Appendices of:
Soil water repellency: a potential driver of vegetation dynamics in coastal dunes.

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A Composition of the hydrophobic compounds.

The total hydrophobic compound concentration was obtained by sequentially extracting hydrophobic compounds from the soils with dichloromethane/methanol (DCM/MeOH) and isopropanol/ammonia solution (IPA/NH_3) (Mao et al., 2014, 2015). Three fractions were obtained: DCM/MeOH extractable lipids (D), DCM/MeOH soluble part of IPA/NH_3 extract (AS) and DCM/MeOH insoluble part of IPA/NH_3 extract (AI). Ten main compound groups were identified in these three fractions: (D) fatty acid, (D) alcohol, (D) alkane, (AI) fatty acid, (AI) alcohol, (AI) ω-hydroxy fatty acid, (AI) α,ω-dicarboxylic acid, (AS) fatty acid, (AS) alcohol and (AS) ω-hydroxy fatty acid. The total hydrophobic compounds concentration is obtained by summing the concentrations of these ten compound groups. More details on the extraction methods can be found in the papers by Mao et al. (2014, 2015).

B Gravimetric and volumetric soil moisture content

In Figure 3b soil moisture is presented as gravimetric soil moisture content, which is defined as:

$$\Theta_g = \frac{m_w}{m_b + m_w} \tag{B.1}$$

where m_w is the mass of water, m_b is the bulk mass of the oven-dried soil (40 gram) and m_b+m_w is the total weighted mass of the soil. If the density of the soil is known, the gravimetric soil moisture content can be converted to the volumetric soil moisture content using the following equation:

$$\Theta_v = \frac{\Theta_g}{1 - \Theta_g} \frac{\rho_b}{\rho_w} \tag{B.2}$$

where ρ_b is the density of the oven-dried soil (approximately 1.6 g cm^{-3} for sandy soils) and ρ_w is the density of water.

C Parameter values for the model

We adopted the parameters as used in the study by Rietkerk et al. (1997), but use a higher precipitation rate: $p = 2.5$ mm day^{-1}, $u = 0.05$ dm^3 g^{-1} day^{-1}, $r = 0.1$ day^{-1}, $k_3 = 3$ mm and $W^* = 7$ mm, where $W^* = \frac{mk_3}{cu-m}$. To account for the lower temperatures and incoming solar radiation, the dynamics in plant biomass B were assumed to be a factor 10 slower compared to the semi-arid regions for which the model by Rietkerk et al. (1997) was developed (i.e. $c = 1$ g dm^{-3} and $m = 0.035$ day^{-1}). This assumption does not affect the presented dynamics, but merely sharpens the shifts between hydrophilic wet and hydrophobic dry soils (Figure 6b). For the infiltration function, the SWR threshold k_1 was set to 7 mm and exponent α was set to 5.

In this paper B and C are sometimes assumed to be constant, their values for the different figures are listed in Table 1. As indicated in the table, C is dynamic in Figures 8 and 9. In Figure 8 we triggered a SWR lock by selecting a low value of k_2 ($k_2 = 5$ g m^2; which corresponds to a high impact of hydrophobic compounds on infiltration) and a high value of f ($f = 0.0065$ g g^{-1}; which is the maximum measured value listed in Appendix D). In Figure 9 we used a more realistic value for k_2 (k_2=250 g m^2) and selected the lower and upper measured of f ($f = 0.0008$ and $f = 0.0065$ g g^{-1}). For both figures $d = 1 \times 10^{-5}$ day^{-1}, which corresponds to a mean residence time of about 250 years (see Appendix E). For the runs used to illustrate the drought stress amplification (Figure 10) we selected a species with low water competitiveness ($W^* = 14$ mm) by lowering the conversion coefficient c to a value of 0.85 g dm^{-3}.

Table 1: Values for B and C as used in the different figures. Hyphens indicate dynamic B or C.

Figure	B [g m^{-2}]	C [g m^{-2}]
5a	20	0
5b	20	$4k_2$
6a I	5	$4k_2$
6a I & IV	20	$4k_2$
6a III	35	$4k_2$
6b	-	$4k_2$
7a	-	0
7b	-	$4k_2$
7c	-	$9k_2$
8	-	-
9	-	-
10	-	0 / $4k_2$

D Hydrophobic compound content in plant tissues

The hydrophobic compound content of different plant tissues were obtained by summing the mass of the identified hydrophobic compounds in Mao et al. (2015) that comprise extractable lipids (alkanes, alcohols and fatty acids) and ester-bound lipids (alcohols, fatty acids, ω-hydroxy fatty acids, α,ω-dicarboxylic acids) and dividing by the total mass of the plant tissue. The results are presented in Table 2. Part of the data (*) refers to Mao et al. (2015) and part of the data (**) refers to Mao et al. (under review).

Table 2: Hydrophobic compound content in plant tissues.

Species (Latin)	Species (common)	Tissue	Hydrophobic compound content [mg g^{-1} dry weight]
Festuca ovina (*)	Sheep fescue	whole plant	4.10
Hypnum lacunosum (*)	Hypnum moss	whole plant	1.16
Hippophae rhamnoides (*)	Sea-buckthorn	leaves	1.20
		roots	3.76
Crataegus sp.(*)	Hawthorn	leaves	4.30
		roots	2.83
Pinus nigra (*)	Black pine	needles	2.77
		roots	0.84
Quercus robur (*)	Common oak	leaves	2.49
		roots	2.16
Festuca ruba (**)	Red fescue	leaves	3.78
		roots	3.92
Poe nemoralis (**)	Wood bluegrass	leaves	2.36
		roots	5.13
Phleum pratense (**)	Timothy-grass	leaves	3.76
Agrostis stolonifera (**)	Creeping bentgrass	leaves	6.49
Holcus lanatus (**)	Tufted grass	leaves	5.80
		roots	3.58
Carex sp.(**)	Sedge	leaves	4.14
		roots	2.59

E Decomposition rates of hydrophobic compounds in soils.

Hydrophobic compounds in soils are decomposed by abiotic and biotic processes. The decomposition rate of organic matter is controlled by many internal and external factors, such as temperature (Davidson and Janssens, 2006), microorganisms, compound quality and water availability (Melillo et al., 1982; Riederer et al., 1993; Norby et al., 2001; Otto and Simpson, 2006) and land-use (Wiesenberg, 2004). Table 3 lists the mean residence times (MRT) of different hydrophobic compounds in various soils.

Table 3: Mean Residence Times (MRT) of hydrophobic compounds in soils. MRT is the inverse of the decomposition rate (d^{-1}).

hydrophobic compounds	MRT [years]	soil type	soil description	carbon labelling	reference
alkane	35	Haplic Phaeozem	grain-maize crop	^{13}C	Wiesenberg et al. (2004)
	60	Haplic Phaeozem	silage-maize crop	^{13}C	Wiesenberg et al. (2004)
fatty acid	21	Haplic Phaeozem	grain-maize crop	^{13}C	Wiesenberg et al. (2004)
	49	Haplic Phaeozem	silage-maize crop	^{13}C	Wiesenberg et al. (2004)
ester-bound long-chain fatty acid	31.8	Ultic alfisols	pine forest	^{13}C	Feng et al. (2010)
cutin-derived compounds	34.4	Ultic alfisols	pine forest	^{13}C	Feng et al. (2010)
suberin-derived compounds	33.2	Ultic alfisols	pine forest	^{13}C	Feng et al. (2010)
suberin/cutin	250	Leptic Cambisols	Europ. beech forest	^{14}C	Spielvogel et al. (2010)

F Additional drought simulations

In this appendix we show additional model runs akin the ones of Figure 10, but now with slowly decreasing precipitation (Figure F.1) and precipitation shifting back to the original values (Figure F.2). Figures F.3 and F.4 are the same as Figures 10 and F.2, but show the response of a competitive species (low W^*; right side of Figure 9) to changes in precipitation. All runs are on a soil with hydrophobic compounds ($C = 4k_2$) as in the lower row of Figure 10.

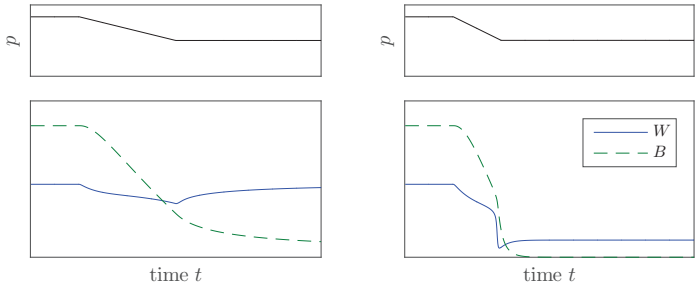

Figure F.1: Only rapid decreases in precipitation can trigger a shift to a hydrophobic dry state without vegetation. Precipitation was reduced by 40 % over a period of 1000 days (left) and 500 days (right), corresponding to a rate of change of 0.001 mm day^{-2} (≈133 mm year^{-2}) and 0.002 mm day^{-2} (≈266 mm year^{-2}) respectively. Parameter values are the same as for Figure 10.

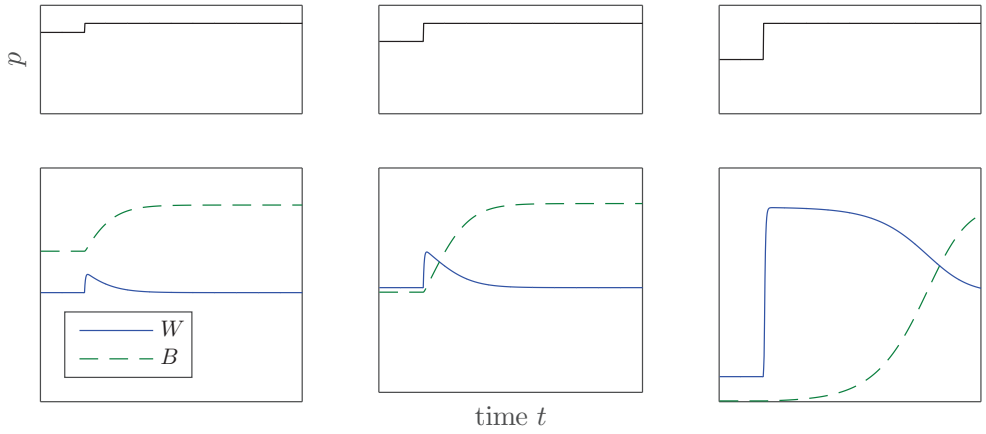

Figure F.2: Restoring the original values of the precipitation of Figure 10 (2.5 mm day^{-1}) enables plants to recover. Parameter values are the same as for Figure 10.

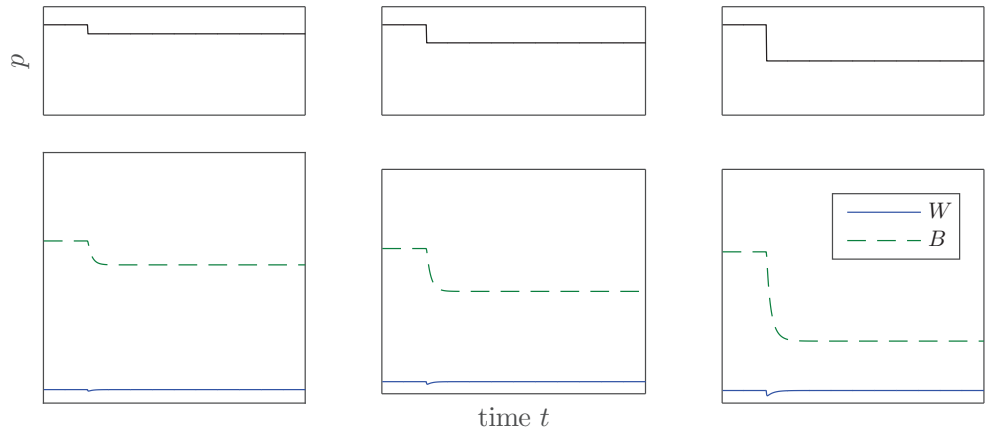

Figure F.3: Competitive species respond in a linear way to decreases in precipitation. Parameter values are the same as for Figure 10, except $W^* = 1.62$ mm, which was obtained by setting c to 2 g dm^{-3}.

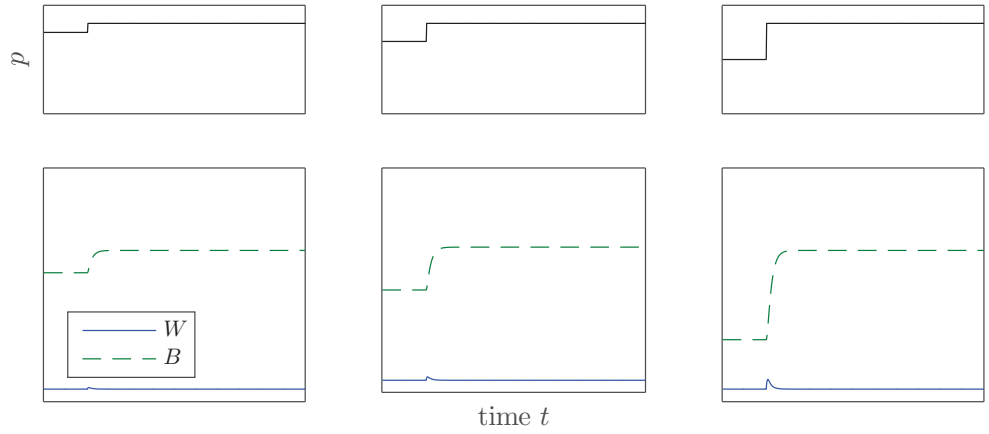

Figure F.4: Same as for Figure F.2, but now for the competitive species described in the caption of Figure F.3.

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