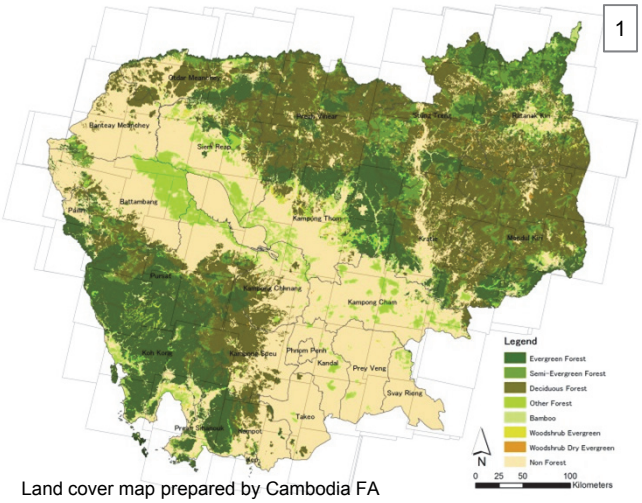
Influence of Seasonality on Land Cover Classification

Forest Monitoring under REDD+

The implementation of international frameworks such as REDD+ (Reduced Emissions from Deforestation and Forest Degradation) in a post-2012 climate regime require transparent, reproducible and verifiable monitoring of national forest cover within each country. The application of satellite remote sensing techniques for deforestation and forest degradation monitoring is widely accepted and provides the only means to forest monitoring in Cambodia is based on visucover such large areas.

In this brochure we will deal with the forests of Cambodia as a typical example for the vast biome of tropical dry forests. Up to now al delineation of high resolution optical satellite data by human interpreters (Fig. 1). The manually derived land cover maps show a very high accuracy but the quality strongly depends on the performance of the human interpreters.

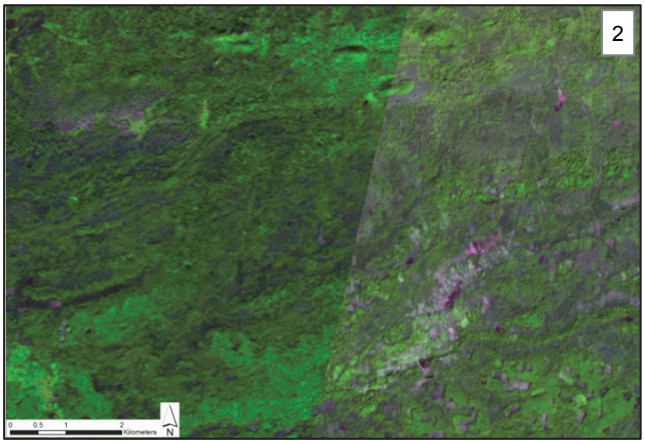
As optical sensors depend on cloud-free scenes, only dry season data can be used. The leaf phenology of the semi-evergreen and deciduous forest types changes considerably between early to late dry season due to leaf shedding. This results in different spectral properties of the corresponding forests (seasonality effects). Using SPOT 4/5 satellite data more than 80 scenes are needed to derive a mosaic of whole Cambodia (Fig. 1) . And as optical satellite imagery acquired during the dry season is not completely free of atmospheric disturbances such as clouds and haze, it is unavoidable that single scenes of this mosaic stem from different times of the dry season. Therefore the mosaic will combine satellite scenes from the beginning of the dry season, when deciduous forests still have leaves, with scenes from the mid or end of the dry season, showing the same forest type without leaves.

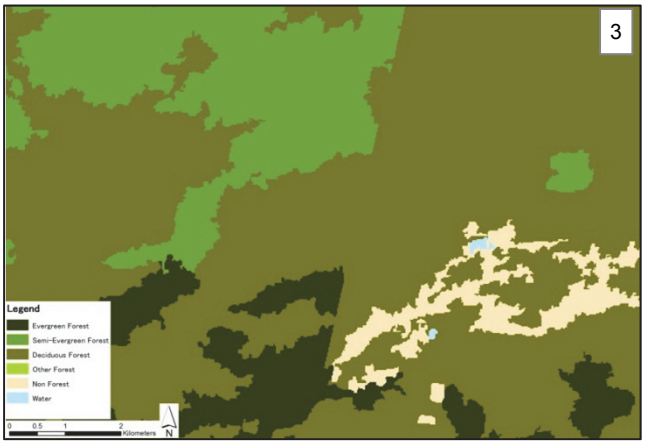


Land cover map prepared by Cambodia FA

Transparency under MRV

A change from manual to automatic classification is expected to increase the transparency and reproducibility of the monitoring process, but might also lead to lower overall accuracies due to increased misclassifications (Fig. 2 and 3). One major cause for such misclassifications is the influence of the seasonality on the reflectance values of the various vegetation types, which strongly affect computer-based land cover classifications. Together with the Cambodia Forestry Administration FFPRI is conducting a project to adjust for such seasonality effects.





For that sake, the influence of the seasonality on the spectral properties of all satellite bands per forest type has to be analyzed, resulting in functions describing the correlation between reflectance values and acquisition date. These functions can be used to correct for the influence of seasonality.

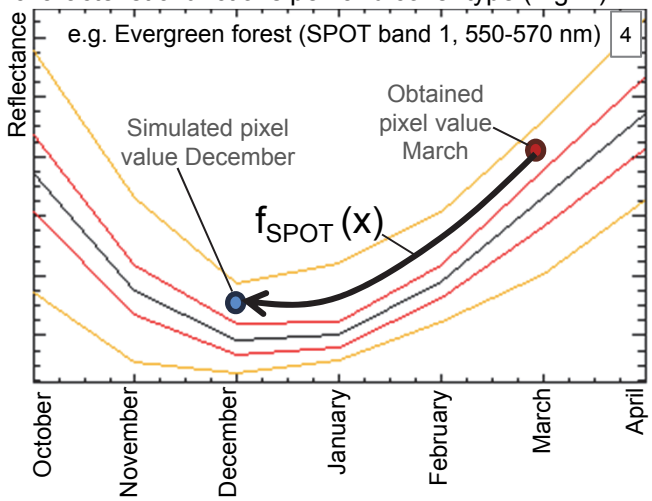
Influence of Seasonality on Land Cover Classification

Technical Approach

In a first step the influence of seasonality on the reflectance values of MODIS (Moderate Resolution Imaging Spectroradiometer) data are analyzed. In our study NASA LP DAAC (Land Processes Distributed Active Archive Center) MODIS Surface Reflectance 8-Day L3 Global 500m are used for analysis. The medium spatial resolution of this sensor, situated on two satellite systems Terra and Aqua, allows due to its wide swath of view and therefore high overpass frequency a dense temporal coverage of the whole study area. This is crucial, as only this high temporal resolution data allows deriving monthly composites of whole Cambodia, which are completely free of clouds. These composites are derived using the arithmetic mean of the 8 available monthly 8-day datasets (2 x 4 scenes per month) for each month from October till April.

For forest cover monitoring under REDD+ and to understand the various drivers of deforestation it is crucial to have detailed knowledge about the temporal trend of forest cover changes within a country. Therefore, forest cover maps have to be derived at regular 2-year intervals. Due to inter-annual variability in precipitation, each year might show slightly different temporal reflectance patterns. Thus, the analysis of the effects of seasonality using MODIS data has to be undertaken separately for each single year of investigation.

Based on a manually derived high quality land cover classification map obtained from the Cambodia Forestry Administration of a base year (e.g. 2005/6), the temporal change of the reflectance properties (mean reflectance value and standard deviation) per each single MODIS band and land cover type are analyzed. This is done for the investigation period preceding the base-year. Polynomial models are fitted in these analyses in order to derive the characteristic functions per land cover type (Fig. 4).



As the final land cover map will be based on spatial high resolution (20m/10m) SPOT 4/5 data, a regression analysis between the corresponding MODIS and SPOT bands is undertaken in order to adjust above described functions. Using these modified functions, a temporal adjustment of the single SPOT scenes within the cloud-free mosaic, derived at different dates during the dry season, is possible and allows the simulation of the reflectance values at similar acquisition dates.

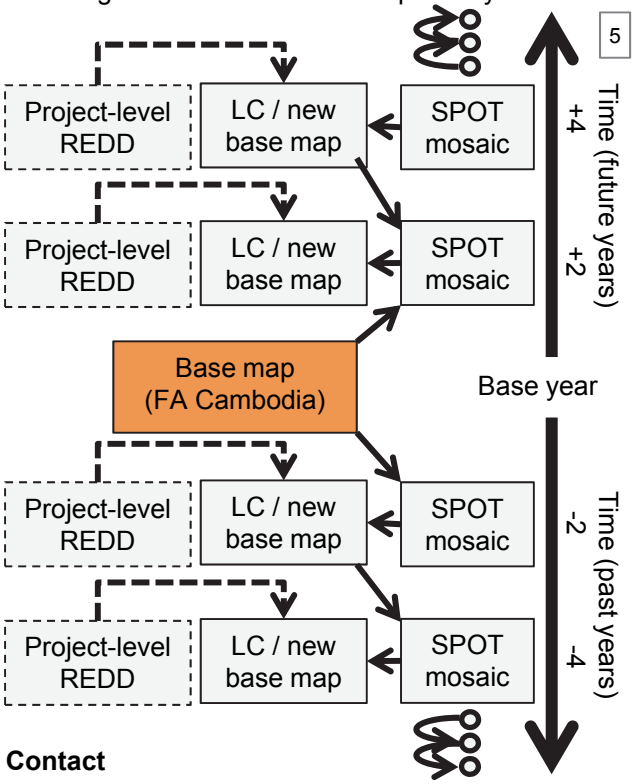
This finally facilitates an automatic land cover classification for REDD+ forest monitoring on country-level based on high resolution optical satellite data. In order to secure consistency and comparability between the single investigation periods, an object-based classification approach will be applied on the season-adjusted SPOT mosaic using the land cover classification of each particular preceding investigation period as supplementary information.

Bridging Project- and National-Level Activities

The derived land cover map will be validated and if necessary corrected using information obtained by various local project-level REDD+ activities. This is a crucial step, as only the integration of the existing project-level activities can secure the success for national-level REDD+ monitoring in the long-term.

The validated land cover map additionally serves as basis to analyze the seasonality of the following investigation period, which can then be used to correct a next SPOT mosaic as described above. The iteration of these steps forward as well as backward in time finally allows deriving historic land cover maps, providing information about the temporal trend in forest cover change (Fig. 5).

Depending on the results in Cambodia, this REDD+ monitoring approach might be also applicable in other regions of the world with tropical dry forests.



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