MAPPING AND EVALUATION OF DRYNESS CONDITIONS

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Mapping and evaluation of dryness conditions with GIS

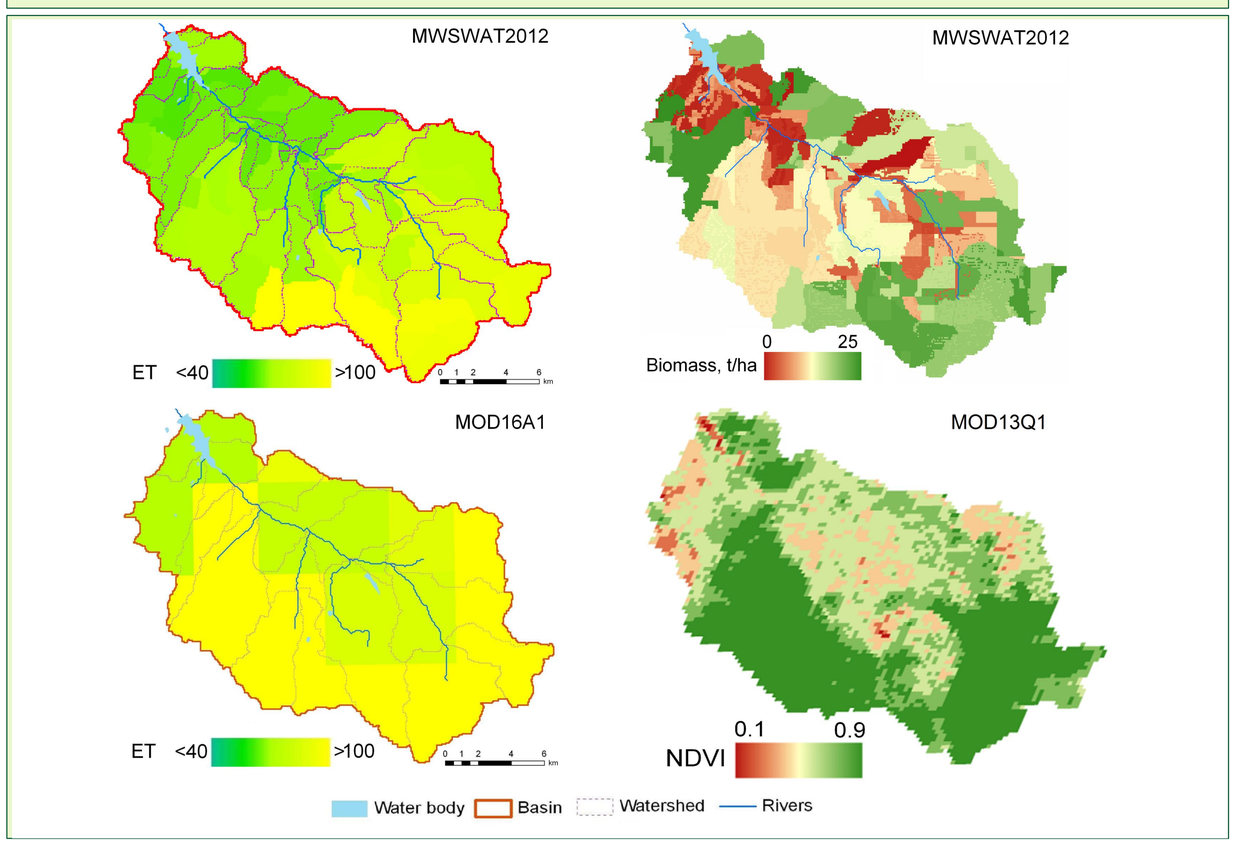
Joint use of open GIS MapWindow and results of simulation of agro-hydrological model MWSWAT2012

Aridity index (AI)

Research is conducted on the example of three different zones of the Crimean peninsula: foothill zone, central steppe zone and western seashore zone. AI of the territory – precipitation ratio to potential Evapotranspiration on selected time step (day, month, and year). AI classified as hyperarid, when AI < 0.05, arid – 0.05 < AI < 0.20, semi-arid – 0.20 < AI < 0.50, dry subhumid – 0.50 < AI < 0.65 (UNEP (1992) World Atlas of Desertification).

The AI on sub-basins for foothill zone watershed shows heterogeneous distribution of humidification on the territory, the most favorable conditions here are observed in the middle part of catchment basin. Watershed on the whole is characterized by the insufficient moistening during a vegetation period. Additional advantages have the joint use of GIS and Earth remote sensing data. An actual Evapotranspiration jointly with the normalized difference vegetation index (NDVI) allows estimating the influence of meteorological conditions on vegetation cover forming. Value of actual Evapotranspiration is calculated in MWSWAT2012 (Penman–Monteith equation) on the basis of meteorological information of watershed territory and obtained from MOD16A1 (0.05 grid data). NDVI values are re-calculated from MOD13Q1 16-day 250-meter spatial resolution gridded level-3 product in QGIS 2.6.1. Figure shows that the leveling of conditions made by the ET and NDVI is the same, but GIS gives the possibility to evaluate conditions on daily time step.

ET (mm) in comparison with NDVI and biomass of the foothill zone of Crimea (June 2014)



Mapping and evaluation of dryness conditions with Earth remote sensing data.

Decoding remote sensing data

Normalized Difference Drought Index (NDDI)

NDDI was developed by University of Nebraska for the estimation of drought conditions and based on the use of satellite information(Gu et al, 2007). NDDI is calculated on the basis of NDVI and Normalized Difference Water Index (NDWI) by the next equation:

$$NDDI = (1- NDWI / NDVI) / (1+NDWI / NDVI).$$

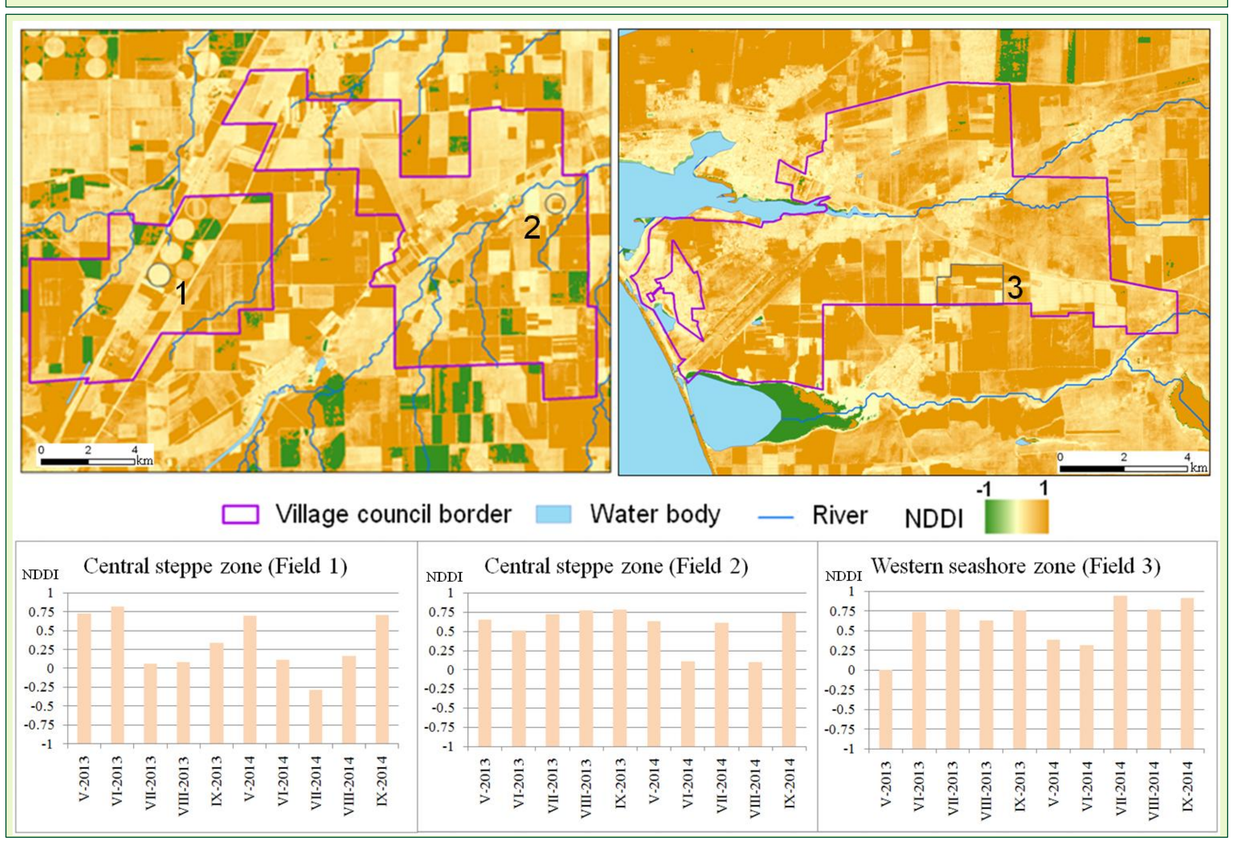
NDDI varies from -1 to 1, and can be presented both within the limits of this range and in percent. The large values of index show severity of drought.

Analysis of water availability of the territory of central steppe and western seashore zone has been carried out with the use of QGIS 2.6.1 and L8 OLI/TIRS (spatial resolution 30 m) Landsat 8 (Level 1 GEOTIFF Data Product). The territories have been evaluated with the remote sensing data captured during 2013-2014 years for vegetation period.

In the end of the vegetation season NDDI mapping classifies lands into water stressed territories and lands with the most appropriate conditions as a result of irrigation and reclamation. Evaluation of nature water availability of the analyzed territories shows that effective agriculture in the Crimea is possible only with the stable work of irrigated infrastructure of the North Crimean Canal.

NDDI mapping for the level of dryness estimation and water availability of central steep and western seashore zone is shown on figure (top picture – proceeded L8 L1 Oli/Tirs , acquisition time - 05.09.2014)

Level of dryness evaluation with NDDI of central steep and western seashore zone



Evaluation of dryness conditions in the areas with a shortage of local water resources

The mapping of water stress territories with the purpose of finding appropriate irrigation solutions and determining the areas with favorable conditions for growing crops is performed with the use of open source GIS with agro-hydrological model and satellite information.
The use of remote sensing data in combination with GIS and agro-hydrological model creates additional opportunities to obtain accurate data regarding state, temporal and spatial dynamics of physical processes and is becoming an effective tool for monitoring.
Dynamics of water availability is evaluated on the base of indicators of dryness: NDVI (MOD13Q1), amount of precipitation (climate data base) and evapotranspiration (MOD16A1).

Indicators of dryness: NDVI, amount of ET and PP