Application of Sentinel-1 Data Data for Biomass and Soil Moisture for Different Areas of Vegetation

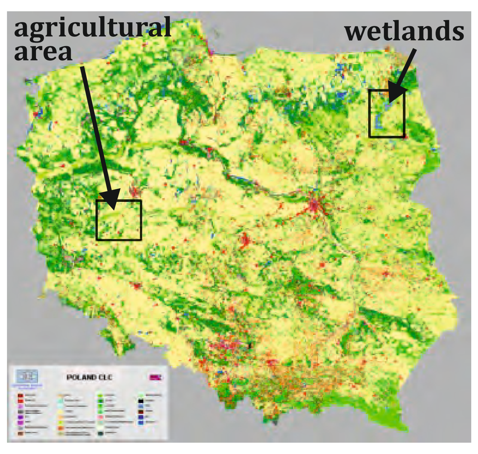
K. Dabrowska – Zielinska, M. Budzynska , M. Tomaszewska, A. Malinska, J. Musial, M. Bartold, M. Gatkowska, I. Malek, K. Paradowski, A. Mironczuk

Institute of Geodesy and Cartography, Remote Sensing Centre, Modzelewskiego 27, 02-679 Warsaw, Poland, **www.igik.edu.pl**

ABSTRACT

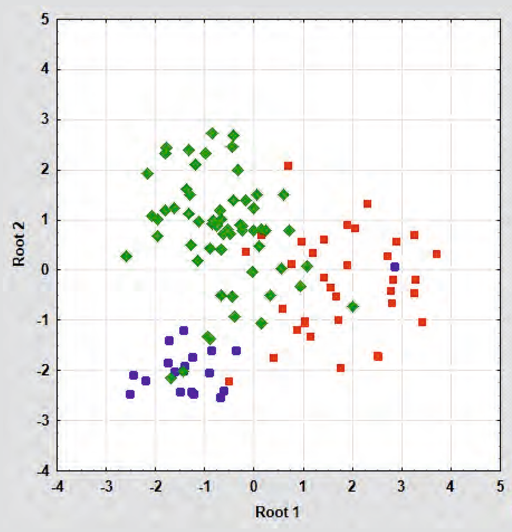
The goal of the study was to find the impact of vegetation and soil moisture on backscattering coefficient (σ^o) calculated from Sentinel1 images. The results were analysed along with ground truth measurements of vegetation parameters and soil moisture. There were considered two sites: **1/ Agriculture Area and 2/Grassland Wetlands**. LAI, biomass, Soil Moisture (SM) has been measured for different vegetation. It was modelled the impact of soil moisture on backscatter and the impact of vegetation descriptor as LAI and vegetation descriptor SWIR on backscatter. The relationship between LAI and σ^o was adversely proportional when the soil was covered by short vegetation, after the threshold the vegetation index was proportional to the backscatter. Vegetation attenuates the signal until some amount of biomass (different for different vegetation). Soil moisture varied for these two test sites : soil moisture at wetlands was high and then soil moisture dominated the values of backscatter while with the increase of canopy cover, the sensitivity of radar signal to dry soil conditions was low.

Due to possibilities of obtaining SPOT5 and information from Short Wave Infrared SWIR, it was possible to examine the relationship between backscatter and vegetation moisture. Sentinel1 has been applied for distinguishing the crop types. During the S-1 acquisition the ground measurements has been carried out.



AGRICULTURAL AREA

Sentinel1 21/05/2015 - wielkopolskie
classification of agricultural cultivations - Discriminant Analysis



Canonical variables:
Root1 = -4.42 - 0.60 * VH + 0.53 * VV
Root2 = -8.68 – 0.36 * VH – 0.20 * VV

Classification funcions:
Frape = -30.0 – 4.41 * VH + 0.35 * VV
Fbeet-corn = -55.76 – 6.78 *VH + 1.56 * VV
Fwheet = -52.33 – 5.71 * VH + 0.11 * VV

Max(Frape, Fbeet-corn, Fwheet) -> CLASS

Result : above 83%

Water cloud model
backscatter descriptors: LAI; SM; H; SWIR (SPOT 5)

Water cloud model represents the total backscatter from the canopy σ^0 as the sum of the contribution of vegetation σ_v^0 and of underlying soil σ_s^0

$$\sigma^0 = \sigma_v^0 + \tau^2 \sigma_s^0 \qquad (m^2m^{-2})$$

where:

$$\sigma_v^0 = AV_1^E \cos\vartheta\,(1-\tau^2) \qquad (m^2m^{-2})$$

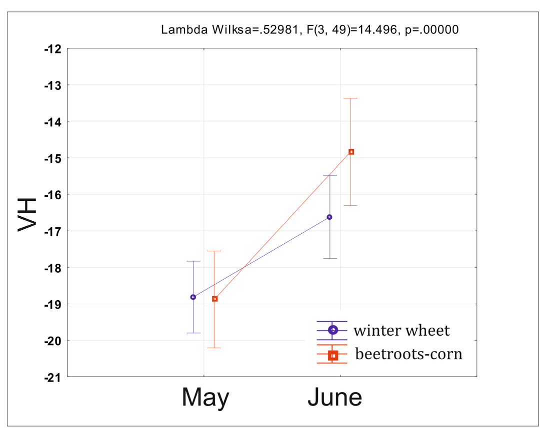
$$\sigma_s^0 = C + D\,SM \qquad (dB)$$

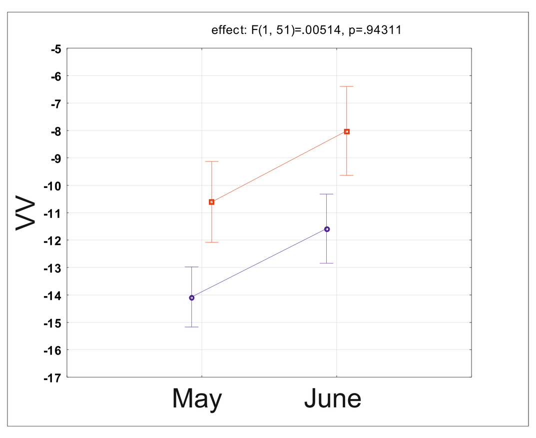
$$\tau^2 = \exp(-2BV_2/\cos\vartheta) \qquad (unitless)$$

$$\sigma^0 = [\,AV_1^E \cos\vartheta\,(1-(\exp(-2BV_2/\cos\vartheta)))] + (\exp(-2BV_2/\cos\vartheta)\,\sigma_s^0) \qquad (m^2m^{-2})$$

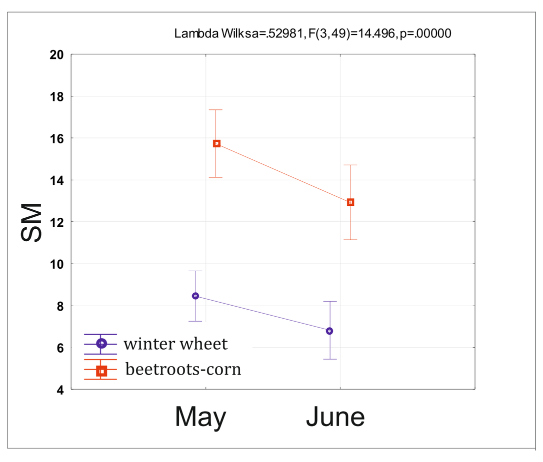
where, ϑ: incidence angle, τ^2: two way attenuation through the canopy: V1 and V2 are descriptors of the canopy.

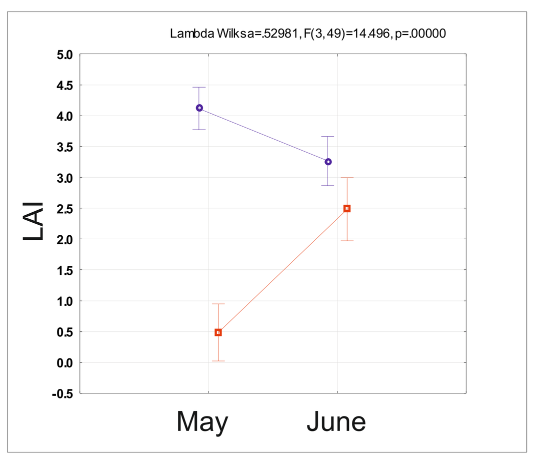
Variation of backscatter S1 VH and VV in May and June



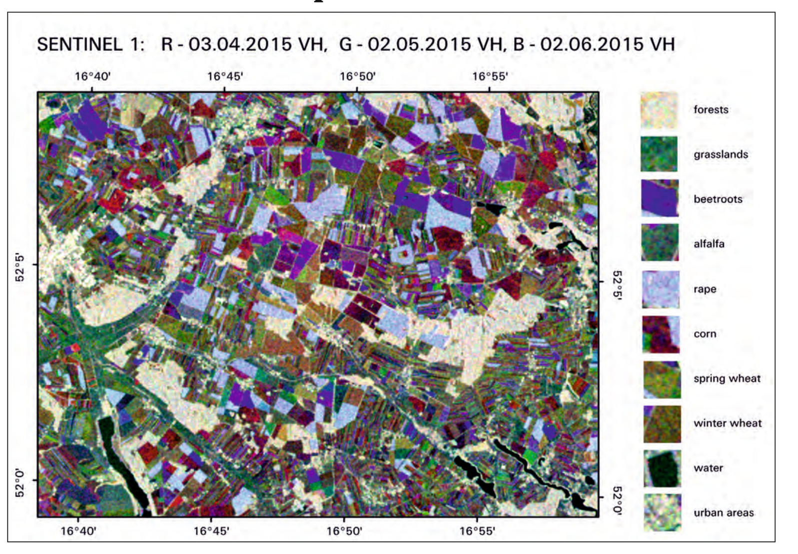


Variation of SM and LAI in May and June





Sentinel1 – Crop Variation at the test site

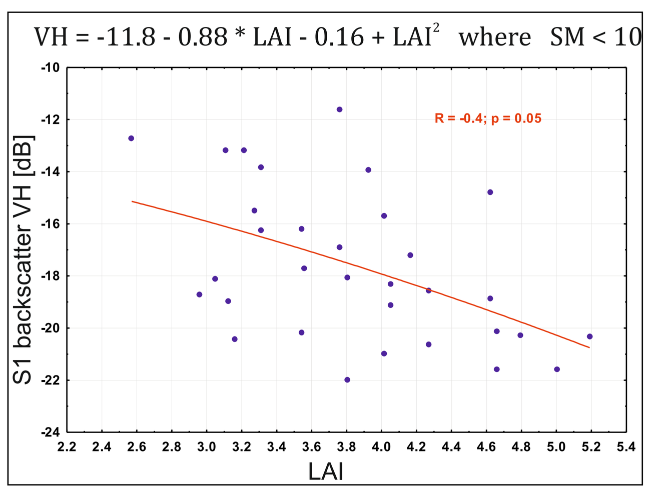


GROUND MEASUREMENTS

WINTER WHEAT SM<10%

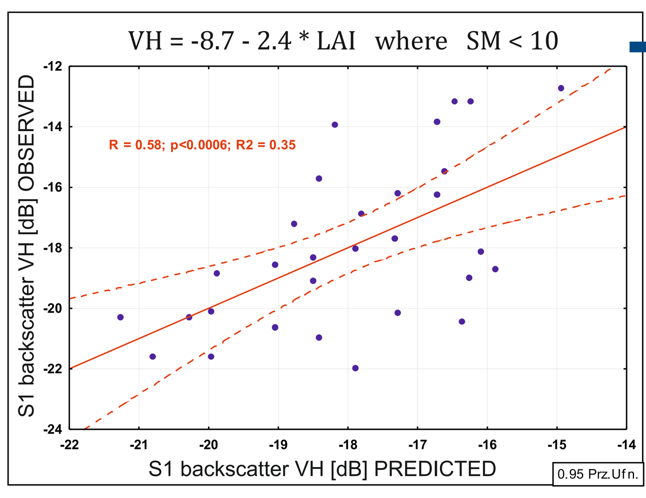
Impact of vegetation descriptor – LAI

VH = -11.8 - 0.88 * LAI - 0.16 + LAI² where SM < 10

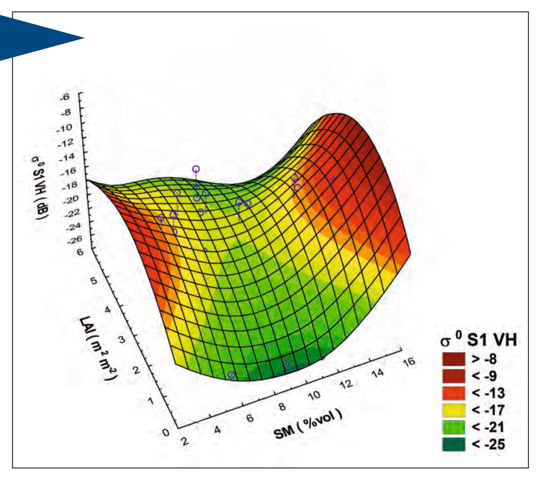


Modelled Backscatter VH - descriptor LAI

VH = -8.7 - 2.4 * LAI where SM < 10

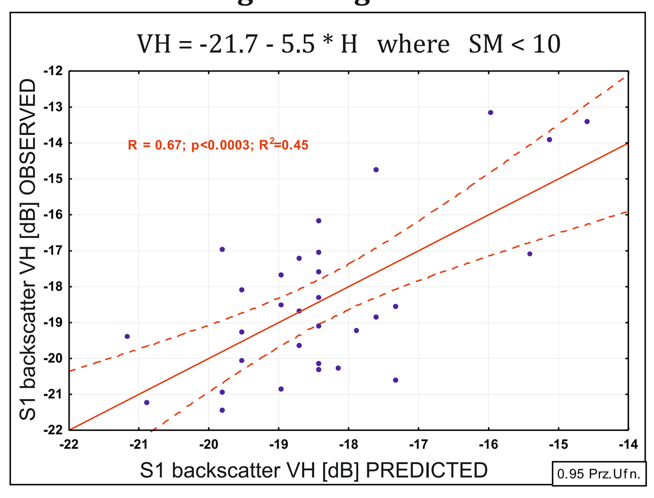


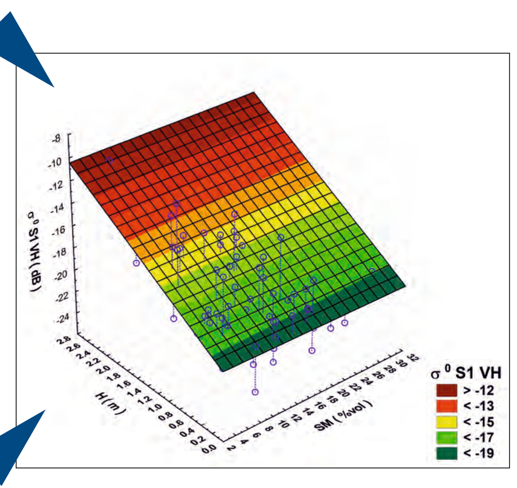
Model of backscatter VH descriptor to LAI and SM



Modelled Backscatter VH - descriptor height of vegetation

VH = -21.7 - 5.5 * H where SM < 10

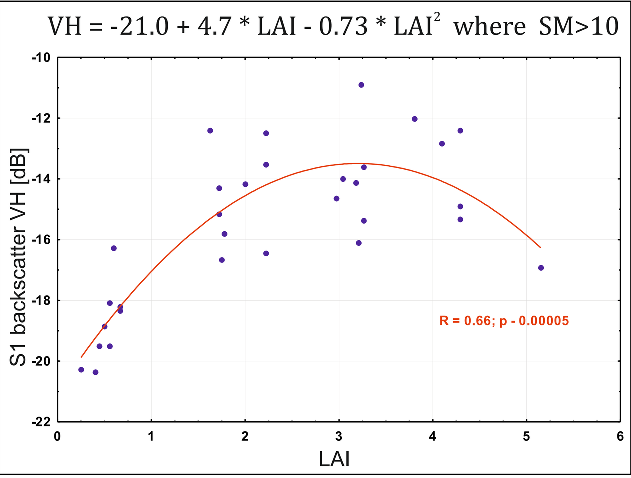




BEETROOTS-CORN SM>10%

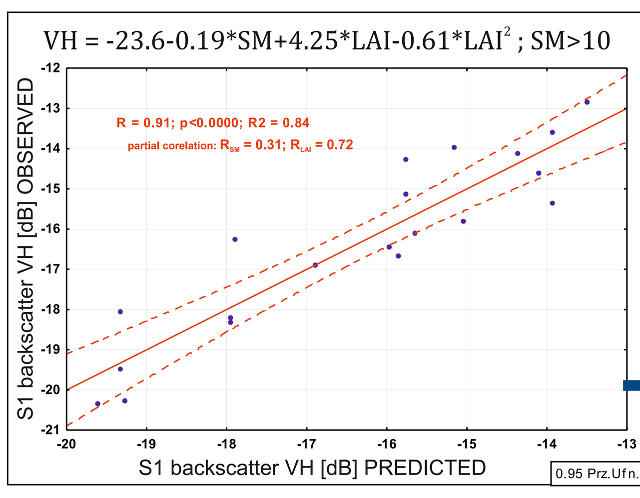
Impact of LAI on Backscatter

VH = -21.0 + 4.7 * LAI - 0.73 * LAI² where SM>10

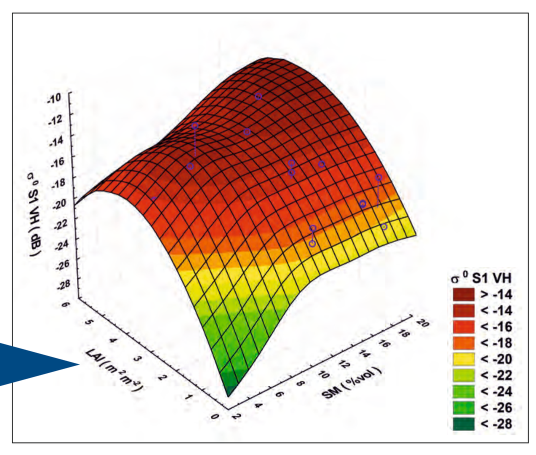


Modelled backscatter VH (LAI; SM)

VH = -23.6-0.19*SM+4.25*LAI-0.61*LAI²; SM>10

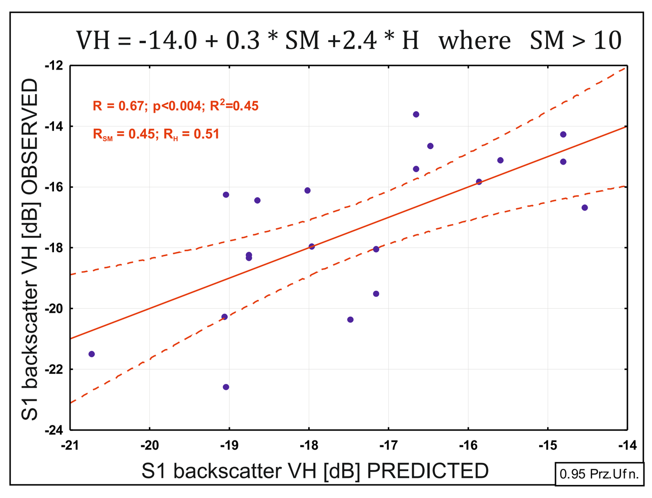


Model of backscatter VH descriptor to LAI and SM



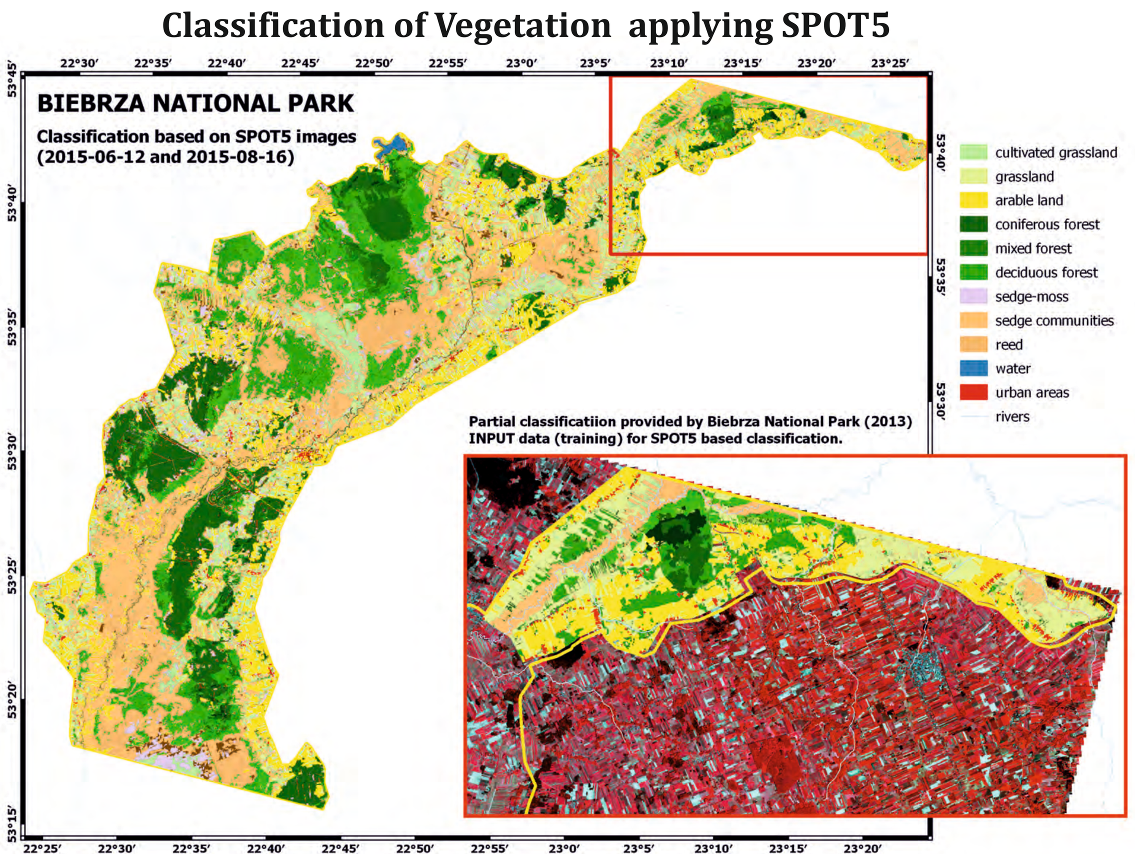
Modelled backscatter VH – descriptor H; SM

VH = -14.0 + 0.3 * SM +2.4 * H where SM > 10

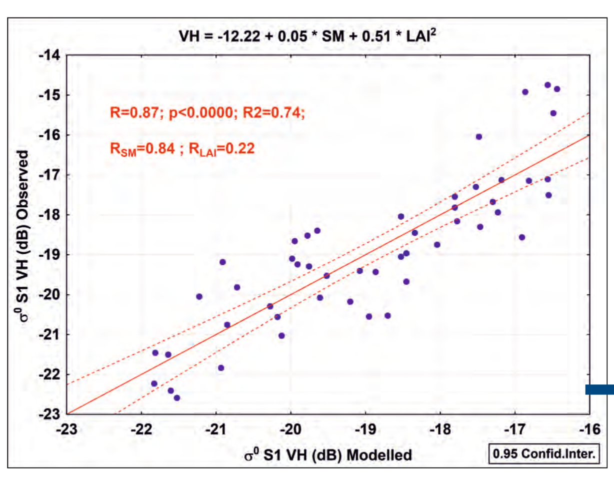


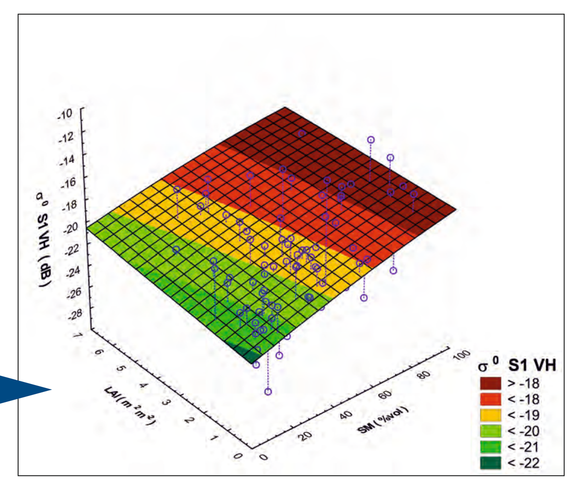
WETLANDS

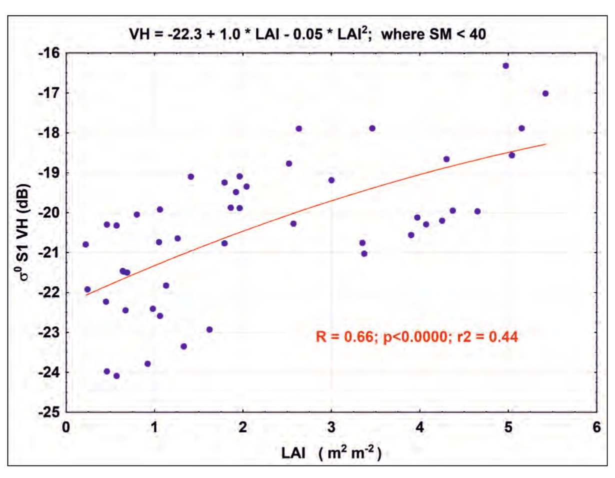
Classification of Vegetation applying SPOT5

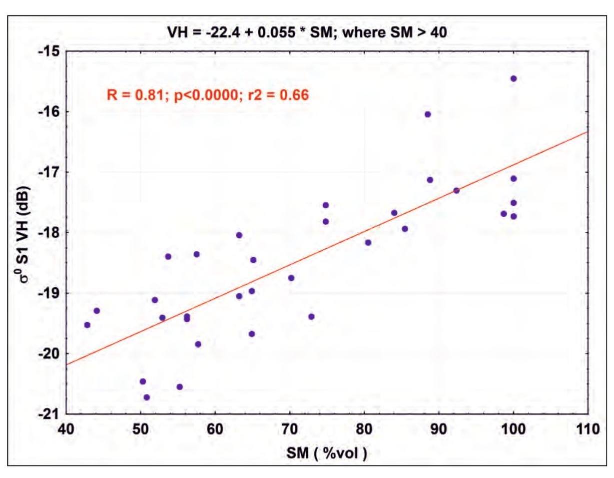


Modeled backscatter VH with small influence of LAI and strong influence of SM

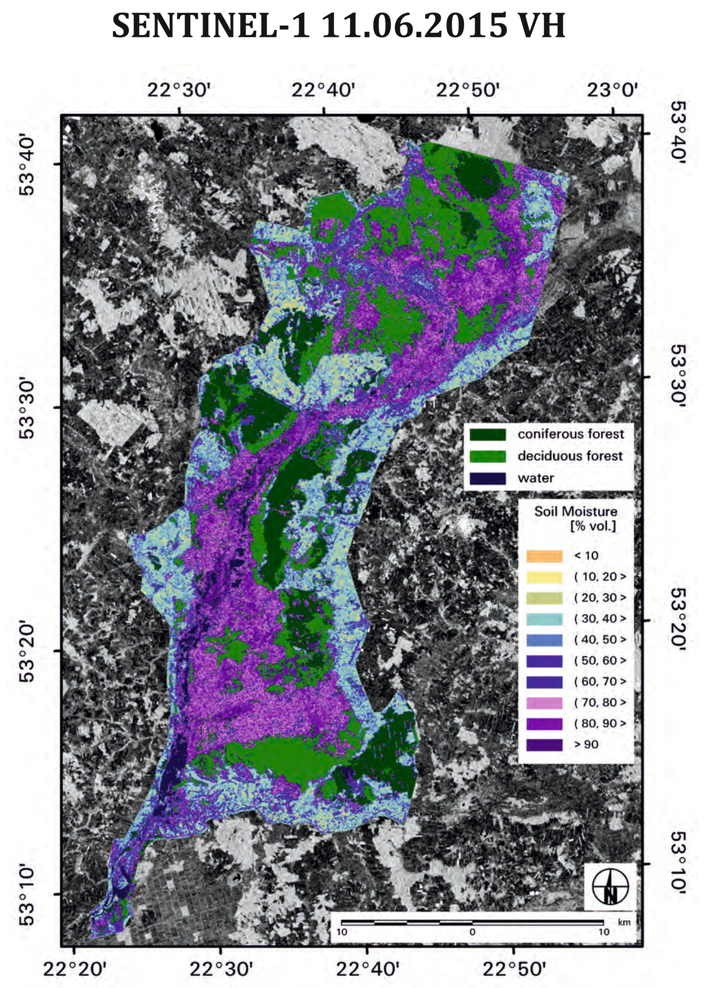




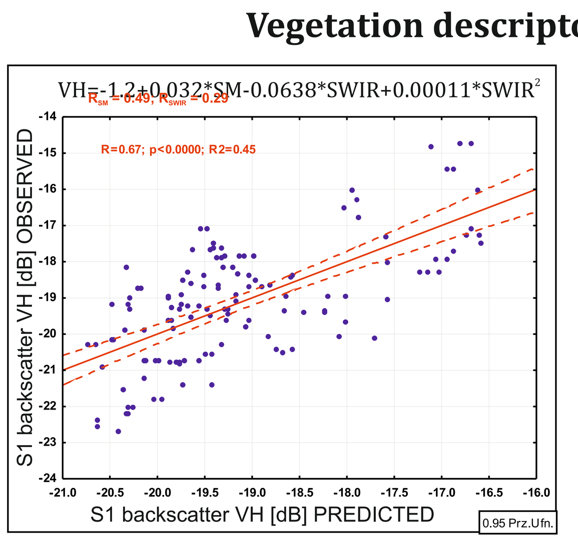


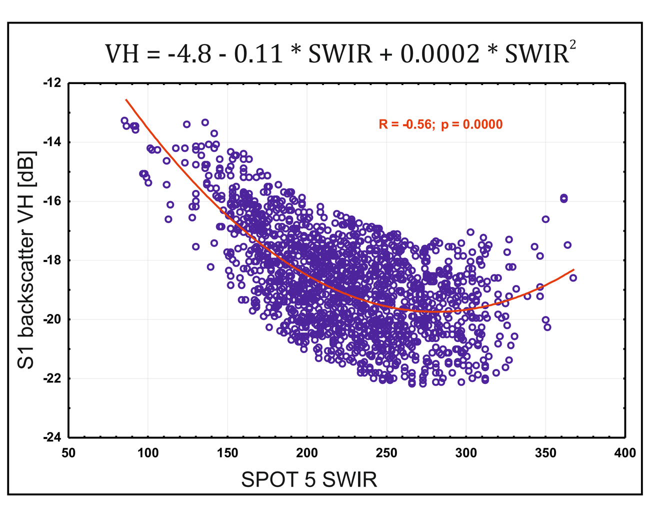


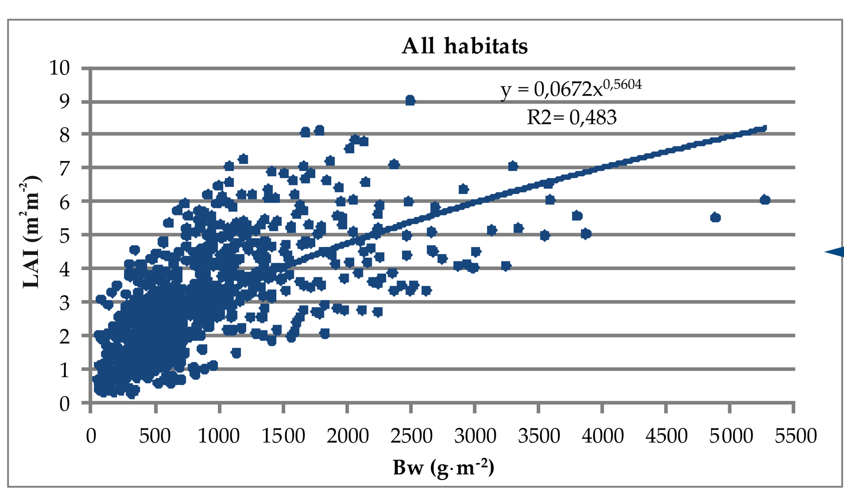
SENTINEL-1 11.06.2015 VH



Vegetation descriptor from SPOT5 – SWIR







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