Supplementary file 1: Procedure for estimating the travel time

To begin this, a cost surface algorithm was designed with these parameters: a grid cell of size 10m was assigned to the spatial features and values were then assigned to the predetermined grids. The essence of this was to grant the user control over travel time estimation. Every image file is divided into grids or cells and as a strategy to determine travel time, these grids or cells are leveraged on to calculate how much users should travel and the equivalent of that in time. In essence, to travel a 10m grid of roads, the travel time on roads and the medium of travel is considered and this eventually determines the value of time for the 10m grid of road. This concept applies for the other land cover features. Based on this logic and the following algorithm roads were assigned low values because traveling on roads is faster than travel via paths or impediments. Assigning of values to spatial features was done via the map algebra tool and because cost distance requires the cost surface dataset and the source, the calibrated spatial dataset served as the cost surface dataset and referral hospitals served as the source for calculating the cost distance. The output is a map showing shortest travel time (cell by cell) from any point in the map to referral hospitals in the region. It is imperative that the right cell size be determined because it impacts the results of the study. The cell size must be small enough to capture the details on the image and it should not be too large to affect the efficiency of processing the algorithm or model.

Algorithms which allowed for carrying out conversion of data from vector to raster, map algebra (cost surface models) and cost distance was developed using Python 2.7. Designing the algorithm helped to avoid developing multiple algorithms for the varying districts. Based on information gathered, the identified (most common) mode of travel was the tricycle and the travel speed was pecked at 20 km/h/. This served as a guide for determining travel time in the region.

The process of calculating travel time leveraged on the cell size of 10 meters and in order to sync the units, our determined travel time of 20km/h was converted to 20,000 meters. In order to estimate how many seconds it takes to travel 1 meter, a new unit of meters per second (m/s) had to be established. Seeing that 3,600 seconds make an hour, it was divided by 20,000 meters which equals 0.18 seconds. Our cell size was set at 10 meters so to find out how long it takes to travel each cell we multiplied 0.18 seconds by 10. This meant it took 1.8 seconds to travel via road using the tricycle. The raster calculator was then used in reassigning each cell to 1.8 seconds as the travel time required to travel each cell. This algorithm was applied to the other land cover types which includes the DEM data set, paths and rivers.

Supplementary file 2: Distance/travel time categorisation of the towns and their names

Less than 10 kilometers / 30 minutes

AKOMKONGU	KAGBIRI	NAGA	SHIA	YARIGUGU
ASONGE	KALBEO	NAGTUNA	SINENSI	YELWOKO
BALUNGU	KANDIGA	NAKOLO	SIRIGU	YINDURI
BANSUNDE	KAYILO	NAMON	SOE	YOROGO
BAWKU	KOBURI	NANGODE	SOKOBO	YUWA
BINABA	KONGO	NASIA	SSNIT FLAT	ZAARE
BOGOROGO	KOSANABA	NAVRONGO	SUMBRUNGU	ZABUGU
BOLGATANGA	KPATIA	NINKONGO	TARIUAGO	ZALERIGU
BONGO	KUBONGO	PAGA	TESHIE	ZARRE
BOYAA	KUGURAGO	PELUNGU	TIMONDE	ZEBILLA
DABILA	KULUNGUGU	PINDA	TIMPANE	ZESERI
DAKEO	KULWASE	PULIMAKOM	TONGO	ZOKO
DUA	MANYORO	PUNGU	TONGO SHRINE	ZONGOYIRI
FEO	MELIGA	SAMBULUNGU	WEDENA	ZORSI
GAMBIBGU	MIRIGU	SANDEMA	WIAGA	ZUARUNGU
GARU	MISSIGA	SEKOTI	WIDENABA	
GUNYORO	MOGNORI	SHEAGA	WINKOGO	
GYNTIGA	NABISI	SHERIGU	WORRICAMBO	

Between 10 and 15 kilometers (30 and 45 minutes)

ATOBA	BUGRI	KATIU	KUGRI	SIKIRI
BANSI	CHIANA	KOIKPIRA	KUKA TAMBALIGE	SOMFUSI
BAZUA	CHUCHULIGA	KOKORE	NAFKULIGA	SUGUDI
BIDURI	DATOKO	KOMNAB TINGA	PUSIGA	TILLI
BIU	KAADI	KOWMOKA	PWALUGU	WIRINYANGA

Between 15 and 20 kilometers (45 and 60 minutes)

BIUN	GWADEMA	NAKONG	SESHIE
DONINGA	KADEMA	SAPELIGA	SINEBAGA

Between 20 and 25 kilometers (60 and 75 minutes)

BECHUASE · KANJARGA · NUNGO · UWASI

CHANSA · KAYORO · TULA

Greater than 25 kilometers (75 minutes)

BECHISI · FUMBISI · GWEDEMBISA · WIASI