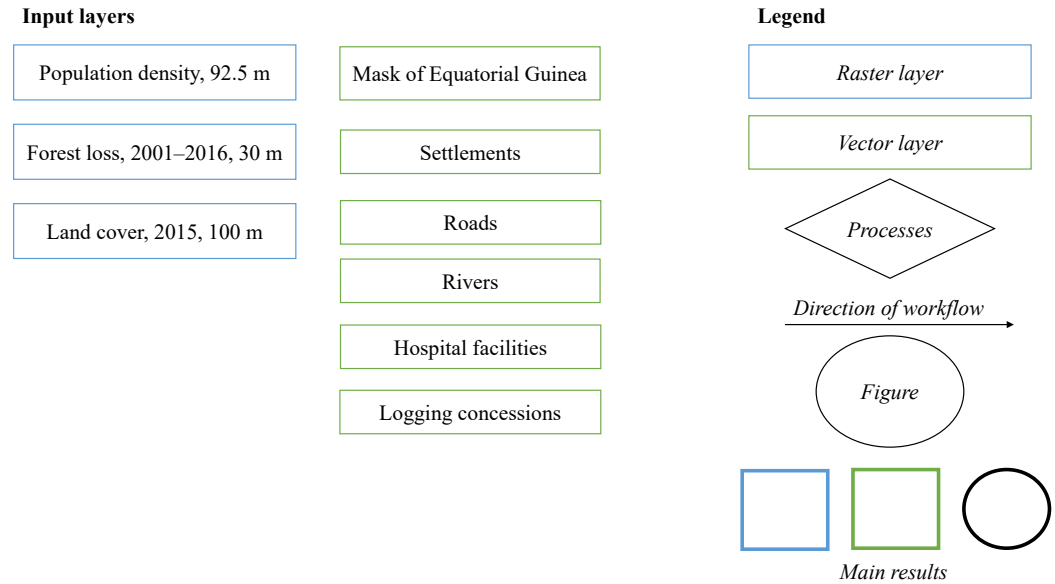
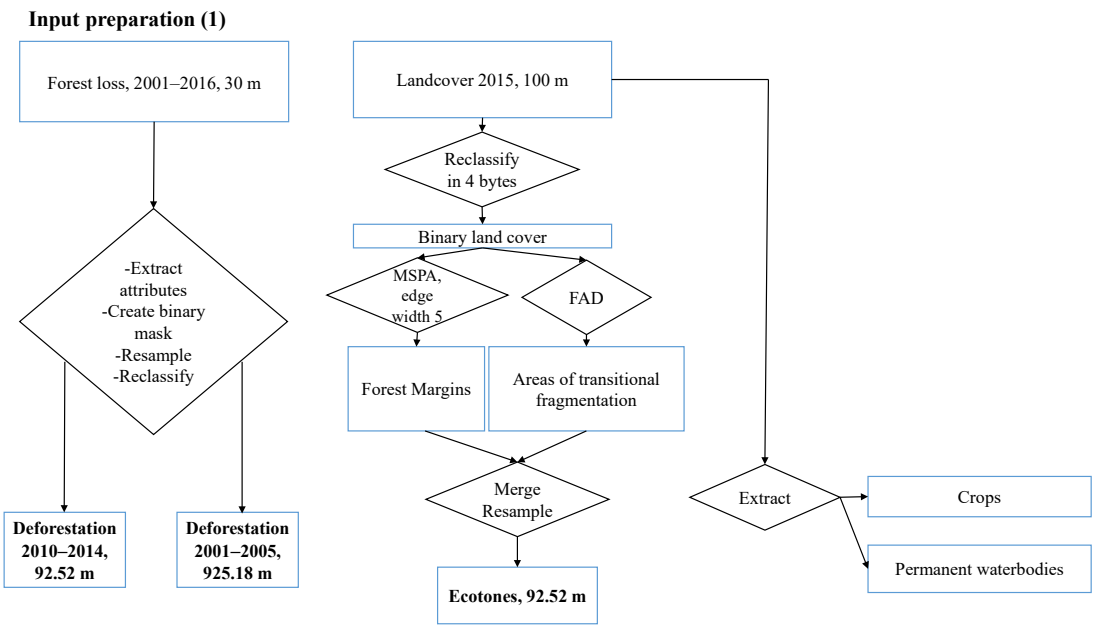
Supplementary

1. Data preparation and process workflow





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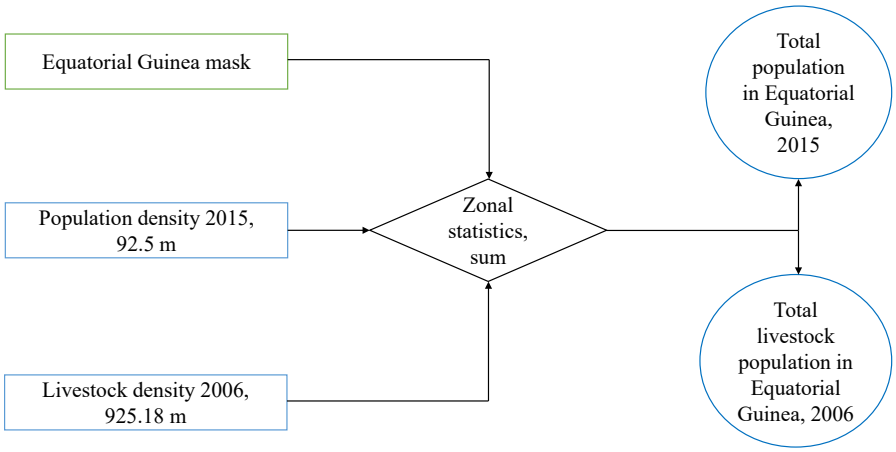
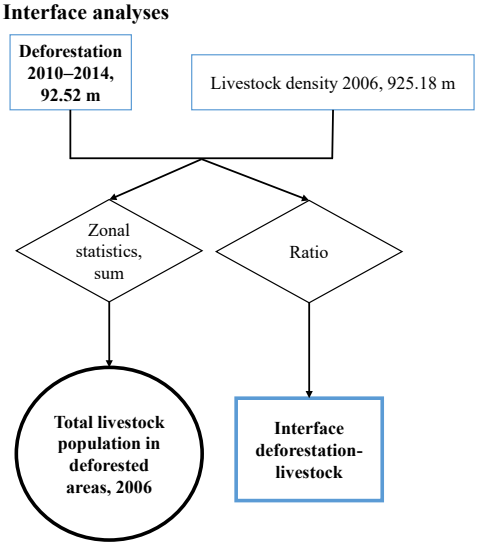
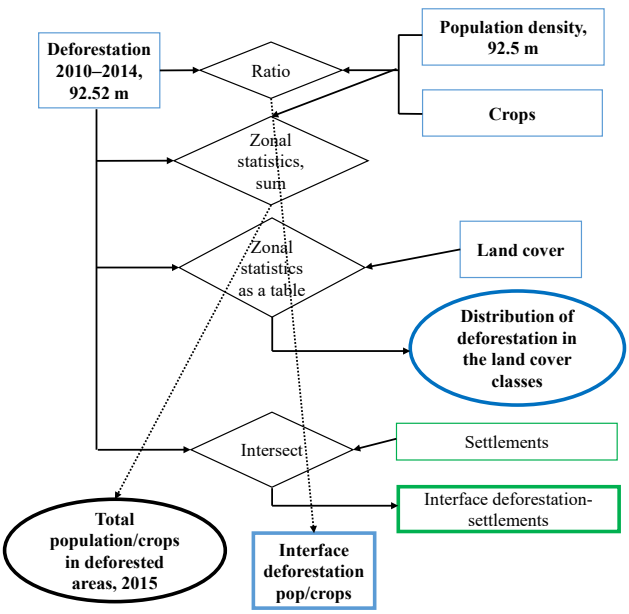
Input preparation (2)



Interface analyses



Same processes with ecotone layer



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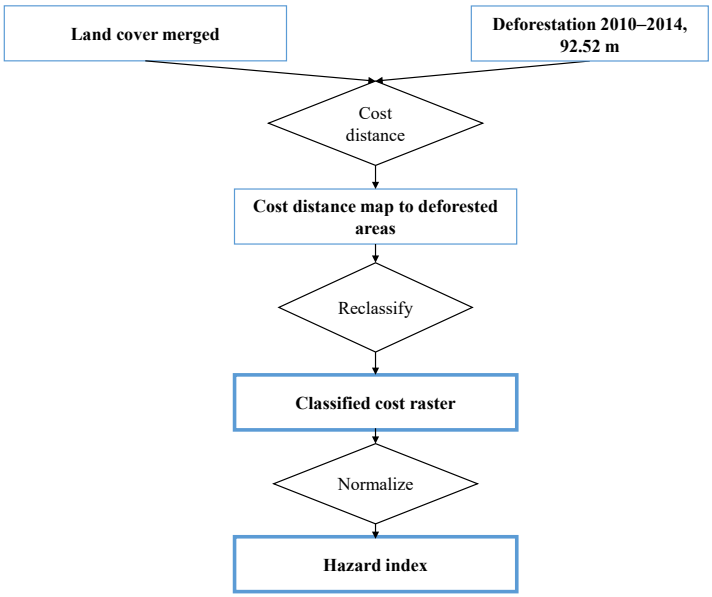
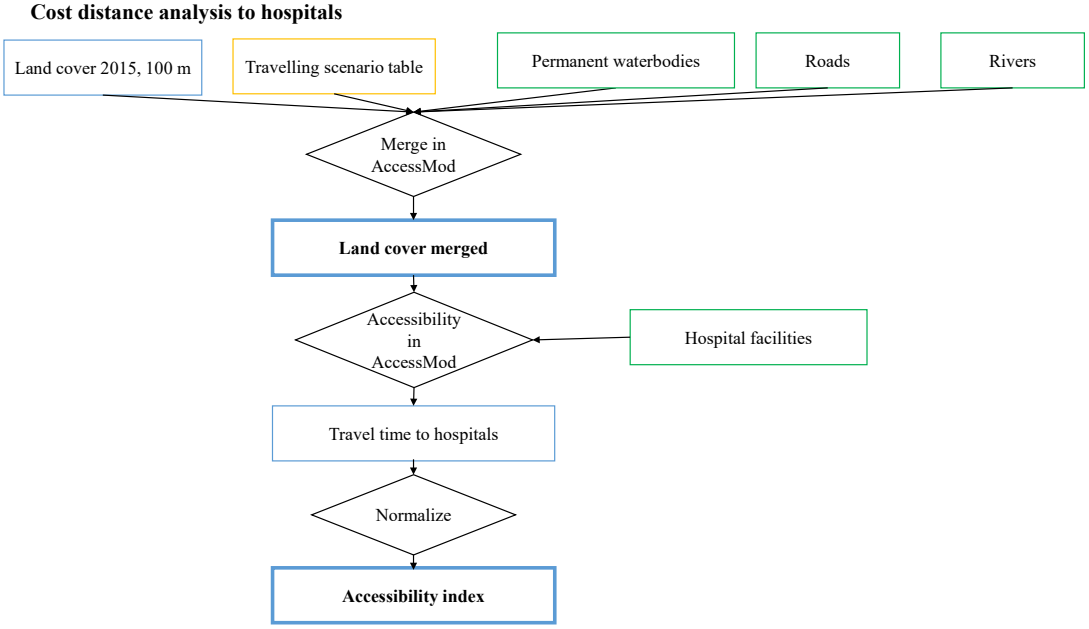
Cost distance analysis to hazardous areas

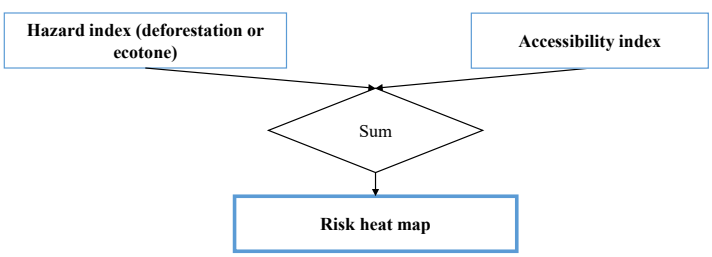


Same processes with ecotone layer

Cost distance analysis to hospitals



Risk modelling



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2. Data sets used in the workflows (*Table S1*)

Table S1 Information on all data sets used in the workflows

Data	Year	Source/author	Description	Type	Original raster resolution	URL
Equatorial Guinea borders	2018	GADM website (40)	Mask created to define the extent of the Equatorial Guinean territory and used to clip out all other data sets	Shape file	–	https://gadm.org/
Deforestation	2001–2005 & 2010–2014	University of Maryland (28)	Locates the deforested pixels and indicates the year of deforestation	Raster	30 m	http://data.globalforestwatch.org
Landcover	2015	Copernicus Global Land Service (CGLS) (46)	Landcover categories for considered territory: evergreen broadleaf closed and open forest, deciduous broadleaf closed and open forest, herbaceous wetland, temporary and permanent water bodies, herbaceous wetland, urban areas, shrubs, herbaceous vegetation, cropland and open sea areas	Raster	100 m	https://land.copernicus.eu/global/index.html
Population	2018	HDX website (51)	High-resolution density maps based on census data, population statistics and building identification	Raster	30 m	https://data.humdata.org/dataset/highresolutionpopulationdensitymaps-gnq
Settlements	2011	National Geospatial-Intelligence Agency (NGA) (53)	Location and name of 2049 settlements in Equatorial Guinea	Shape point	–	https://data.humdata.org/dataset/equatorial-guinea-settlements
Hospitals	2017	Ouma *et al.* (48)	18 public hospitals in Equatorial Guinea "targeted at a broad range of emergency or referral care to the general population"	Shape point	–	Requested to the authors
Roads	2017	Open Street Map (47) and Ouma *et al.* (48)	Roads in Equatorial Guinea extracted from two different datasets and merged together	Shape line	–	http://download.geofabrik.de/africa/equatorial-guinea-latest-free.shp.zip
Waterways	2018	United Nations office for Coordination of Human Affairs (OCHA)	River features in Equatorial Guinea	Shape line	–	https://data.humdata.org/dataset/
Digital elevation model (DEM)	2011	United States Geological Survey (USGS)	Various tiles combined together and clipped on the mask of Equatorial Guinea	Raster	30 m	https://earthexplorer.usgs.gov/
Livestock	2006	Gridded Livestock of the World 2 (54-56)	Cattle, goat and sheep densities data combined together into a unique dataset	Raster	1,000 m	https://livestock.geo-wiki.org/Application/index.php
Logging concessions	1993–2013	Equatorial Guinea Ministry of Agriculture and Forests and The World Resource Institute (60)	Logging concessions localization including the holding company, date of exploitation, area and state of exploitation	Shape point	–	http://data.globalforestwatch.org/datasets

3. Detailed methodology

Areas with greater potential for spillover events occurrence

In order to translate the land use change associated with greater spillover risk described by the literature, we started by modelling forest habitat degradation through the identification of deforested and fragmented areas.

Deforested areas

The Global Forest Watch provides fine resolution (30 m), locally relevant records of forest change since 2000, from Earth observation satellite data (28). The "Global forest cover loss 2000–2014" dataset maps deforestation considered as "a stand replacement disturbance or a change from a forest to non-forest state" (*ibid*). Forest loss data were extracted from this dataset for the periods 2001–2005 and 2010–2014.

A part of this work has aimed at mapping the interface between the areas of forest degradation and anthropic activities. Therefore, the periods of study of these interfaces need to precede the dates (2006 and 2015) of the available data of proxies for anthropic activities (human and livestock population, land cover, settlements, etc.), as described hereafter.

Deforestation was analyzed over a period of five years (2001–2005 and 2010–2014) in order to reflect the array of possible ecological and epidemiological mechanisms described in the literature depending on the infectious disease studied; 4 years for malaria in (41), 5 years for malaria in (42), within the same year as deforestation for Ebola in (18,61). Another subset of deforestation events was extracted for the period 2001–2014 in order to compare them with logging concessions data which also range across this timeline.

Binary masks of deforestation were created by assigning a common value to all the deforested pixels. These masks were resampled using a majority technique in order to match the resolution of the proxies for anthropic activities; 925.18 m for the livestock densities and 92.52 for all the other layers. These resolutions were chosen to match the population and the livestock layers. The majority technique of resampling was chosen because it minimized the pixel loss between the original and the final resolutions. All these processes were executed using ArcGIS.

Ecotones and areas of transitional fragmentation

The Morphological Segmentation of binary Patterns (MSPA) processing first consisted in identifying areas of interspecies contact, which correspond to forest margins, forest islet, loop and branch, bridge, perforation and edges such as described in *Figure S1* below. Faust *et al.*'s (15) methodology considered the area within 200 m on each

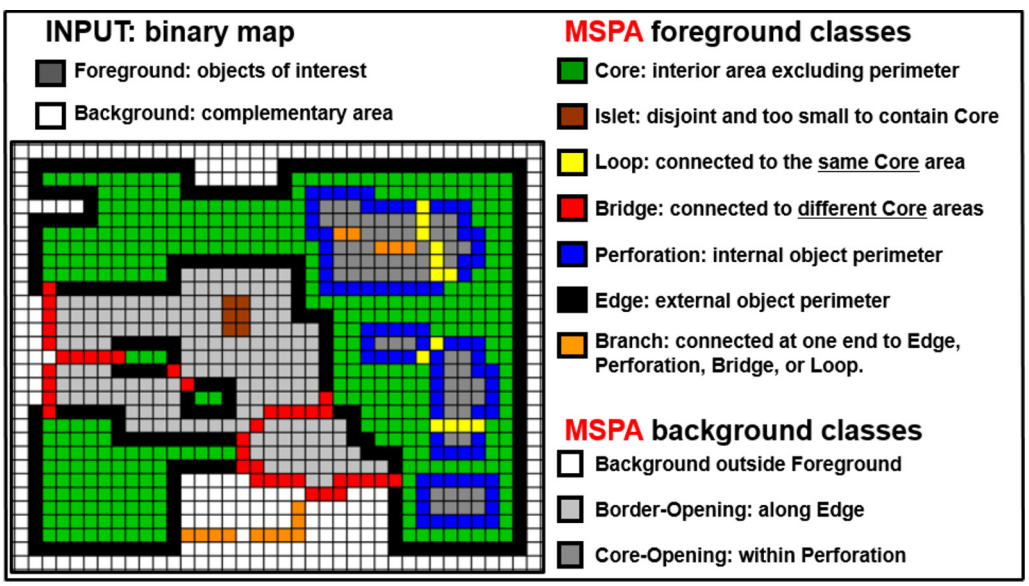

Figure S1 MSPA: overview of the various foreground and background MSPA, extracted with permission from Vogt (2018).

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Table S2 Travel scenario

Landcover element	Speed (km/h)	Mode of transportation	Time to travel across the 92.52 m cell (min)
Road types			
Tertiary road	20	Motorized	0.2776
Major arterial	60	Motorized	0.0925
Minor arterial	60	Motorized	0.0925
Primary highway	80	Motorized	0.0694
Secondary road	70	Motorized	0.0793
Motorway	100	Motorized	0.0555
Landscape elements (from the 2015 land cover)			
Shrubs	4	Foot	1.3878
Herbaceous vegetation	5	Foot	1.1102
Cropland	4	Foot	1.3878
Urban	5	Foot	1.1102
Permanent water bodies	0	None	Infinite
Temporary water bodies	3	Foot	1.8504
Herbaceous wetland	3	Foot	1.8504
Evergreen broadleaf closed forest	2	Foot	2.7755
Deciduous broadleaf closed forest	2	Foot	2.7755
Evergreen broadleaf open forest	4	Foot	1.3878
Deciduous broadleaf open forest	4	Foot	1.3878

side of the forest edge. This was reflected in our analysis by setting up the edge width to 5 pixels, in order to span equally on both sides of the originally 1-pixel wide forest edge.

The fragmentation analysis developed in Vogt and Riitters (62) consisted in identifying the different levels of fragmentation of an area based on spatial density of forest cover. The smallest observation window available (7×7 pixels) was used in order to get a localized assessment of the fragmentation and best reflect the creation of interspecies contact at the finest scale. The analysis was conducted on a recoded land cover layer (4 bytes) to indicate foreground, background and non-fragmenting background pixels. This process enabled to assess the fragmentation level of the country and extract the areas with transitional levels of fragmentation (between 40% and 60%).

Both the MSPA and the fragmentation analysis processing were based on the 2015 land cover layer.

Cost raster

Table S2 describes the travel scenario that was applied to the cost raster. The speed on major and minor arterial, primary and secondary roads were drawn from Ouma *et al*. (48). The other speeds were inspired from the World Health Organization (63) and the World Road Transport Organisation (64) platforms. Considering an average walking speed of 5 km/h for an average adult, each landscape element was assigned a scaled down average walking speed, depending on the relative difficulty to walk through it. Waterways and permanent water bodies were considered as barriers to travelling (unless a road crosses over) and were assigned a *NoData* value by AccessMod in order to translate infinite costs of travel.

Accessibility analysis to hospitals

AccessMod's accessibility analysis used the merged land

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cover produced and described in the previous section, the vector points layer of hospital facilities and the travelling scenario described in *Table S2*. The analysis may either be anisotropic (reflects the influence of slope on travel time) or isotropic (ignores it). In this analysis, the travel time was computed over the whole territory and without considering the effect of slope in order to enable the comparison with the analysis conducted in ArcMap that cannot take it into account similarly.

Mapping risk levels

The simple normalization of the cost distance to hazardous areas and of the accessibility hospitals levels enables to bring the information of hazard exposure and of vulnerability to a comparable range and to combine them together.

Areas of interfaces: hazardous areas and anthropic activities

Interface between each risk defined area (deforested or anthropic-ecotones) and anthropic activities were computed and modelled in ArcGIS 10.3 (ESRI, Redlands, USA) using zonal statistics coverage tools and raster calculations. All these analyses were conducted with the 2000–2014 deforestation areas except for the livestock data for which the 2001–2005 deforestation areas were used since the data relative to these densities were only available for 2006. Prior to the interface analyses, the proxy layers had been resampled to match the population density layers, using the nearest neighbor technique.

References

60. Equatorial Guinea Ministry of Agriculture and Forests, World Resource Institute. Equatorial Guinea Logging Concessions. Global Forest Watch, 2013.
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