Transpiration in an oil palm landscape: effects of palm age

Publons ID	(not set)
Wos ID	WOS:000362972200004
Doi	10.5194/bg-12-5619-2015
Title	Transpiration in an oil palm landscape: effects of palm age
First Author	
Last Author	
Authors	Roll, A; Niu, F; Meijide, A; Hardanto, A; Hendrayanto; Knohl, A; Holscher, D;
Publish Date	2015
Journal Name	BIOGEOSCIENCES
Citation	41
Abstract	Oil palm (Elaeis guineensis Jacq.) plantations cover large and continuously increasing areas of humid tropical lowlands. Landscapes dominated by oil palms usually consist of a mosaic of mono-cultural, homogeneous stands of varying age, which may be heterogeneous in their water use characteristics. However, studies on the water use characteristics of oil palms are still at an early stage and there is a lack of knowledge on how oil palm expansion will affect the major components of the hydrological cycle. To provide first insights into hydrological landscape-level consequences of oil palm cultivation, we derived transpiration rates of oil palms in stands of varying age, estimated the contribution of palm transpiration to evapotranspiration, and analyzed the influence of fluctuations in environmental variables on oil palm water use. We studied 15 two-to 25-year old stands in the lowlands of Jambi, Indonesia. A sap flux technique with an oil palm specific calibration and sampling scheme was used to derive leaf-, palm-and stand-level water use rates in all stands under comparable environmental conditions. Additionally, in a two-and a 12-year old stand, eddy covariance measurements were conducted to derive evapotranspiration rates. Water use rates per leaf and palm increased 5-fold from an age of 2 years to a stand age of approx. 10 years and then remained relatively constant. A similar trend was visible, but less pronounced, for estimated stand transpiration rates of oil palms; they varied 12-fold, from 0.2mmday 1 in a 2-year old to 2.5mmday 1 in a 12-year old stand, showing particularly high variability in transpiration rates among medium-aged stands. Comparing sap flux and eddy-covariance derived water fluxes suggests that transpiration contributed 8% to evapotranspiration in the 2-year old stand and 53% in the 12-year old stand, indicating variable and substantial additional sources of evaporation, e. g., from the soil, the ground vegetation and from trunk epiphytes. Diurnally, oil palm transpiration rates were characterized by an early peak between 10 and 11 a. m.; there was a pronounced hysteresis in the leaf water use response to changes in vapor pressure deficit for all palms of advanced age. On the day-to-day basis this resulted in a relatively low variability of oil palm water use regardless of fluctuations in vapor pressure deficit and radiation. We conclude that oil palm dominated landscapes show some spatial variations in (evapo) transpiration rates, e. g., due to varying age-structures, but that the temporal variability of oil palm transpiration is rather low. The stand transpiration of some of the studied oil palm stands was as high or even higher than values reported for different tropical forests, indicating a high water use of oil palms under yet to be explained site or management conditions. Our study provides first insights into the eco-hydrological characteristics of oil palms as well as a first estimate of oil palm water use across a gradient of plantation age. It sheds first light on some of the hydrological consequences of the continuing expansion of oil palm plantations.
Publish Type	Journal
Publish Year	2015
Page Begin	5619
Page End	5633
Issn	1726-4170

Eissn	1726-4189
Url	https://www.webofscience.com/wos/woscc/full-record/WOS:000362972200004
Author	AFIK HARDANTO, S.TP, M.Sc., Ph.D