

## **Earth observation supported monitoring of oil field development in conflict-prone regions in South Sudan**

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**ABSTRACT:** Several studies have found a positive correlation between the dependence on oil exports and violent conflicts in developing countries. Such conflicts are often linked with questions of cost-benefit distribution between central governments and the local population living near oil production areas. The conflicts are further fueled by grievances stemming from environmental destruction and social dislocation caused by oil exploration and exploitation activities. Oil is the most important source of revenue for the South Sudanese government. The development of the oil fields took place against the backdrop of Sudan's second civil war which lasted from 1983 to 2005. The history of oil exploration and production in the area was characterized by bloodshed, displacement and other grave human rights violations. Apart from the violence, oil field development led to big-scale environmental problems. Crop patterns changed, poorly constructed roads led to drain blocks which caused draughts and floods and polluted ponds posed a danger for humans and animals alike.

A case study on monitoring oil-related developments in Melut County, located in the Upper Nile region, in South Sudan for the period from 1999 to 2011 is presented. Conflict history of the region was visualised by conflict data taken from two conflict databases: Armed Conflict Location & Event Data Project (ACELD) and Uppsala Conflict Data Program (UCDP). Six points in time – 1999, 2002, 2004, 2006, 2009 and 2011 – were chosen to map human activity in the context of oil extraction and to assess its impacts in the area of interest. In order to document the spatio-temporal development of the oil fields and impacts on their surroundings, Landsat-5 and -7 satellite data was analysed with regard to land cover changes as well as the evolution of transportation and oil field infrastructure. Two very high resolution scenes (WorldView-2, QuickBird-2) from 2004 and 2012 were also analyzed to explore reported population growth in the town of Paloich. Feature extraction consisted of onscreen digitization as well as classification approaches. With regard to the latter, pixel- and object-based classification of land cover was performed as a base for further object-based classification of cropland areas and oil well pads. The interplay between the features of interest was investigated by applying geospatial analysis operations.

Apart from a sharp decline in cropland areas between 1999 and 2002, agricultural lands increased steadily over time and more than doubled in size. Oil infrastructure grew enormously in size throughout the whole time series with 555 oil well pads identified in 2011, compared to a single one in 1999. Geospatial analysis revealed that causal connections between the increase in all three types of features is likely, but cannot be assessed solely from satellite data. Remotely sensed information and its geospatial analysis added not only an additional perspective to developments on the ground but also proved to be a valuable analysis tool for conflict researchers.