Supplementary Materials: Effect of Protection Level in the Hydroperiod of Water Bodies on Doñana's Aeolian Sands. *Remote Sensing* 2016, *8*, Article ID

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Table S1. Number of images used, distribution by months, and correction factor (C) for each cycle.

Cycle	Months													
	09	10	11	12	01	02	03	04	05	06	07	08	Total	C
1985	1	1		1		1	1			2		2	**9**	1.034
1986					2				1	2	1		**6**	1.746
1987		1				1			1	1	1	2	**7**	1.137
1988	1		1		1	1		2		1		1	**8**	1.083
1989	2	1		1	1	1	1	1		1	1	1	**11**	1.083
1990		1			1	1		1	1	1	1	2	**9**	1.137
1991								1	2	1		1	**5**	2.829
1992	1		2		1	1	1	2	1	1	1	1	**12**	1.083
1993		1			1					1	1		**4**	1.263
1994	1	1		1	1		1		1		1		**7**	1.263
1995	1	1	1	1	1			2	1	1	1	1	**11**	1.034
1996	1								1	1	1	2	**6**	1.034
1997	1		1			1	1		1	1	2	2	**10**	1.083
1998		1	1				2			1	1	1	**7**	1.197
1999		2	1	2	1	1		1	1	1		1	**11**	1.109
2000	1		3	1	1	2			1	1	1	1	**12**	1.155
2001	3		1		1	1		1	2	2			**11**	1.290
2002	1				1	1		1	1	2	2	1	**10**	1.077
2003		1	1		1	1		1	1	1		2	**9**	1.166
2004	1	1		1	1		2	1		1	3	1	**12**	1.130
2005	2	1	1	1	2	2		1	2	2	2	1	**17**	1.342
2006	3	2	2	1	2	2		1		3	3	3	**22**	1.197
2007		1	2	2	1		3		2	2	2	1	**16**	1.352
2008		1	1			1	1	1		2	3	4	**14**	1.347
2009	2	1	1			1	1	2	3	2	2	1	**16**	1.096
2010	1	2	1	1	1	1		2	3	3	1	2	**18**	1.237
2011	1	1	2			3	1	1	2	1		2	**14**	1.077
2012	2	2	1		2	2	1	2	1			1	**14**	1.103
2013	1	2							2	2		1	**8**	1.083
2014	1	1		2			1	1	1			2	**9**	1.034
Total	**28**	**26**	**23**	**15**	**23**	**25**	**17**	**25**	**32**	**40**	**31**	**40**	**325**	

Table S2. Reclassification of land use/land cover map as used to calculate distance to irrigated agriculture. First a clip of the area of the polygon defined by the "Almonte-Marismas" aquifer with a 5 km buffer was taken from the 2007 REDIAM MUCVA_25_07_EscDetalle (Land use and land cover vegetation map of Anadalusia 2007). Then in Qgis the following land uses were reclassified as irrigated agriculture. The reclassified shapefile is named W_regadio_ED50-PS.

REDIAMMUCVA_25_07_EscDetalle Class	Translation
CULTIVOS FORZADOS BAJO PLASTICO	Crops cultivated under plastic
CULTIVOS HERBACEOS EN REGADIO: NO REGADOS	Irrigated herbaceous crops: non irrigated
CULTIVOS HERBACEOS EN REGADIO: REGADOS Y NO REGADOS	Irrigated herbaceous crops: irrigated and not irrigated
CULTIVOS HERBACEOS Y LEÑOSOS REGADOS	Irrigated herbaceous and woody crops
CULTIVOS LEÑOSOS EN REGADIO: PARCIALMENTE REGADOS O NO REGADOS	Irrigated woody crops: partially or not irrigated
CULTIVOS LEÑOSOS REGADOS: CITRICOS	Irrigated woody crops: citrus crops
CULTIVOS LEÑOSOS REGADOS: OLIVOS	Irrigated woody crops: olive crops

MOSAICO DE LEÑOSOS EN REGADIO	Mosaic of irrigated woody crops
MOSAICO DE SECANO Y REGADIO CON CULTIVOS HERBACEOS	Mosaic of dryland and irrigated herbaceous crops
MOSAICO DE SECANO Y REGADIO CON CULTIVOS HERBACEOS Y LEÑOSOS	Mosaic of dryland and irrigated crops. Herbaceous and woody crops.
MOSAICO DE SECANO Y REGADIO CON CULTIVOS LEÑOSOS	Mosaic of dryland and irrigated woody crops.
OTROS CULTIVOS HERBACEOS REGADOS	Other irrigated herbaceous crops
OTROS CULTIVOS LEÑOSOS REGADOS	Other irrigated woody crops

Table S3. Reclassification of land use /land cover map as used to calculate distance to residential areas. First a clip of the area of the polygon defined by the "Almonte-Marismas" aquifer with a 5 km buffer was taken from the 2007 REDIAM MUCVA_25_07_EscDetalle (Land use and land cover vegetation map of Anadalusia 2007) . Then in Qgis the following land uses were reclassified as residential areas. The reclassified shapefile is named W_residencial_ED50-PS.

REDIAMMUCVA_25_07_EscDetalle Class	Translation
EQUIPAMIENTO DEPORTIVO Y RECREATIVO	Recreation and sport fields
TEJIDO URBANO	Urban matrix
URBANIZACIONES AGRICOLA / RESIDENCIALES	Agricultural and residential housing development
URBANIZACIONES RESIDENCIALES	Residential housing developments
ZONAS VERDES URBANAS	Urban green areas

Both shapefiles were rasterized to boolean images in IDRISI Selva and then maps of euclidean distance to the pixel were calculated (with Distance).

Table S4. Criteria used in the photo-intrepretation of water bodies. The polygons selected were transformed into a klm file and overlayed in Google Earth and Bing using the mosrt recent images of the area. The interior part of the polygon was classified exclusively in one of the following categories.

Class	Description
(1) Natural pond	A natural pond with water or dry areas with a clearly defined pond basin
(2) stream	Dry or inundated area in a clearly defined natural drainage network
(3) irrigation pond	Artificial pond used as temporary storage for irrigation. Usually square or rectangular in shape and with impervious bottom
(4) artificial pond	Pond with irregular shape but with pipes and other infrastructure that denotes its use as storage of water for irrigation
(5) dense pine wood	Dense coverage of pines. The soil is not visible so flooding could not be detected
(6) other dense vegetation	Dense coverage of woody vegetation. The soil is not visible so flooding could not be detected
(7) disperse vegetation	Disperse herbaceous or woody vegetation. Flooding should be detectable in a Landsat image. No appreciable basin or drainage network
(8) non vegetated.	Bare soil . Flooding should be detectable. No appreciable basin or drainage network

Table S5. Criteria used in the photo-intrepretation of water bodies. The surroundings of the polygon was classified in one of the following categories.

Surrounding Class	Description
(1) Natural	Natural vegetated or non-vegetated surfaces
(2) Dryland agriculture	Cereal or sunflower fields
(3) Irrigated agriculture	Irrigated cultures (herbaceous or woody cops)
(4) Greenhouses	Greenhouses or crops cultvated under plastic
(5) Industrial	Industrial development
(6) Urban	Residential or urban development
(7) Others	Other (marshland, tidal areas, beaches)

Table S6. Relative importance of predictors in the best gam model for the correlation between annual hydroperiod and precipitation (R-squared) for all water bodies. Irrigation = smoothing spline of log distance to irrigated cultures, residential = smoothing spline of log distance to residential areas, protection = protection level (factor, four levels), altitude = altitude above sea level, latitude, longitude = surface smoothing spline of spatial coordinates in m. Predictors in decreasing order of relative importance based on Δ AIC estimated by single term simplification from the full model.

Predictors	Df	*F*	*p*	Δ AIC
latitude, longitude	3	22.973	<0.0001	62.542
irrigation	3	22.048	<0.0001	61.942
protection	3	22.771	<0.0001	59.804
residential	3	4.607	0.00319	7.849
altitude	1	2.844	0.091	0.854
Residual	3664			
Null Deviance =		60.18		
Full Model Residual Deviance =		51.91		
Full model AIC =		−5202.6		

Table S7. Relative importance of predictors in best gam model for annual hydroperiod trend corrected for precipitation (Kendall's tau) for all water bodies. Irrigation = smoothing spline of log distance to irrigated cultures, protection = protection level (factor, four levels), altitude = altitude above sea level, latitude, longitude = surface smoothing spline of spatial coordinates in m. Predictors in decreasing order of relative importance based on Δ AIC estimated by single term simplification from the full model.

Predictors	Df	*F*	*p*	Δ AIC
protection	3	96.028	<0.0001	272.158
irrigation	3	31.638	<0.0001	87.986
latitude, longitude	3	20.493	<0.0001	55.154
altitude	1	11.315	<0.0001	9.331
Residuals	3667			
Null Deviance =		64.09		
Full Model Residual Deviance =		54.66		
Full model AIC =		−5018.7		

Table S8. Relative importance of predictors in the best gam model for the correlation between annual hydroperiod and precipitation (R-squared) for a random selection of natural water bodies. Irrigation = smoothing spline of log distance to irrigated cultures, residential = smoothing spline of log distance to residential areas, protection = protection level (factor, four levels), latitude, longitude = surface smoothing spline of spatial coordinates in m. Predictors in decreasing order of relative importance based on Δ AIC estimated by single term simplification from the full model.

Predictors	Df	*F*	*p*	Δ AIC
latitude, longitude	3	4.211	0.0062	6.824
irrigation	2	4.852	0.0084	5.897
protection	3	2.085	0.102	0.415
residential	2	2.014	0.135	0.145
Residuals	305			
Null Deviance =		5.505		
Full Model Residual Deviance =		5.013		
Full model AIC =		−398.6		

Table S9. Relative importance of predictors in the best gam model for temporal trend in annual hydroperiod corrected for precipitation (Kendall's tau) for natural water bodies. Residential = smoothing spline of log distance to residential areas, protection = protection level (factor, four levels), latitude, longitude = surface smoothing spline of spatial coordinates in m. Predictors in decreasing order of relative importance based on Δ AIC estimated by single term simplification from the full model.

Predictors	Df	*F*	*p*	Δ AIC
protection	3	14.655	<0.0001	36.295
residencial	3	2.880	0.036	2.770
latitude, longitude	2	3.215	0.042	2.551
Residuals	307			
Null Deviance =		7.56		
Full Model Residual Deviance =		6.28		
Full model AIC =		-321.30		

Table S10. Relative importance of predictors in best gam model for annual hydroperiod trend corrected for precipitation (Theil-Sen slope) for all water bodies. Irrigation = smooth spline of log distance to irrigated cultures, residential = smooth spline of log distance to residential areas, protection = protection level (factor, four levels), latitude, longitude = surface smooth spline of spatial coordinates in m. Predictors in decreasing order of relative importance based on Δ AIC estimated by single term simplification from the full model.

Predictors	Df	*F*	*p*	Δ AIC
protection	3	15.835	<0.0001	41.366
residential	3	11.422	<0.0001	28.228
irrigation	3	9.039	<0.0001	21.114
latitude, longitude	3	3.490	0.0151	4.492
Residuals	3665			
Null Deviance =		3666.4		
Full Model Residual Deviance =		3480.4		
Full model AIC =		10263		

Table S11. Relative importance of predictors in the best gam model for temporal trend in annual hydroperiod corrected for precipitation (Theil-Sen slope) for natural water bodies. protection = protection level (factor, four levels), latitude, longitude = surface smooth spline of spatial coordinates in m. Predictors in decreasing order of relative importance based on Δ AIC estimated by single term simplification from the full model.

Predictors	Df	*F*	*p*	Δ AIC
protection	3	4.291	0.0055	6.857
latitude, longitude	2	2.6201	0.0744	1.297
Residuals	310			
Null Deviance =		564.33		
Full Model Residual Deviance =		529.27		
Full model AIC =		1073.7		

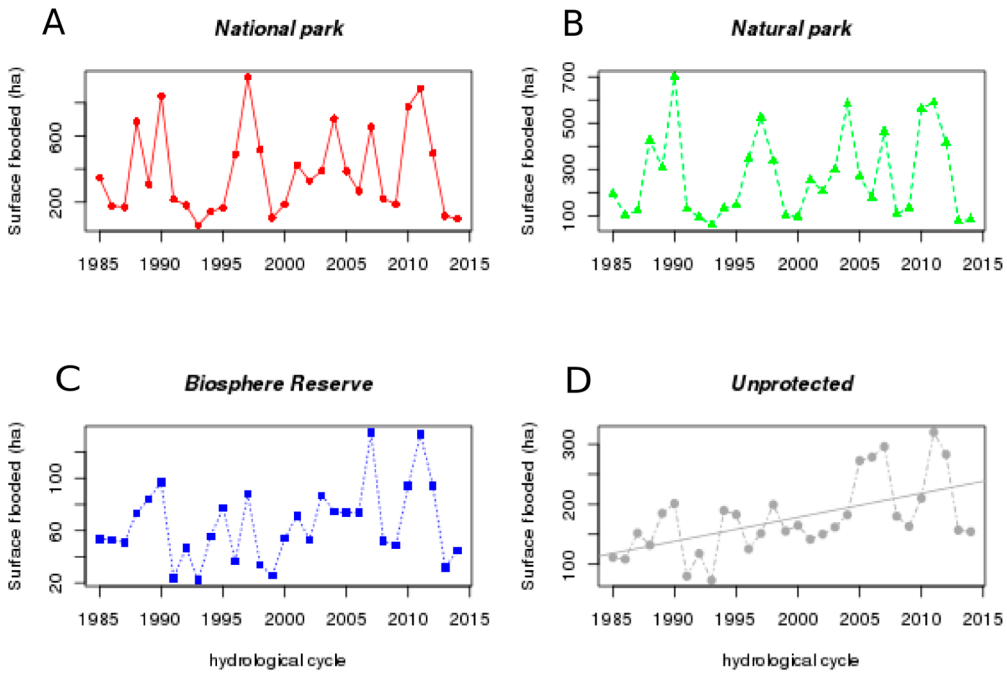

Figure S1. Temporal trends in the maximum flooded surface of potential temporary waters within protection levels. (**A**) Red circles = National Park; (**B**) green triangles = Natural Park; (**C**) blue squares = Biosphere Reserve; (**D**) gray circles = unprotected. Only statistically significant trend lines are shown.

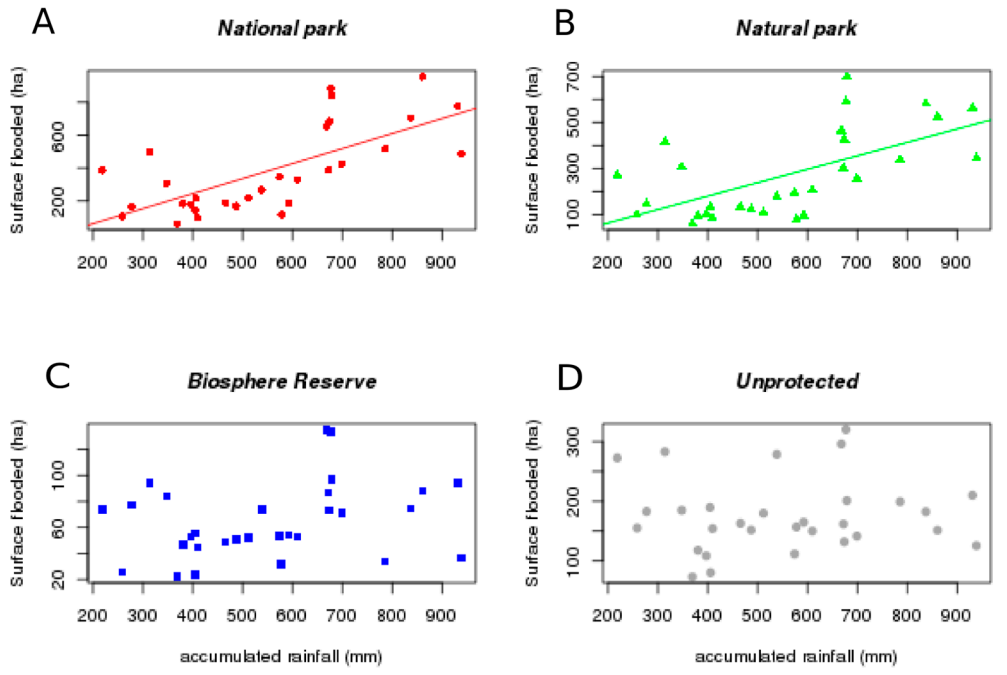

Figure S2. Relationship between annual accumulated precipitation and the maximum flooded surface of potential temporary waters within protection levels. (**A**) Red circles = National Park; (**B**) green triangles = Natural Park; (**C**) blue squares = Biosphere Reserve; (**C**) gray circles = unprotected. Only statistically significant trend lines are shown.

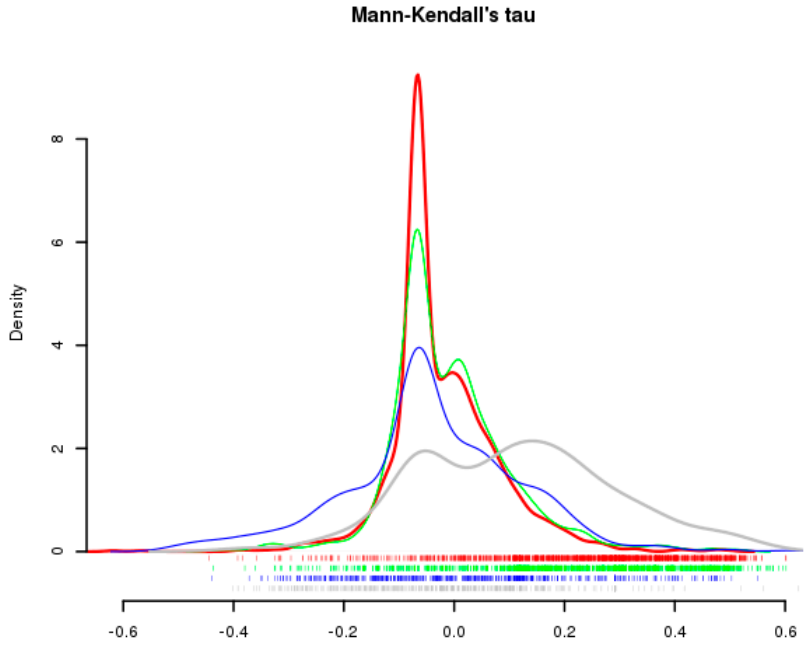

Figure S3. Density plot of the Kendall's tau of water bodies. Positive values indicate increasing hydroperiods and negative values decreasing hydroperiods, once corrected for annual precipitation. Protection level indicated with colors: high protection = red, medium protection = green, low protection = blue, unprotected = gray. The rug plots below indicate the distribution of water bodies. High protection (red) and unprotected (gray) lines are drawn thicker for clarity.

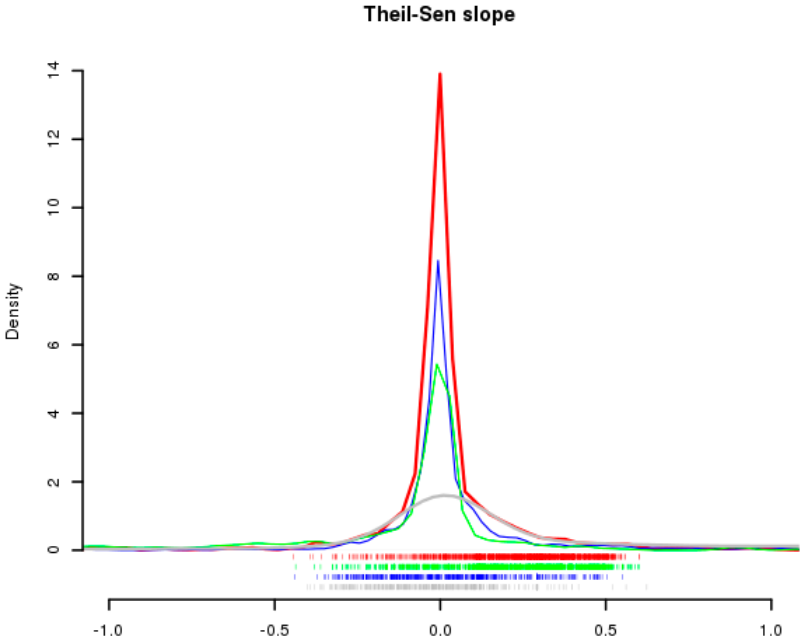

Figure S4. Density plot of the Theil-Sen slope of water bodies. Positive values indicate increasing hydroperiods and negative values decreasing hydroperiods, once corrected for annual precipitation. Protection level indicated with colors: high protection = red, medium protection = green, low protection = blue, unprotected = gray. The rug plots below indicate the distribution of water bodies. High protection (red) and unprotected (gray) lines are drawn thicker for clarity.

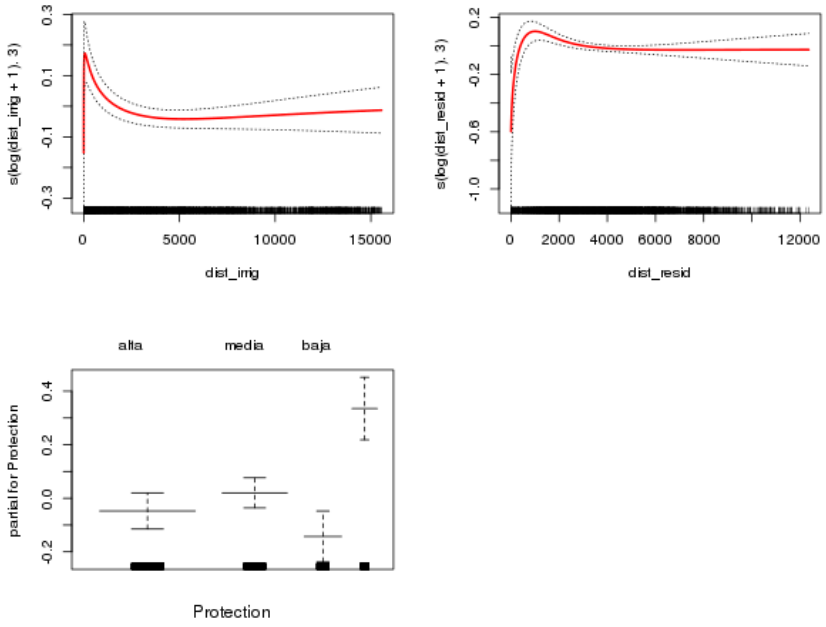

Figure S5. Partial effect of predictors in the best gam model for annual hydroperiod trend corrected for precipitation (Theil-Sen slope) for all water bodies.

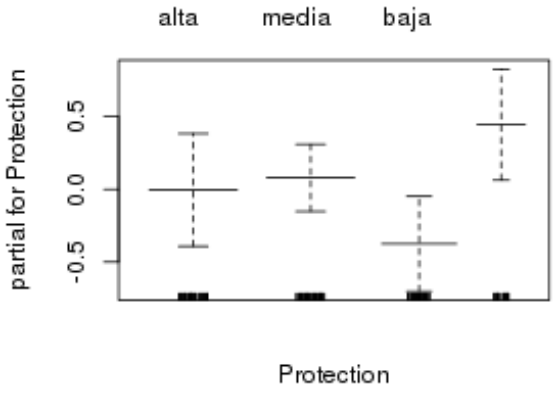

Figure S6. Partial effects in the best gam model for temporal trend in annual hydroperiod corrected for precipitation (Theil-Sen slope) for natural water bodies.

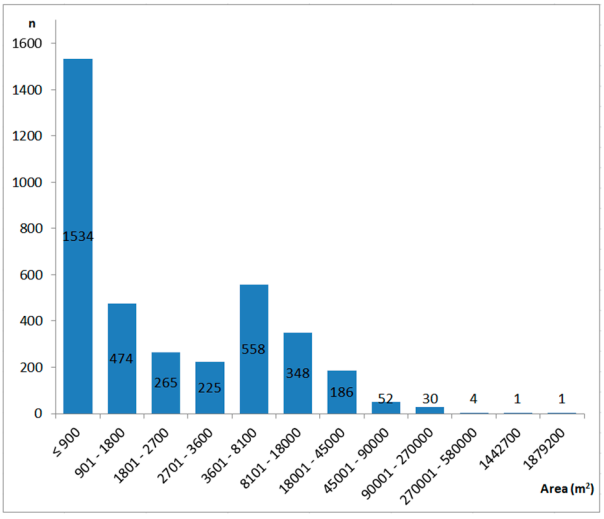

Figure S7. Distribution of water bodies according to their size. Size in m². Sample size for each size interval indicated on the column.

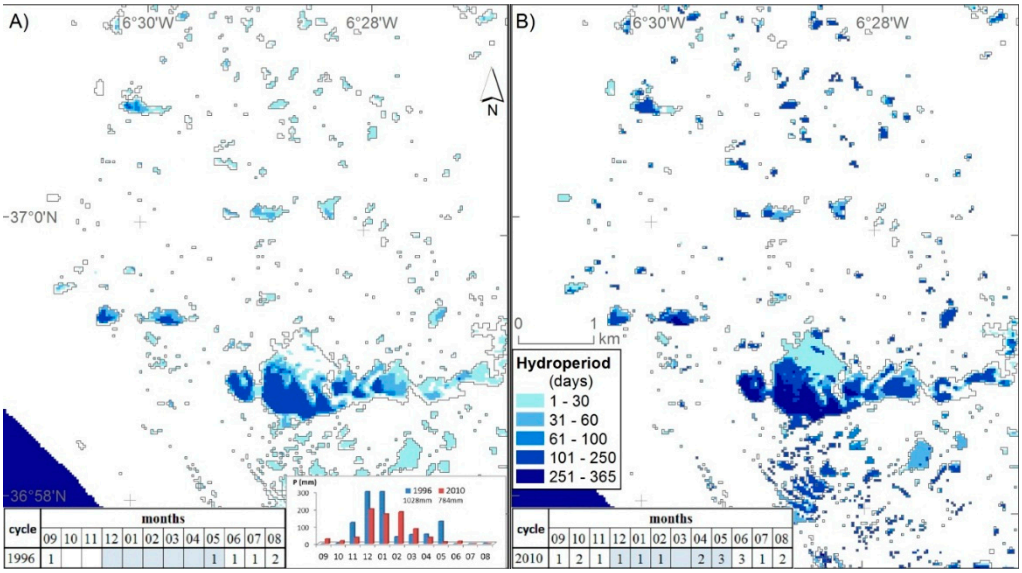

Figure S8. Example of hydroperiod distribution maps for a small area inside the National park for two cycles that have similar precipitation but a different number of Landsat images. (**A**) 1996; (**B**) 2010. Darker blue indicates longer hydroperiod for the pixel. The black line indicates the maximum extent of temporary waters (pixels that have been flooded at least once in 30 years). The distribution of images in the flooding cycle is shown.