temperate climate	Alpine grassland	Umberto Morra di Cella
335.03	IT_MAV_PPE	Italy	45.65	7.54	2790	1.70	1250	Temperate climate	Scree vegetation	Umberto Morra di Cella
335.04	IT_MAV_CM	Italy	45.91	7.69	3014	-1.70	1200	Temperate climate	Scree vegetation	Umberto Morra di Cella
338.01	IT_CAM_MAM	Italy	42.10	14.12	2722	2.90	898	Mediterranean climate	Alpine grassland	Angela Stanisci
338.02	IT_CAM_MAC	Italy	42.05	14.10	2625	2.90	898	Mediterranean climate	Alpine grassland	Angela Stanisci
338.03	IT_CAM_FEM	Italy	42.03	14.10	2411	2.90	898	Mediterranean climate	Alpine grassland	Angela Stanisci
341.01	IT -NAP-MOM	Italy	44.28	10.25	1842	5.70	1269	Temperate climate	Mosaic between primary subalpine shrublands and secondary grassland	Tomaselli Marcello
341.02	IT-NAP-CAS	Italy	44.33	10.21	1960	4.80	1055	Temperate climate	Subalpine secondary grassland	Tomaselli Marcello
341.03	IT -NAP-PCA	Italy	44.20	10.70	1803	5.10	992	Temperate climate	Subalpine secondary grassland	Tomaselli Marcello
341.04	IT -NAP-FOG	Italy	44.12	10.62	1696	5.10	1065	Temperate climate	Mosaic between primary subalpine shrublands and secondary grassland	Tomaselli Marcello
356	IDENT-Macomer	Italy	13.82	8.70	640	13.80	866	Mediterranean climate	Abandoned fields in nursery	Simone Mereu
397	Lamto	Ivory Coast	6.22	5.03	100	26.80	2146	Equatorial humid climate; tropical rain forest	Wet tropical savannah (transition tropical rain forest-Guinean savannah)	Jean-Christophe Lata
398	Comoé	Ivory Coast	9.11	-3.73	300	27.20	1096	Semi-arid tropical climate	West Sudanian savannah	Jean-Christophe Lata
399	Banco	Ivory Coast	5.39	-4.05	75	26.20	1738	Equatorial humid climate; tropical rain forest	Tropical rain forest	Jean-Christophe Lata
163	Kanumazawa Riparian Research Forest	Japan	39.10	141.85	450	9.20	2056	Temperate climate	Forest, deciduous	Kazuhiko Hoshizaki
164.01	University of Tokyo Chichibu Forest	Japan	35.92	138.83	880	9.00	1554	Temperate climate	Natural forest	Satoshi Suzuki
164.02	University of Tokyo Chichibu Forest	Japan	35.92	138.82	1320	6.60	1554	Temperate climate	Natural forest	Satoshi Suzuki
164.03	University of Tokyo Chichibu Forest	Japan	35.92	138.80	1780	3.60	1554	Temperate climate	Natural forest	Satoshi Suzuki
165	Kasuya Research Forest	Japan	33.65	130.55	520	14.60	1917	Warm-temperate, humid climate	Natural forest	Tsutomu Enoki
166	Uryu	Japan	44.36	142.26	300	4.40	1400	Temperate climate	Cool temperate mixed forest (evergreen coniferous and deciduous broad-leaved species)	Hideaki Shibata Karibu Fukuzawa
167	Yamashiro Experimental Forest	Japan	34.78	135.85	255	13.80	1676	Warm-temperate, humid climate	Secondary forest, deciduous	Mioko Ataka, Yuji Kominami
168	Ashoro	Japan	43.26	143.51	330	5.50	1051	Temperate climate	Forest, deciduous	Yasuhiro Utsumi
169	Akazu Research Forest	Japan	36.22	137.17	304	9.70	1838	Temperate climate	Secondary forest, deciduous	Takanori Sato
170.01	Mt. Hakkoda Forest_400B	Japan	40.59	140.96	416	9.00	1501	Warm-temperate, humid climate	Natural forest	Hiroko Kurokawa
170.02	Mt. Hakkoda Forest_600B	Japan	40.60	140.95	649	7.90	1501	Warm-temperate, humid climate	Natural forest	Hiroko Kurokawa
170.03	Mt. Hakkoda Forest_800B	Japan	40.64	140.93	791	7.00	1501	Warm-temperate, humid climate	Natural forest	Hiroko Kurokawa
170.04	Mt. Hakkoda Forest_1000A	Japan	40.66	140.85	980	6.50	1501	Warm-temperate, humid climate	Natural forest	Hiroko Kurokawa
170.05	Mt. Hakkoda Forest_1200A	Japan	40.67	140.87	1214	5.50	1501	Warm-temperate, humid climate	Natural forest	Hiroko Kurokawa
170.06	Mt. Hakkoda Forest_1400A	Japan	40.67	140.87	1404	4.90	1412	Warm-temperate, humid climate	Natural forest	Hiroko Kurokawa
171	Ashiu Experimental Forest	Japan	36.01	137.00	260	9.00	2065	Temperate climate	Natural Forest	Takeshi Ise
172	Kamigamo Experimental Station	Japan	34.08	135.77	220	12.30	2498	Warm-temperate, humid climate	Natural Forest	Naoko Tokuchi
173	Shiiba Research Forest	Japan	32.40	131.17	1050	12.50	3072	Warm-temperate, humid climate	Natural mixed forest	Takuo Hishi
174	Sugadaira	Japan	36.52	138.50	1320	10.60	1239	Warm-temperate, humid climate	Grassland, Natural forest	Tanaka Kenta
175	Tomakomai Experimental Forest	Japan	42.70	141.57	80	6.70	1112	Temperate climate	Secondary forest, deciduous	Tatsuro Nakaji Tsutom Hiura
401	Kapiti	Kenya	-1.60	37.13	1646	17.80	1004	Semi-arid tropical climate	Rangeland	Victoria Carbonell
402	Nairobi	Kenya	-1.27	16.72	1857	18.90	592	Subtropical highland climate	Grassland	Victoria Carbonell
176	Engure LTSER	Latvia	57.29	23.15	10	6.30	634	Temperate climate	Pine Forest	Inara Melece
179	Engure LTSER	Latvia	57.30	23.05	7	6.30	634	Temperate climate	Deciduos Forest	Inara Melece
180.01	Aukstaitija IMS	Lithuania	55.46	26.00	188	5.70	658	Temperate climate	Forest, coniferous	Algirdas Augustaitis
180.02	Aukstaitija IMS	Lithuania	55.45	26.07	159	5.70	658	Temperate climate	Forest, coniferous	Algirdas Augustaitis
181	Zemaitija IMS	Lithuania	56.02	21.89	170	6.10	790	Temperate climate	Forest, coniferous	Algirdas Augustaitis
182	Forest Research Institute Malaysia, Kepong	Malaysia, Selangor	3.24	101.63	82	26.10	358	Equatorial humid climate; tropical rain forest	Planted and naturally regenerating forest	Jeyanny Vijayanathan
183	SSDE-1	Mali	15.32	-9.05	270	28.10	1500	Subtropical arid climate	NA	Niall Hanan
184	SSDE-2	Mali	14.53	-9.97	262	27.90	712	Semi-arid tropical climate	NA	Niall Hanan
185	SSDE-3	Mali	12.88	-8.48	370	27.00	986	Semi-arid tropical climate	NA	Niall Hanan
186	SSDE-4	Mali	11.60	-7.05	368	27.20	1017	Semi-arid tropical climate	NA	Niall Hanan
187	SSDE-5	Mali	11.03	-6.08	347	27.10	1105	Semi-arid tropical climate	NA	Niall Hanan
188	Estero Pargo	Mexico	18.65	-91.76	1	26.40	1502	Equatorial humid climate; tropical rain forest	Natural mangrove forest	José Gilberto Cardoso Mohedano

(continued on next page)

Table 2s (*continued*)

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
189	ESTERO DE URIAS LAGOON	Mexico	23.17	-106.33	1	24.80	752	Mediterranean climate	Natural mangrove forest	Ana Carolina Ruiz Fernández
192	MARISMAS NACIONALES	Mexico	22.41	-105.64	1	25.10	1627	Mediterranean climate	Natural mangrove forest	Joan-Albert Sanchez Cabeza
193	SALAZAR FOREST	Mexico	19.29	-99.38	3124	12.40	1098	Subtropical arid climate	Sacred fir and pinus forest	Eduardo Ordoñez Regil
332.01	Vole (BLA_VOL)	Norway	61.90	9.14	1100	0.28	563	Boreal climate	Alpine Tundra (low alpine lichen heath)	Dirk Wundram
332.02	Derik (BLA_DER)	Norway	61.91	9.18	1221	-0.17	629	Boreal climate	Alpine Tundra (low alpine lichen heath)	Dirk Wundram
332.03	Skurvehøe (BLA_GRA)	Norway	61.90	9.22	1365	-0.54	713	Boreal climate	Alpine Tundra (low alpine lichen heath)	Dirk Wundram
332.04	Rundhøe (BLA_RUN)	Norway	61.91	9.25	1565	-1.11	804	Boreal climate	Alpine Tundra (mid alpine lichen heath)	Dirk Wundram
452.01	Iskoras_Finnmark	Norway	69.42	25.61	350	-0.50	360	Boreal climate	tundra palsa mire (dry palsa w intact permafrost)	Casper T. Christiansen
452.02	Iskoras_Finnmark	Norway	69.42	25.61	350	-0.50	360	Boreal climate	tundra palsa mire (degrading palsa, degraded permafrost)	Casper T. Christiansen
452.03	Iskoras_Finnmark	Norway	69.42	25.61	350	-0.50	360	Boreal climate	tundra palsa mire (thaw pond, degraded permafrost)	Casper T. Christiansen
201	Wadi Nar station	Palestine	31.72	35.29	415	18.30	412	Subtropical arid climate	Olive orchard	Jawad Shoqeir
202.01	Companhia das Lezírias	Portugal	38.84	-8.77	60	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.02	Companhia das Lezírias	Portugal	38.85	-8.78	43	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.03	Companhia das Lezírias	Portugal	38.86	-8.78	47	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.04	Companhia das Lezírias	Portugal	38.83	-8.81	43	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.05	Companhia das Lezírias	Portugal	38.83	-8.81	42	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.06	Companhia das Lezírias	Portugal	38.81	-8.80	50	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.07	Companhia das Lezírias	Portugal	38.80	-8.82	45	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.08	Companhia das Lezírias	Portugal	38.84	-8.82	28	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.09	Companhia das Lezírias	Portugal	38.84	-8.83	27	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.1	Companhia das Lezírias	Portugal	38.83	-8.84	30	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.11	Companhia das Lezírias	Portugal	38.81	-8.85	31	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
202.12	Companhia das Lezírias	Portugal	38.82	-8.86	28	17.43	774	Mediterranean climate	Evergreen cork oak forest	Cristina Branquinho
203	Ria de Aveiro	Portugal	40.60	-8.74	1	14.30	800	Mediterranean climate	Wetland, Salt marsh	Ana I. Lillebø
203.01	Ria de Aveiro	Portugal	40.60	-8.74	1	14.30	800	Mediterranean climate	Wetland, Salt marsh	Ana I. Lillebø
204	Luquillo Experimental Forest	Puerto Rico	18.34	-65.83	61	25.40	1943	Equatorial humid climate; tropical rain forest	NA	Jill Thompson
205	Elevational gradient	Puerto Rico	18.34	-65.83	61	25.07	2003	Equatorial humid climate; tropical rain forest	NA	Grizelle González
431	Qatar 1 Acacia	Qatar	25.51	51.41	10	26.70	71	Subtropical arid climate	Acacia dryland	Juha Alatalo
432	Qatar 2 mangrove	Qatar	25.74	51.58	0	26.70	71	Subtropical arid climate	Arid mangrove	Juha Alatalo
433	Qatar 3 Saltmarsh veg	Qatar	25.73	51.58	1	26.70	71	Subtropical arid climate	Arid saltmarsh with vegetation	Juha Alatalo
434	Qatar 4 mangrove planted	Qatar	25.66	51.55	0	26.70	71	Subtropical arid climate	Arid planted magrove	Juha Alatalo
435	Qatar 5 saltmarsh without veg	Qatar	25.66	51.54	1	26.70	71	Subtropical arid climate	Arid saltmarsh without vegetation	Juha Alatalo
436	Qatar 6 Grass	Qatar	25.22	51.29	10	26.70	71	Subtropical arid climate	Arid grassland	Juha Alatalo
437	Qatar 7 Zygophyllum	Qatar	25.23	51.29	10	26.70	71	Subtropical arid climate	Zygophyllum dryland	Juha Alatalo
438	Qatar 8 Acacia	Qatar	25.41	51.46	10	26.70	71	Subtropical arid climate	Acacia dryland	Juha Alatalo
439	Qatar 9 Mangrove	Qatar	25.70	51.55	0	26.70	71	Subtropical arid climate	Arid mangrove	Juha Alatalo
440	Qatar 10 saltmarsh veg	Qatar	25.70	51.55	1	26.70	71	Subtropical arid climate	Arid saltmarsh with vegetation	Juha Alatalo
206	Braila Islands LTSER	Romania	44.89	27.86	9	11.50	454	Arid-temperate climate	Wetland	Elena Preda
207	Braila Islands LTSER	Romania	44.89	27.86	9	11.50	454	Arid-temperate climate	Wetland	Elena Preda
208	Neajlov basin LTSER	Romania	44.34	25.67	85	10.80	598	Temperate climate	Forest	Elena Preda
209	Neajlov basin LTSER	Romania	44.34	25.67	85	10.80	598	Temperate climate	Forest	Elena Preda
331.01	RO-CRO, SE Carpathians, Rodna Mts., Rebra Peak	Romania	47.59	24.64	2250	1.60	1255	Temperate climate	Alpine grassland	Mihai Puşcaş
331.02	RO-CRO, SE Carpathians, Rodna Mts., Buhăiescu Peak	Romania	47.58	24.63	2200	1.60	1255	Temperate climate	Alpine grassland	Mihai Puşcaş
331.03	RO-CRO, SE Carpathians, Rodna Mts., Gropile Peak	Romania	47.57	24.62	2050	1.60	1255	Temperate climate	Alpine grassland	Mihai Puşcaş
272.01	Tigirek Strict Reserve, Plot 01	Russia	51.06	82.99	1426	1.60	1120	Temperate climate	Alpine meadow	Evgeny Davydov
272.03	Tigirek Strict Reserve, Plot 03	Russia	51.11	83.05	994	1.60	980	Temperate climate	Meadow	Evgeny Davydov
272.05	Tigirek Strict Reserve, Plot 05	Russia	51.05	82.98	1493	1.60	1120	Temperate climate	Natural forest (Pinus sibirica open forest)	Evgeny Davydov

272.06	Tigirek Strict Reserve, Plot 06	Russia	51.04	83.00	1572	1.60	1120	Temperate climate	Natural forest + meadow (timberline)	Evgeny Davydov
272.07	Tigirek Strict Reserve, Plot 07	Russia	51.04	83.00	1391	1.60	1120	Temperate climate	Natural forest (montane)	Evgeny Davydov
272.08	Tigirek Strict Reserve, Plot 08	Russia	51.04	83.00	1453	1.60	1120	Temperate climate	Natural forest + meadow (timberline)	Evgeny Davydov
272.09	Tigirek Strict Reserve, Plot 09	Russia	51.01	83.00	1537	1.60	1120	Temperate climate	Natural forest + meadow (timberline)	Evgeny Davydov
272.1	Tigirek Strict Reserve, Plot 10	Russia	51.11	83.02	948	1.60	980	Temperate climate	Natural forest (Abies sibirica)	Evgeny Davydov
272.12	Tigirek Strict Reserve, Plot 12	Russia	51.05	82.99	1526	1.60	1120	Temperate climate	Natural forest (Pinus sibirica open forest)	Evgeny Davydov
272.13	Tigirek Strict Reserve, Plot 13	Russia	51.06	82.99	1455	1.60	1120	Temperate climate	Subalpine tall-grasses	Evgeny Davydov
272.14	Tigirek Strict Reserve, Plot 14	Russia	51.06	82.99	1432	1.60	1120	Temperate climate	Alpine meadow	Evgeny Davydov
273.01	State Nature Reserv "Stolby", Plot 01	Russia	55.91	92.73	703	1.10	552	Boreal climate	Natural forest (Pinus sylvestris L., Larix sibirica Ledeb.)	Elena Tropina
273.02	State Nature Reserv "Stolby", Plot 02	Russia	55.95	92.83	285	1.20	471	Boreal climate	Natural forest (Populus tremula L.)	Elena Tropina
273.03	State Nature Reserv "Stolby", Plot 03	Russia	55.71	92.93	239	1.20	471	Boreal climate	Natural forest (Betula pendula Roth)	Elena Tropina
273.04	State Nature Reserv "Stolby", Plot 04	Russia	55.74	92.78	218	1.20	471	Boreal climate	Mesophytic meadow	Elena Tropina
273.05	State Nature Reserv "Stolby", Plot 05	Russia	55.79	92.72	214	1.20	471	Boreal climate	Mesophytic meadow	Elena Tropina
273.06	State Nature Reserv "Stolby", Plot 06	Russia	55.83	92.81	722	1.10	552	Boreal climate	Natural forest (Pinus sylvestris L., Larix sibirica Ledeb.)	Elena Tropina
273.07	State Nature Reserv "Stolby", Plot 07	Russia	55.85	92.83	673	1.10	552	Boreal climate	Natural forest (Abies sibirica Ledeb.) +wet meadow	Elena Tropina
273.08	State Nature Reserv "Stolby", Plot 08	Russia	55.91	92.89	208	1.20	471	Boreal climate	Mesophytic meadow	Elena Tropina
273.09	State Nature Reserv "Stolby", Plot 09	Russia	55.87	92.94	709	1.10	552	Boreal climate	Natural forest (Pinus sylvestris L., Larix sibirica Ledeb., Populus tremula L.)	Elena Tropina
273.10	State Nature Reserv "Stolby", Plot 10	Russia	55.89	92.92	263	1.20	471	Boreal climate	Mesophytic meadow	Elena Tropina
274	State Nature Reserv "Olekminsky"	Russia	58.00	121.00	450	-8.60	424	Boreal climate	Natural forest(Pinus sylvestris L., Larix gmelinii(Rupr.) Rupr.)	Yury Rozhkov
301	Northeast Science Station, Cherskiy, Russia	Russia	68.74	161.41	30	-11.60	230	Arctic climate	Larch forest	Heather Alexander
443	Mukhrino Field Station	Russia	60.89	68.70	50	8.20	545	Boreal climate	Raised bog	Nina Filippova
317	Aktru	Russia	50.08	87.78	2140	-5.20	430	Boreal climate	Alpine tundra	Roberto Cazzolla Gatti
318	Ob River	Russia	57.20	84.32	70	0.30	532	Boreal climate	Taiga forest and weatlands	Roberto Cazzolla Gatti
451	Khibiny Station	Russia	67.64	33.73	320	-1.70	600	Boreal climate	Podsolic, peat	Yulia Zaika
210.01	Fruska gora	Serbia	45.14	19.64	403	11.10	679	Temperate climate	Deciduous Forest	Dušanka Krašić
210.02	Fruska gora	Serbia	45.14	19.65	478	11.10	679	Temperate climate	Deciduous Forest	Dušanka Krašić
210.03	Fruska gora	Serbia	45.14	19.68	468	11.10	679	Temperate climate	Deciduous Forest	Dušanka Krašić
212.01	Podunajská nížina Lowland forest	Slovakia	48.28	17.32	173	9.40	669	Temperate climate	Vineyard on loess	Róbert Kanka
212.02	Podunajská nížina Lowland vineyard	Slovakia	48.28	17.32	173	9.40	669	Temperate climate	Pannonian oak and hornbeam forest	Róbert Kanka
212.03	Podunajská nížina Lowland grove grassland	Slovakia	48.31	17.29	177	9.40	669	Temperate climate	Cherry orchard (Cerasus avium)	Róbert Kanka
212.04	Podunajská nížina Lowland orchard-garden	Slovakia	48.31	17.29	177	9.40	669	Temperate climate	Lowland ruderalised meadow	Róbert Kanka
213	Tatry, LTER	Slovakia	49.08	20.23	1100	5.40	781	Temperate climate	Temperate oniferous forest	Peter Fleischer
214	Kralova hola	Slovakia	48.89	20.13	1850	3.80	1017	Temperate climate	Alpine grassland	Veronika Piscová
215	Jalovecka dolina	Slovakia	49.22	19.67	1893	2.90	1259	Temperate climate	Alpine grassland	Veronika Piscová
216	Báb	Slovakia	48.30	17.89	190	9.70	600	Temperate climate	Thermophilic oak forest	Veronika Piscová
217	Kremnicke vrchy Ecological Experimental Station	Slovakia	48.63	19.07	500	7.80	742	Temperate climate	Temperate deciduous forest	Milan Barna
218	Hodrusska vrchovina	Slovakia	48.55	18.86	470	7.60	768	Temperate climate	Temperate deciduous forest	Milan Barna
219	Stiavnicke vrchy	Slovakia	48.55	18.95	600	7.60	768	Temperate climate	Temperate deciduous forest	Milan Barna
220	Javorie	Slovakia	48.50	19.19	785	6.70	794	Temperate climate	Temperate deciduous forest	Milan Barna
223	Tierberg Karoo Research Station, SAEON Arid Lands Node	South Africa	-33.17	22.27	752	17.80	177	Subtropical arid climate	Livestock/large game exclosure within wildlife ranch	Joh Henschel
222	Wolwekraal Nature Reserve	South Africa	-33.20	22.03	567	17.80	177	Subtropical arid climate	Protected Nature Reserve	Joh Henschel
224	Collserola	Spain	41.43	2.08	255	16.10	613	Mediterranean climate	Protected Nature Reserve	Anna Avila
225	Montseny	Spain	41.47	2.21	760	12.60	839	Mediterranean climate	Protected Nature Reserve	Fernando Maestre
226	Valdemoro	Spain	40.19	-3.60	622	16.60	631	Mediterranean climate	Protected area with wild and domestic grazers	Fernando Maestre
324.1	ES-SIC-BAR	Spain	40.78	-3.98	2170	8.95	599	Mediterranean climate	Alpine shrubland	Rosario G. Gavilán
324.2	ES-SIC-GUA	Spain	40.79	-3.98	2210	8.95	599	Mediterranean climate	Alpine grassland	Rosario G. Gavilán
324.3	ES-SIC-VAL	Spain	40.79	-3.96	2270	8.95	599	Mediterranean climate	Alpine grassland	Rosario G. Gavilán
324.4	ES-SIC-HEM	Spain	40.83	-3.97	2270	8.95	599	Mediterranean climate	Alpine grassland	Rosario G. Gavilán
344.1	ES-CPY-ACU	Spain	42.64	-0.06	2242	6.90	1383	Temperate climate	Subalpine environment	Juan J. Jiménez

(continued on next page)

Table 2s (*continued*)

Site ID	Site	Country	Latitude	Longitude	Altitude (m asl)	MAT (°C)	MAP (mm)	Biome	Type of biotope	Contact
344.2	ES-CPY-CUS	Spain	42.65	0.03	2519	4.90	1576	Temperate climate	Alpine (inferior)	Juan J. Jiménez
344.3	ES-CPY-TOB	Spain	42.66	-0.01	2779	4.90	1590	Temperate climate	Alpine	Juan J. Jiménez
344.4	ES-CPY-OLA	Spain	42.66	0.05	3022	3.40	1621	Temperate climate	Subnival rock	Juan J. Jiménez
440.01	E. Llebreta_ PN. Aiguestortes	Spain	42.92	1.48	1683	8.80	980	Temperate climate	Mountain grass	Esperança Gacia
440.02	Aiguadasi_ PN. Aiguestortes	Spain	42.95	1.55	1898	10.50	871	Temperate climate	Peatland forest	Esperança Gacia
440.03	Portarró_ PN. Aiguestortes	Spain	42.96	1.60	2046	10.50	871	Temperate climate	Mountain grass	Esperança Gacia
460	Ayora	Spain	39.12	-0.95	1050	15.10	457	Mediterranean climate	Mediterranean mixed shrub	Alejandro Valdecantos
461	San Vicente Del Raspeig	Spain	38.38	-0.58	158	18.00	306	Mediterranean climate	Mediterranean mixed shrub	Alejandro Valdecantos
462	Albatera	Spain	38.23	-0.91	212	18.20	278	Mediterranean climate	Mediterranean mixed shrub	David Fuentes
463	Crevillente	Spain	38.24	-0.87	208	18.20	278	Mediterranean climate	Mediterranean mixed shrub	David Fuentes
228	Aneboda IM	Sweden	57.11	14.55	240	5.80	750	Temperate climate	Coniferous forest	Stefan Löfgren
229	Kindla IM	Sweden	59.75	14.91	320	4.20	900	Boreal climate	Coniferous forest	Stefan Löfgren
354	Uppsala -ECOLINK-Salix	Sweden	60.44	18.08	22	5.60	470	Temperate climate	Arable Land	Martin Weih
429	Latnjajaure Climate change	Sweden	68.21	18.29	1000	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
430.01	Latnjajaure height transect 900-1400m	Sweden	68.21	18.29	900	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
430.02	Latnjajaure height transect 900-1400m	Sweden	68.21	18.29	1000	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
430.03	Latnjajaure height transect 900-1400m	Sweden	68.21	18.29	1100	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
430.04	Latnjajaure height transect 900-1400m	Sweden	68.21	18.29	1200	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
430.05	Latnjajaure height transect 900-1400m	Sweden	68.21	18.29	1300	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
430.06	Latnjajaure height transect 900-1400m	Sweden	68.21	18.29	1400	-2.70	659	Arctic climate	Alpine tundra	Juha Alatalo
230	Vordemwald	Switzerland	47.27	7.89	480	8.80	1028	Temperate climate	Temperate mixed forest	Marcus Schaub
231	Bettlachstock	Switzerland	47.23	7.42	1149	7.40	1113	Temperate climate	Temperate deciduous forest	Marcus Schaub
232	Pfynwald	Switzerland	46.30	7.61	615	3.60	1418	Temperate climate	Xeric mature Scots pine forest	Marcus Schaub
233	Novaggio	Switzerland	46.02	8.84	950	9.90	1272	Temperate climate	Unmanaged former coppice forest	Marcus Schaub
234	Beatenberg	Switzerland	46.70	7.76	1511	6.20	1235	Temperate climate	Temperate spruce forest	Marcus Schaub
235	Schänis	Switzerland	47.17	9.07	733	6.00	1364	Temperate climate	Temperate beech forest	Marcus Schaub
236	Birmensdorf	Switzerland	47.36	8.45	550	8.80	1103	Temperate climate	Temperate mixed forest	Marcus Schaub
237	Salgesch	Switzerland	46.32	7.58	805	3.60	1418	Temperate climate	Xeric mature Scots pine forest	Marcus Schaub
340.01	La Ly	Switzerland	46.03	7.25	2351	2.60	1544	Temperate climate	Dry subalpine-alpine grassland and heath, historical grazing but no more now	Jean-Paul Theurillat
340.02	Mt Brûlé	Switzerland	46.02	7.20	2547	2.60	1544	Temperate climate	Dry alpine grassland, no grazing	Jean-Paul Theurillat
406.01	SN1-MBU	Switzerland	46.64	10.24	2423	0.20	1143	Temperate climate	Grassland, rock and scree, no landuse	Sonja Wipf
406.02	SN1-MCH	Switzerland	46.64	10.23	2532	0.20	1143	Temperate climate	Grassland, rock and scree, no landuse	Sonja Wipf
406.03	SN1-CUO	Switzerland	46.72	10.17	2804	0.80	1146	Temperate climate	Nival rock and scree, no landuse	Sonja Wipf
407.01	SN2-MCS	Switzerland	46.74	10.43	2412	0.10	1179	Temperate climate	Grassland, rock and scree, low intensity cow grazing	Sonja Wipf
407.02	SN2-MIN	Switzerland	46.65	10.34	2507	0.40	1105	Temperate climate	Grassland, some low shrubs, some cow grazing	Sonja Wipf
407.03	SN2-MDG	Switzerland	46.69	10.33	2785	0.80	1146	Temperate climate	Grassland, rock and scree, low intensity cow grazing	Sonja Wipf
238	Fushan	Taiwan	24.76	121.60	720	21.00	3025	Warm-temperate, humid climate	Natural subtrpical mixed broadleaf rain forest	Chiao-Ping Wang
239	YYL	Taiwan	24.59	121.42	1650	15.10	2659	Warm-temperate, humid climate	Subtropical mountain cloud coniferous forest	Chiao-Ping Wang

410	Kenting Karst Forest Dynamics Plot	Taiwan	21.97	120.82	260	24.00	2637	Equatorial humid climate	Natural tropical rain forest	Chiao-Ping Wang
415	Chia-Yi Litchi Orchard	Taiwan	23.15	120.47	48	23.40	2338	Semi-arid tropical climate	Agriculture(Orchard)	Chi-Ling Chen
416	Gu-Keng Litchi Orchard	Taiwan	23.62	120.62	400	21.60	2637	Semi-arid tropical climate	Agriculture(Orchard)	Chi-Ling Chen
417	Min-Jian Tea Garden	Taiwan	23.82	120.65	413	22.60	2000	Semi-arid tropical climate	Agriculture(Tea Garden)	Chi-Ling Chen
240	12 experimental sites	UK	0.00	0.00	NA	NA	NA	Temperate climate	NA	Jill Thompson
357	Bangor Diverse	UK	53.23	-4.13	10	9.00	1045	Temperate climate	NA	Andy Smith
360	Climate-match (Hucking, Kent, UK)	UK	53.40	-0.30	44	9.30	763	Temperate climate	Formerly Arable; Ungrazed pasture	Nadia Barsoum
241	Harvard Forest	USA	42.00	-73.20	310	7.30	1246	Temperate climate	Temperate forest	Jim Tang
242	Toolik Station	USA	68.63	-149.60	760	-11.70	229	Arctic climate	Arctic tundra	Jim Tang
243	Waquoit Bay salt marsh	USA	41.37	-70.50	1	10.00	1138	Temperate climate	Salt marsh	Jim Tang
244	H.J. Andrews Forest	USA	44.37	122.37	162	7.90	1663	Temperate climate	Old-growth forest	Kate Lajtha
245	Central Arizona–Phoenix LTER	USA	33.60	-112.50	448	21.10	198	Arid-temperate climate	Desert	Sally Wittlinger
246	Mansfield_SC1	USA	44.51	-72.84	565	5.20	1070	Temperate climate	Mixed forest	Carol Adair
247	Smithsonian Environmental Research Center	USA	38.88	-76.55	1	13.30	1091	Temperate climate	Deciduous forest	Katalin Szlavecz
248	Smithsonian Global Change Research Wetland	USA	38.89	-77.03	1	12.90	1035	Temperate climate	Salt marsh	Thomas J. Mozdzer
249	PIE-LTER (TIDE Project)	USA	42.72	70.85	2	9.50	1191	Temperate climate	Salt marsh	Thomas J. Mozdzer
250	Reynolds Creek CZO	USA	43.21	-116.75	1200	7.70	330	Arid-temperate climate	Sagebrush steppe	Marie-Anne de Graaff
251	Cedar Point Biological Station	USA	41.21	-101.67	982	9.10	447	Arid-temperate climate	Short Grass Prairie	Johannes M H Knops
252.01	Bartlett Experimental Forest Site C6	USA	44.04	-71.28	460	5.50	1270	Temperate climate	Northern hardwood forest	Ruth Yanai
252.02	Bartlett Experimental Forest Site C8	USA	44.05	-71.30	330	5.50	1270	Temperate climate	Northern hardwood forest	Ruth Yanai
253	Hubbard Brook Experimental Forest (MELNHE)	USA	43.93	-71.73	500	7.40	1123	Temperate climate	Northern hardwood forest	Matt Vadeboncoeur
254	Jeffers Brook	USA	44.05	-72.47	730	5.10	1077	Temperate climate	Northern hardwood forest	Ruth Yanai
255	Hubbard Brook Experimental Forest (ISE)	USA	43.94	-71.76	500	7.40	1123	Temperate climate	Northern hardwood forest	Matt Vadeboncoeur
256	Hubbard Brook Experimental Forest (DroughtNet)	USA	43.95	-71.70	265	7.40	1123	Temperate climate	Northern hardwood forest	Matt Vadeboncoeur
258	Cummins Creek Wilderness Area, Oregon	USA	44.45	-124.17	NA	9.40	2555	Temperate climate	NA	Andy Moldenke
259	Mary's Peak, Oregon	USA	44.83	-123.93	98	10.40	2215	Temperate climate	NA	Andy Moldenke
260	Andrews Forest, LTER, Oregon	USA	44.37	-122.42	564	8.60	2072	Temperate climate	NA	Andy Moldenke
261	Andrews Forest, LTER, Oregon	USA	44.37	-122.22	628	6.80	2143	Temperate climate	NA	Andy Moldenke
262	Andrews Forest, LTER, Oregon	USA	44.37	-122.22	628	6.80	2143	Temperate climate	NA	Andy Moldenke
263	Metolius River Natural Area, Oregon	USA	44.82	-122.05	739	7.10	2123	Temperate climate	NA	Andy Moldenke
264	Sisters, Oregon	USA	44.29	-121.55	971	6.60	641	Temperate climate	NA	Andy Moldenke
265	Sky Oaks Field Station	USA	33.35	116.63	1420	15.40	269	Mediterranean climate	Chaparral	George Vourlitis
266	Santa Margarita Ecological Reserve	USA	33.48	117.18	254	16.60	396	Mediterranean climate	Coastal sage scrub (soft chaparral)	George Vourlitis
267	Ten Thousand Islands National Wildlife Refuge	USA	25.23	-81.12	0	23.80	1219	Semi-arid tropical climate	NA	Sean Charles
278	Eight Mile Lake, Healy, Alaska	USA	63.88	-149.25	684	-1.00	384	Boreal climate	Boreal-tundra ecotone	Rebecca Hewitt
279	Murphy Dome, Fairbanks, Alaska	USA	64.88	-148.39	210	-3.00	275	Boreal climate	Boreal forest	Rebecca Hewitt
280	VCU_Rice_Rivers_Center_Swamp	USA	37.33	-77.21	0	14.30	1123	Temperate climate	Tidal Swamp Wetland	Joe Morina
330	US-PIO	USA	45.49	-112.48	2865	10.00	330	Temperate climate	Northern coniferous forest	Martha Apple
365	IDENT-Cloquet	USA	46.68	-92.52	382	2.60	717	Temperate climate	Forest	Artur Stefanski
374	Hwange	Zimbabwe	-19.01	26.30	1010	21.60	524	Semi-arid tropical climate	Savannah	Hervé Fritz
393	ZAHG-2 Hwange National Park – Fixed vegetation plots	Zimbabwe	-19.01	26.50	1038	21.20	546	Semi-arid tropical climate	Savannah	Hervé Fritz
394	ZAHG-3 Hwange National Park – Sinamatella Mopane	Zimbabwe	-19.01	26.50	1038	21.20	546	Semi-arid tropical climate	Savannah	Hervé Fritz
395	ZAHG-4 Hwange National Park - Main Camp Waterhole transects	Zimbabwe	-19.01	26.50	1038	21.20	546	Semi-arid tropical climate	Savannah	Hervé Fritz
396	ZAHG-5 Magoli Village – Hwange District	Zimbabwe	-19.01	26.50	1038	21.20	546	Semi-arid tropical climate	Savannah	Hervé Fritz

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