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Monitoring the spatial and temporal dynamic of annual floods in the Niger Inner Delta using MODIS satellite imagery

Andrew OGILVIE1,2, Gilles BELAUD2, Carole DELEHNE1, Jean-Claude BADER1, Aurélie OLEKSIAK1 and Jean-Stéphane BAILLY3

1Institut de Recherche pour le Développement, UMR G-eau, Montpellier, France
2Montpellier SupAgro, UMR G-eau, Montpellier, France
3Université Montpellier 2, UMR Hydrosciences Montpellier, France
4AgroParisTech, UMR Tetis-Lisah, Montpellier, France
5Department of Geography, King's College London, United Kingdom

Background

Flooding of large alluvial plains provides a vital resource for ecosystem services and rural livelihoods (crops, fisheries, livestock) Difficulties to monitor the flood of such wetlands due to issues of scale, heterogeneous land use and flat topography

Objective is to develop a method to detect and follow annual floods in the Niger Inner Delta (4M ha wetland) combining the improvements in remote sensing with field data

Results

Spatio-temporal dynamic of the flood

Spatial variations in the timing and duration of the flood

Hydrological correlations for grid cells and the whole delta

Materials and methods

- MODIS 8-day composite satellite images, 500m resolution
- MNDWI-NDMI composite index, constant thresholds
- Three K-means classified Landsat 30m images used for threshold calibration
- Hydrologically relevant grid overlaid
- MRTbatch to crop, project and extract geotiff files
- ENVI IDL programme to automate procedure on 526 images of 2000-2011, producing image of the flood and statistics on % of flooded pixels per grid cell for each image
- Cloud interference evaluated as % of cropped image area using LDOPE and IDL
- Hydrologically relevant grid overlaid
- MNDWI-NDMI composite index, constant thresholds
- Relationships obtained notably allow the estimation of the total flooded area from a single sensed flooded areas validate the method.
- Good correlations (at the grid cell and whole delta level) between stage data and remotely sensed flooded areas validate the method.
- Results per grid cell highlight the spatial differences in hydrological behaviour, with a significantly delayed and prolonged flood in the downstream areas.
- Maximum simultaneously flooded areas vary from 11,700 km² to 21,000 km² over 2000-2011.
- Correlation of the grid cell and whole delta level) between stage data and remotely sensed flooded areas validate the method.
- Relationships obtained notably allow the estimation of the total flooded area from a single stage measurement.
- A 300 m³/s reduction in peak flow due to the Fomi dam could reduce the peak flooded area in the Inner Delta by over 3,000 km²

Conclusions

- Automated method successful in monitoring the flood peak and its subsequent decline.
- Results per grid cell highlight the spatial differences in hydrological behaviour, with a significantly delayed and prolonged flood in the downstream areas.
- Maximum simultaneously flooded areas vary from 11,700 km² to 21,000 km² over 2000-2011.
- Good correlations (at the grid cell and whole delta level) between stage data and remotely sensed flooded areas validate the method.
- Relationships obtained notably allow the estimation of the total flooded area from a single stage measurement.
- A 300 m³/s reduction in peak flow due to the Fomi dam could reduce the peak flooded area in the Inner Delta by over 3,000 km²