The maternity was too far away, so I died!

The challenging role of realistic geographical mapping for reducing maternal mortality in Africa

Prof. Nicolas Ray

GeoHealth group, Inst. of Global Health, Fac. of Medicine, University of Geneva

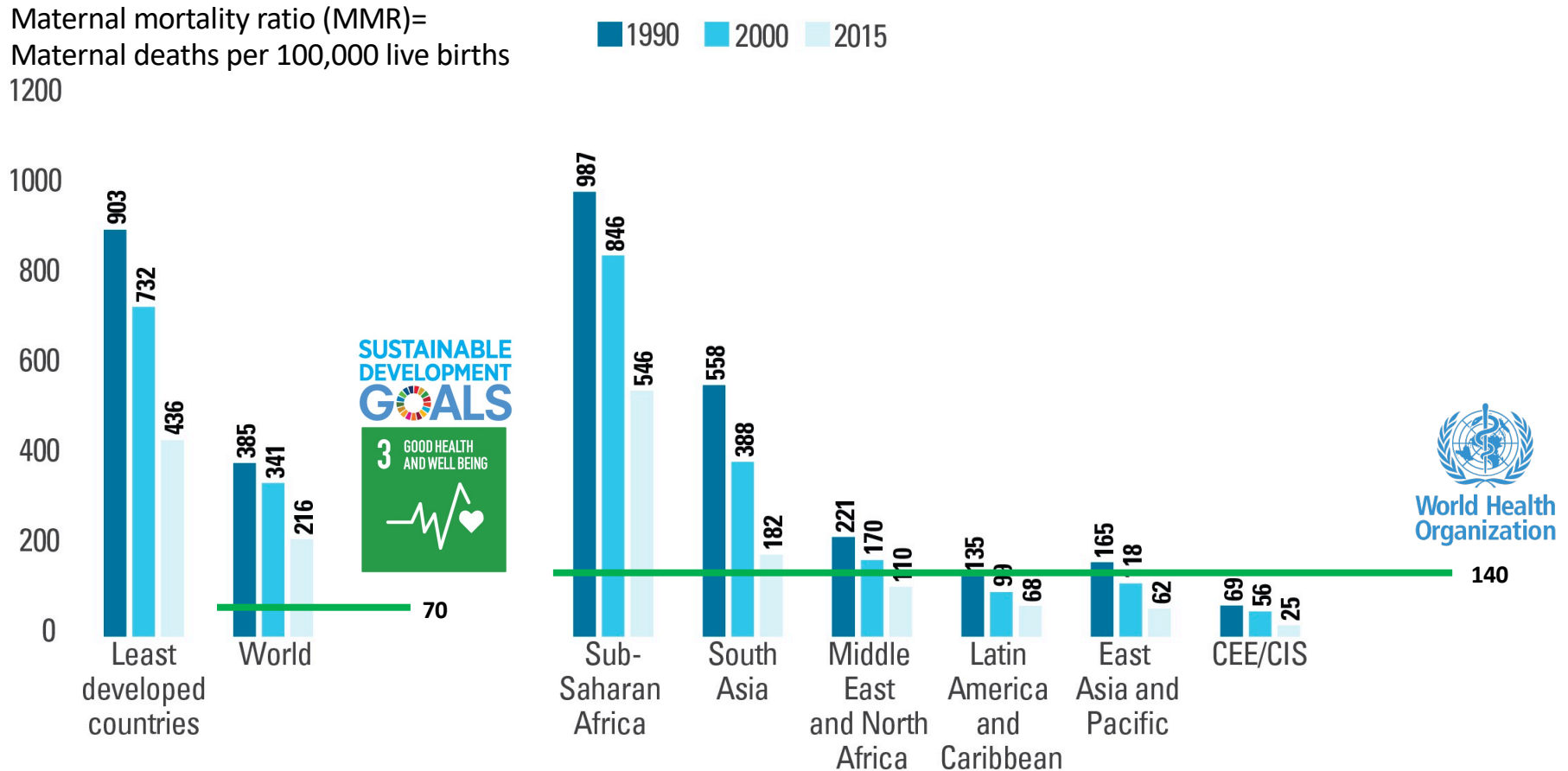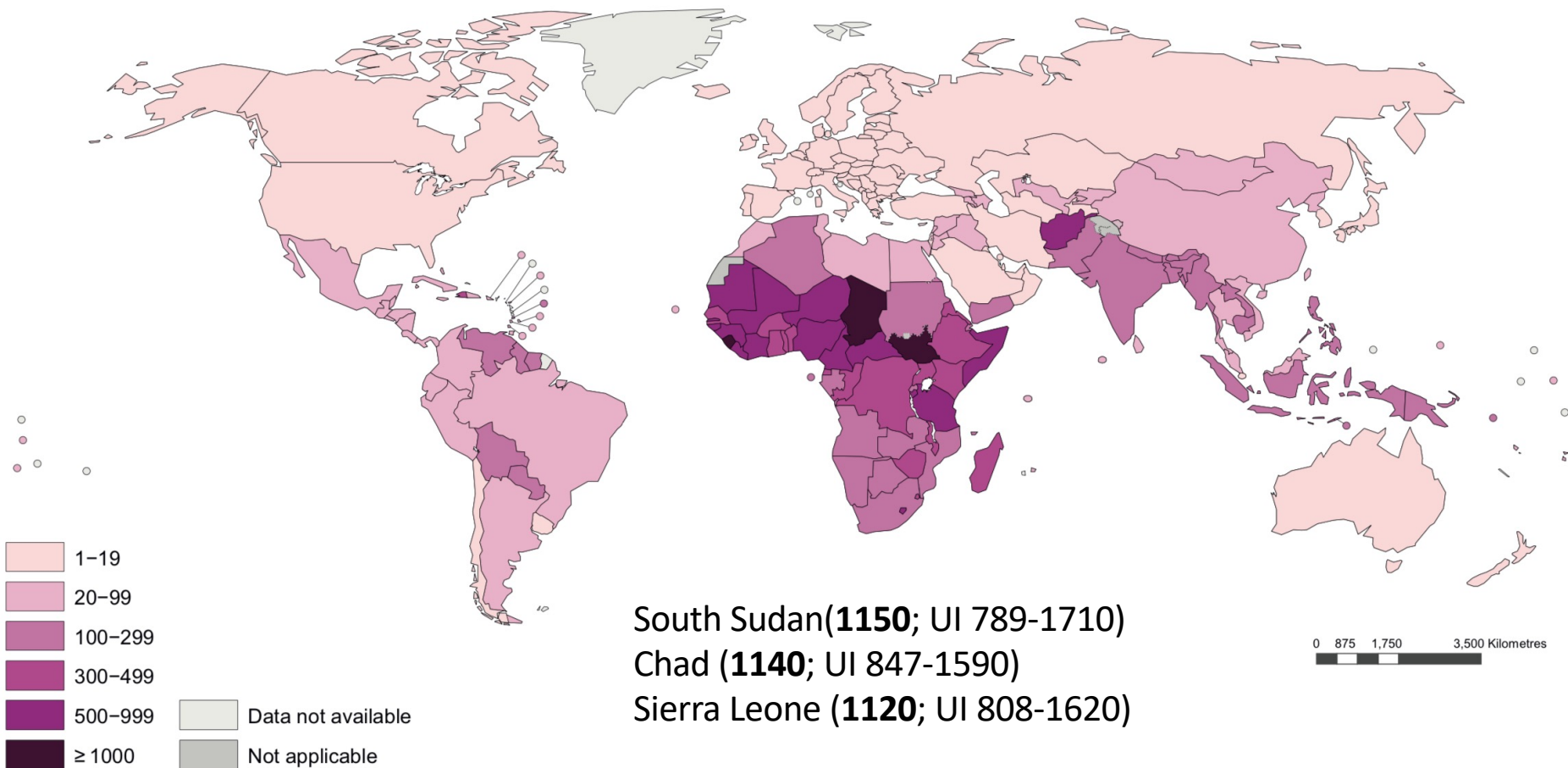19.5.2021

ESTIMATED TIME TO ARRIVAL 00:08:04

TIME LAPSED 04:51:54

THE WALK

Maternal mortality decreased by 50 % since 1990

Maternal mortality ratio (MMR)=
Maternal deaths per 100,000 live births

Legend: 1990, 2000, 2015

Values by region:

- Least developed countries: 903 (1990), 732 (2000), 436 (2015)
- World: 385 (1990), 341 (2000), 216 (2015) — target line 70
- Sub-Saharan Africa: 987 (1990), 846 (2000), 546 (2015)
- South Asia: 558 (1990), 388 (2000), 182 (2015)
- Middle East and North Africa: 221 (1990), 170 (2000), 110 (2015)
- Latin America and Caribbean: 135 (1990), 99 (2000), 68 (2015)
- East Asia and Pacific: 165 (1990), 118 (2000), 62 (2015)
- CEE/CIS: 69 (1990), 56 (2000), 25 (2015) — line 140

SUSTAINABLE DEVELOPMENT GOALS
3 GOOD HEALTH AND WELL BEING

World Health Organization

Source: World Health Organization, UNICEF, United Nations Population Fund and The World Bank, *Trends in Maternal Mortality: 1990 to 2015,* WHO, Geneva, 2015

Maternal mortality rate (maternal deaths per 100'000 live births), 2017

Legend:
- 1–19
- 20–99
- 100–299
- 300–499
- 500–999
- ≥ 1000
- Data not available
- Not applicable

South Sudan(**1150**; UI 789-1710)
Chad (**1140**; UI 847-1590)
Sierra Leone (**1120**; UI 808-1620)

0   875   1,750   3,500 Kilometres

Why do women die?

For more than 75% of the cases:
severe bleeding or infections (usually after childbirth), high blood pressure during pregnancy, complications from delivery, unsafe abortion

Associated factors:
No or few antenatal consultations
Delivery without being assisted by a trained midwife, doctor or nurse

Causes:
Poverty
Distance to facilities
Inadequate and poor quality services

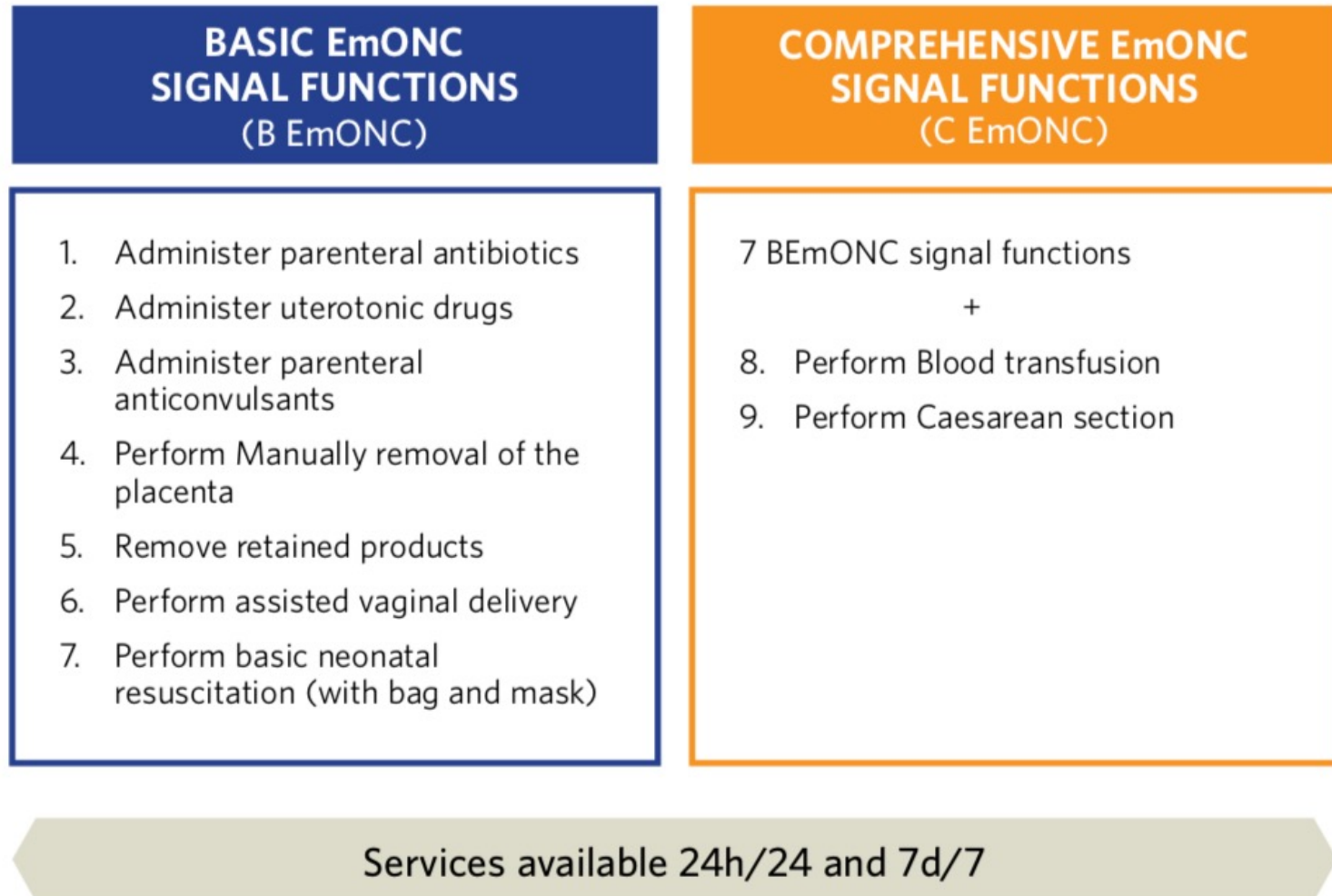Lack of information
Cultural beliefs and practices.

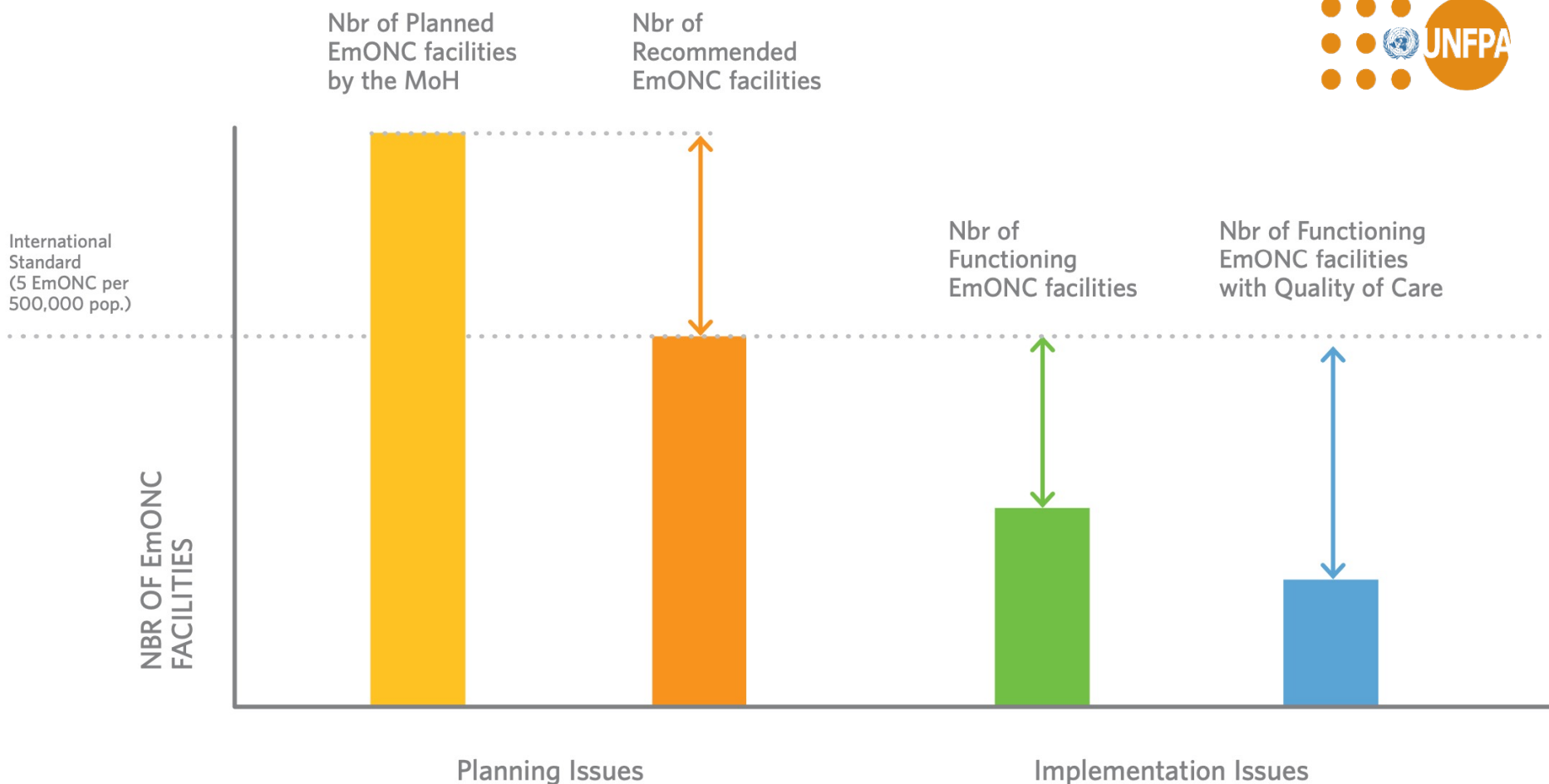Geographical (physical) accessibility to adequate quality services

EmONC (Emergency Obstetric and Neonatal Care)

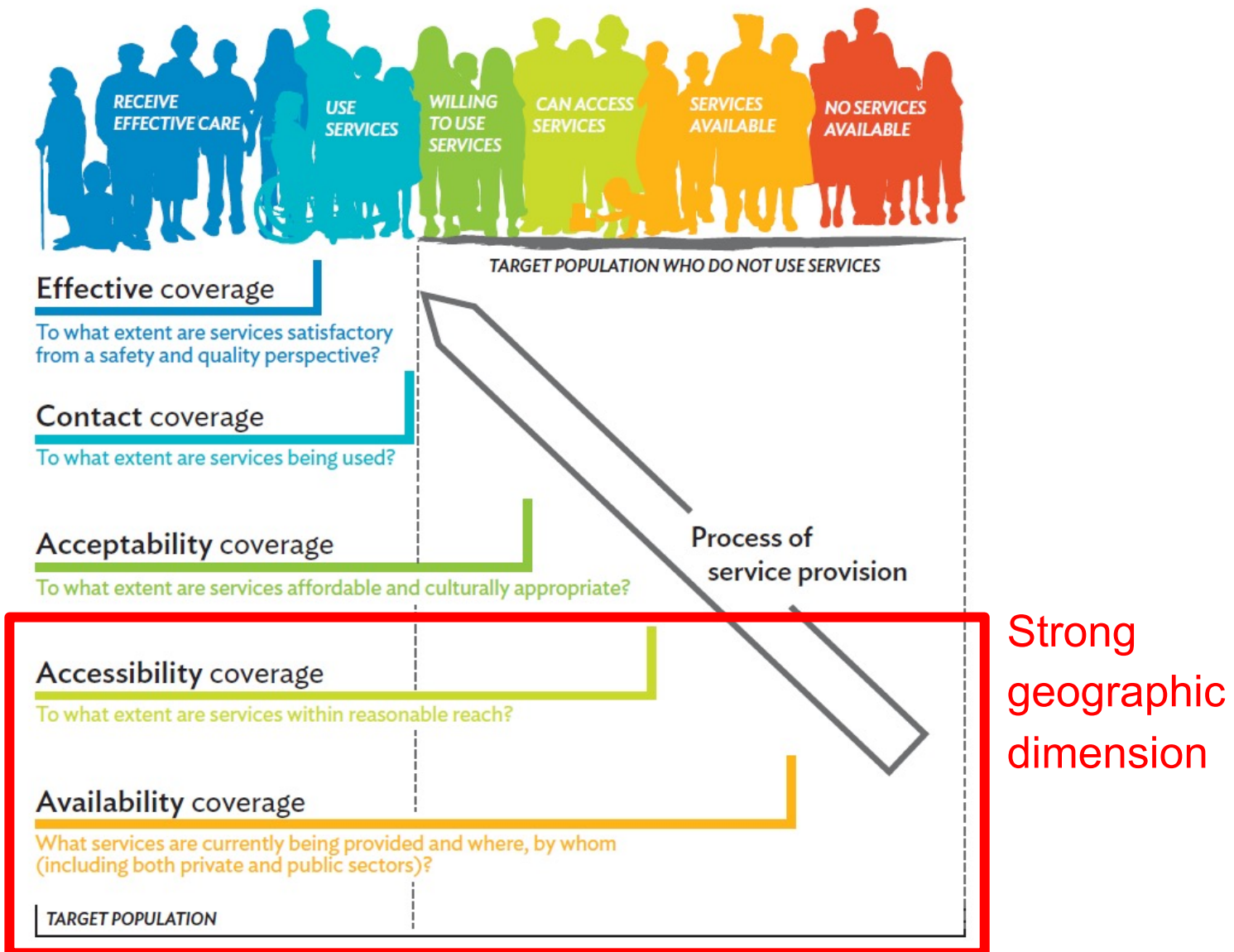FIGURE 1. **EmONC SIGNAL FUNCTIONS**

BASIC EmONC SIGNAL FUNCTIONS (B EmONC)	COMPREHENSIVE EmONC SIGNAL FUNCTIONS (C EmONC)
1. Administer parenteral antibiotics 2. Administer uterotonic drugs 3. Administer parenteral anticonvulsants 4. Perform Manually removal of the placenta 5. Remove retained products 6. Perform assisted vaginal delivery 7. Perform basic neonatal resuscitation (with bag and mask)	7 BEmONC signal functions + 8. Perform Blood transfusion 9. Perform Caesarean section

Services available 24h/24 and 7d/7

EmONC situation in countries with a high burden of maternal and newborn mortality

Nbr of Planned EmONC facilities by the MoH

Nbr of Recommended EmONC facilities

Nbr of Functioning EmONC facilities

Nbr of Functioning EmONC facilities with Quality of Care

International Standard (5 EmONC per 500,000 pop.)

NBR OF EmONC FACILITIES

Planning Issues

Implementation Issues

Tanahashi framework (1978)

Modified from Tanahashi, T. (1978) "Health service coverage and its evaluation", *Bulletin of the World Health Organization*, 56(2) : 295-303.
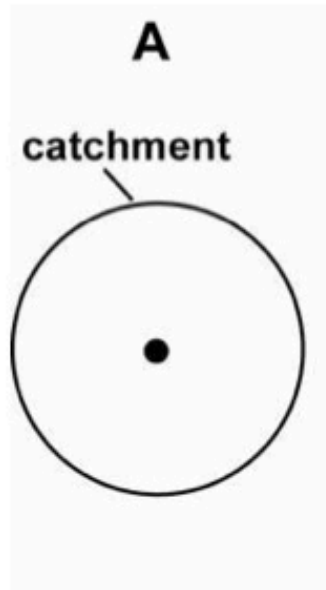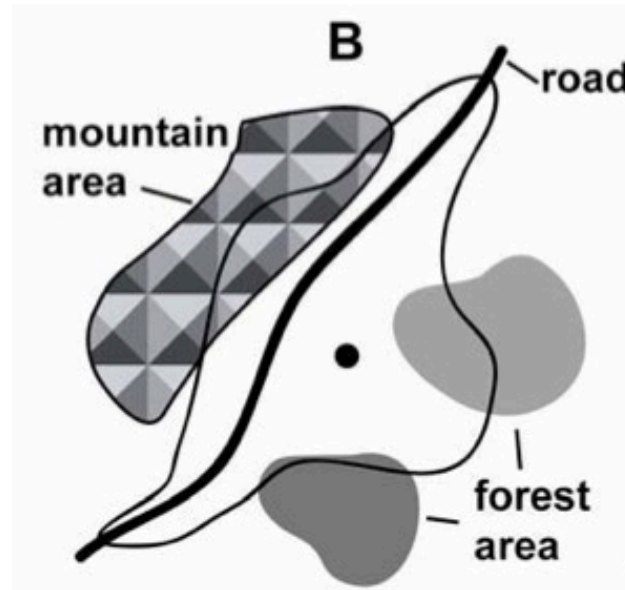
Geographical accessibility
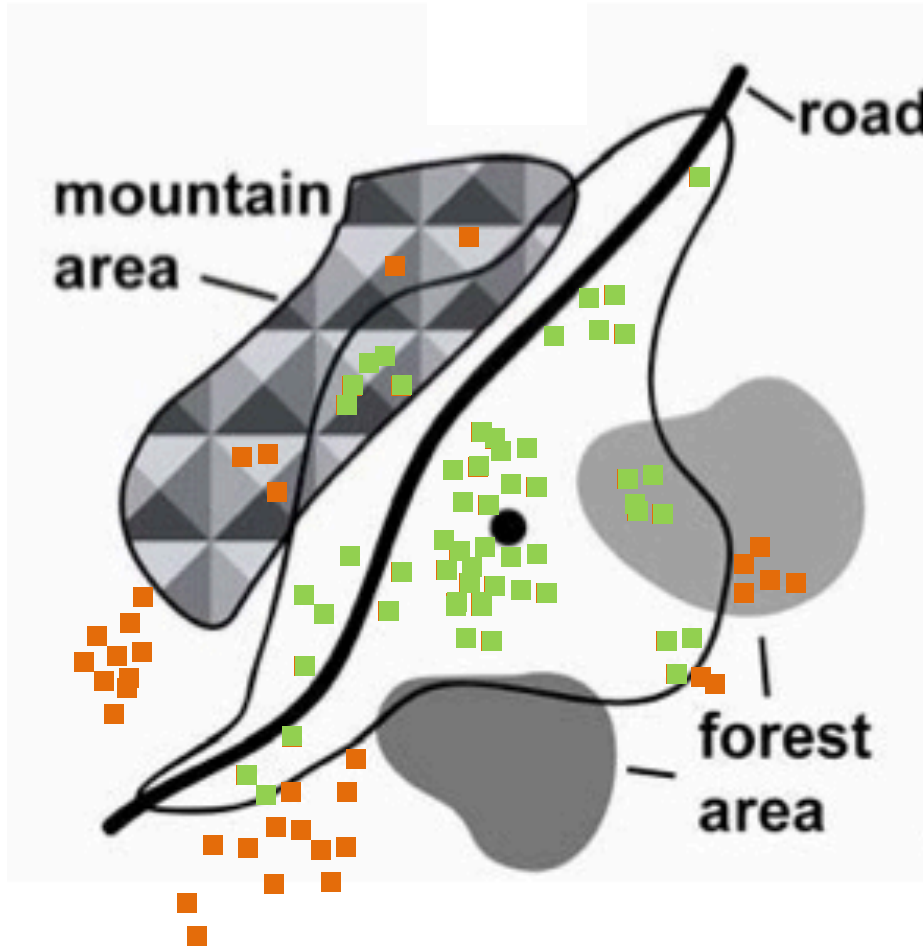## how to model it ?

Circle <u>at a given distance</u>

Accounting for movement facilitators/constraints (roads, forest, rivers, etc.), for a maximum travel time <u>(ex: 60 minutes)</u>
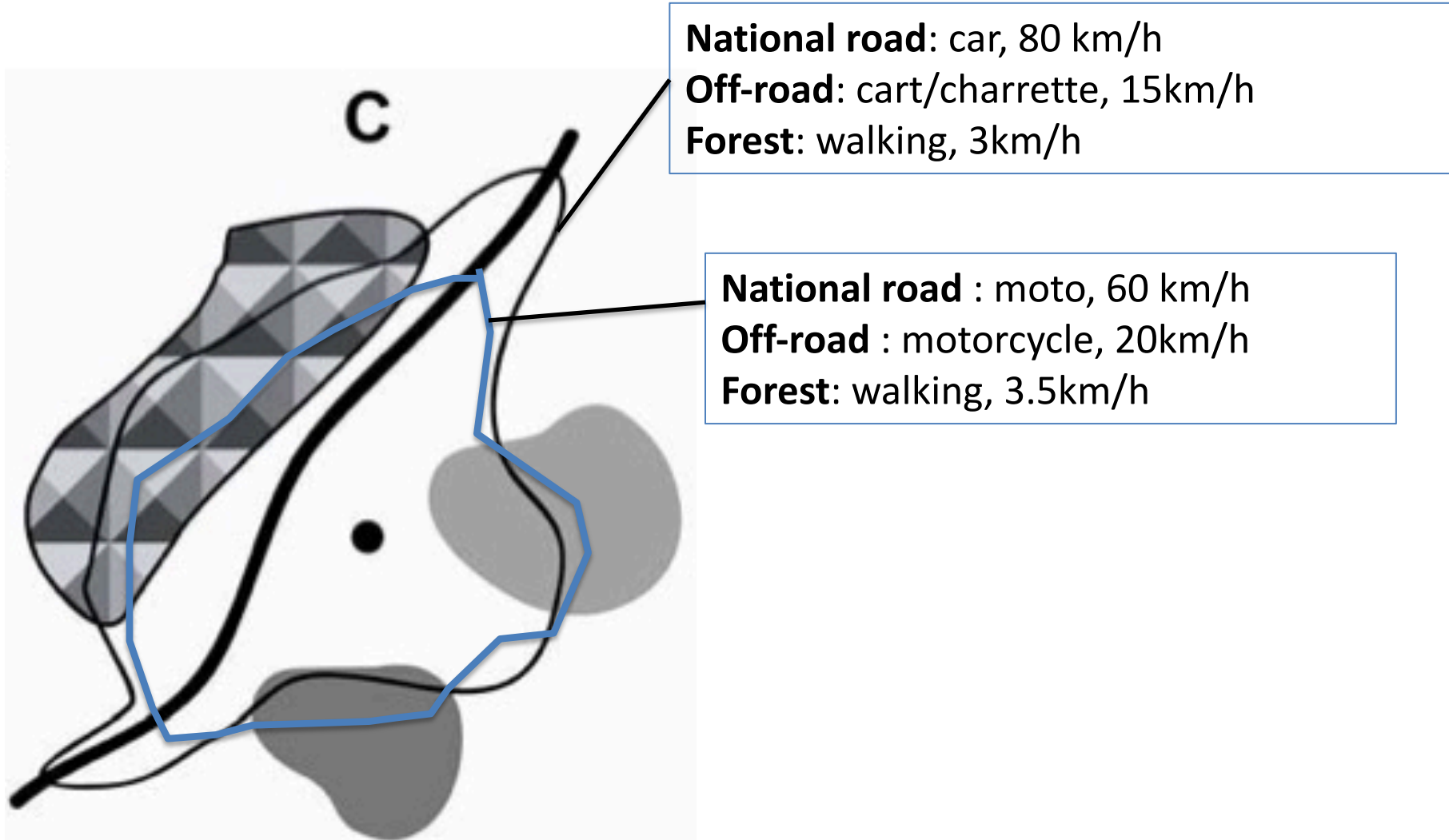
Ray et Ebener, 2008 Int. J. of Health Geo.
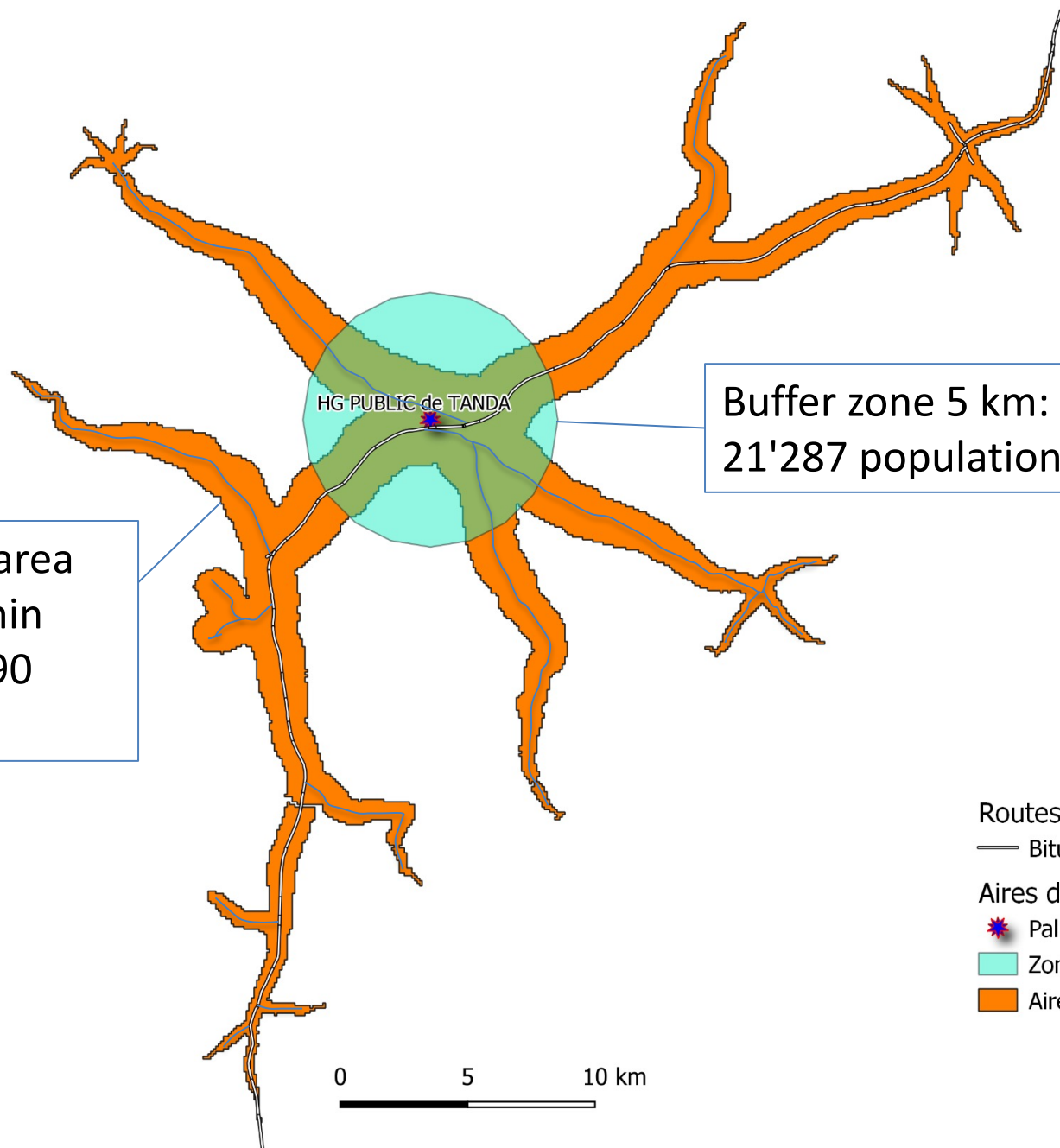
Overlay with population density

Zonal statistics
(e.g., percentage of the population within 2-hour travel time to the health service)

The travel scenario influences the catchment !

National road: car, 80 km/h
Off-road: cart/charrette, 15km/h
Forest: walking, 3km/h

National road : moto, 60 km/h
Off-road : motorcycle, 20km/h
Forest: walking, 3.5km/h

Buffer zone 5 km: 21'287 population

Catchment area at max. 30min travel: 57'690 population

HG PUBLIC de TANDA

Routes
— Bitumées

Aires de captage
✳ Palu grave
Zone tampon de 5km
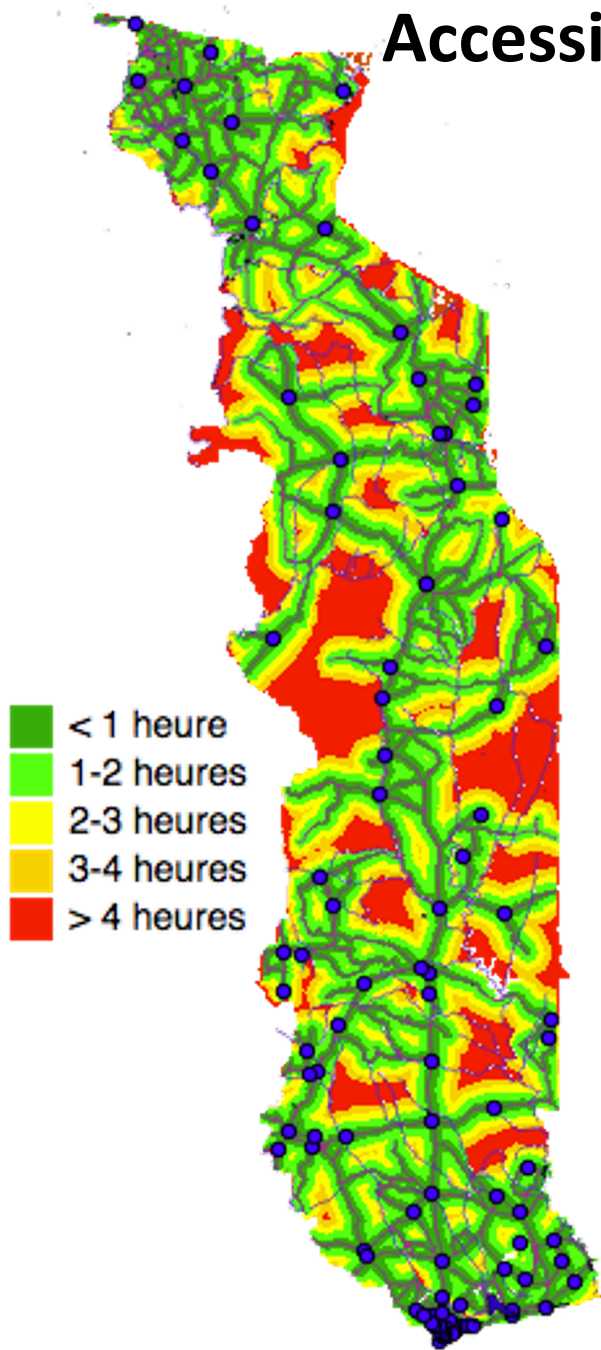Aire de captage géographique

0   5   10 km

CIBITOKE

CIBITOKE

2'300

35'610

Cibitoke

Kayanza

Travel time

- <1 h
- 1 h à 2 h
- 2 h à 3 h
- 3 h à 4 h
- >4 h

Légende

Formations sanitaires

- Autres maternités
- SONUB Potentielle(4)
- SONUB Fonctionnelle(0)
- SONUC Potentielle(2)
- SONUC Fonctionnelle(1)
- Limites des provinces

Routes

- primary
- secondary
- tertiary
- Rivières

Travel time

- <1 h
- 1 h à 2 h
- 2 h à 3 h
- 3 h à 4 h
- >4 h

Légende

Formations sanitaires

- Autres Maternités
- SONUB Potentielle(4)
- SONUB Fonctionnelle(0)
- SONUC Potentielle(2)
- SONUC Fonctionnelle(1)
- Limites des provinces

Routes

- Nationales
- Provinciales
- Communales
- Rivières

Aires de captage

- H Cibitoke
- H Mabayi
- CDS Murwi
- CDS Ndava
- CDS Ndora
- CDS Nyamakarabo
- Clinique AGAPE DE RUGOMBO

2 4 8 12 km

Bujumbura

CDS Kagurutsi
CDS Nyamakarabo
CDS Gifunzo
CDS Rubona
CDS Camakombe
CDS Ruziba
CDS Rukana
CDS Rubirizi
H Mabayi
CDS Buhoro
CDS Busesa
CDS Rutabo
CDS Nyarusebeyi
CDS Kumuhuza
CDS Buseruko II
CDS Masango
CDS Kira
CDS Kiramira
CDS Amahoro kivuruga
CDS Murwi
CDS Buhindo
CDS Rusenda
CDS Rugombo
CDS Munyika
CDS Buhayira
CDS Rusororo
CDS Kivumvu
CDS Kabere
CDS Bumba
H Cibitoke
CDS Mahande
CDS Centre m?dical Saint Marc
CDS Nderama
CDS Gahabura
CDS Gisovu
CDS Dusenga
CDS Ndoraburundi
CDS Ndora
CDS Mikashu
CDS Sehe
CDS Murambi
CDS Manege
CDS Rema
CDS Rugano
CDS Buganda Adventiste
CDS Ruhagarika
CDS Mugabezi
CDS Buhayira
CDS Mes sauveurs
H Clinic Ubuntu
CDS Kaburantwa
CDS Ndava
CDS Nyamitanga

CDS Ruhororo
CDS Butahana
CDS Infirmerie du march? Nyeshenza
CDS Iwabo n'ubuntu
CDS Rubona
CDS Umoja ni nguvu
CDS Rubirizi
CDS Rukana
CDS Rutabo

CDS Kagurutsi
CDS Nyamakarabo
CDS Gifunzo
CDS Rubona
CDS Camakombe
CDS Ruziba
CDS Rukana
CDS Rubirizi
H Mabayi
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CDS Kivumvu
CDS Kabere
CDS Bumba
H Cibitoke
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CDS Ndoraburundi
CDS Ndora
CDS Mikashu
CDS Sehe
CDS Murambi
CDS Manege
CDS Rema
CDS Rugano
CDS Buganda Adventiste
CDS Ruhagarika
CDS Mugabezi
CDS Buhayira
CDS Mes sauveurs
H Clinic Ubuntu
CDS Kaburantwa
CDS Ndava
CDS Nyamitanga

01

Accessibility coverage at national scale in Togo

< 1 heure
1-2 heures
2-3 heures
3-4 heures
> 4 heures

Travelling scenario:

class	Occ. du sol	Vitesse (km/h)	mode
1	AGRICULTURE	3	WALKING
2	PLAN_DEAU	1	WALKING
3	FORET_DENSE	1.5	WALKING
4	HABITATION	3	WALKING
5	CARRIERE	1	WALKING
6	TERRE_ROCHEUSE	3	WALKING
7	SAVANES	3	WALKING
1002	principale	80	MOTORIZED
1003	secondaire	40	MOTORIZED

National population coverage at 120min: **83%**

Region	Perc. coverage
PLATEAUX	70
KARA	75
MARITIME	92
CENTRALE	73
SAVANES	87
LOME_COM	99

Facilities

Centres SONU
- ● B
- ● C
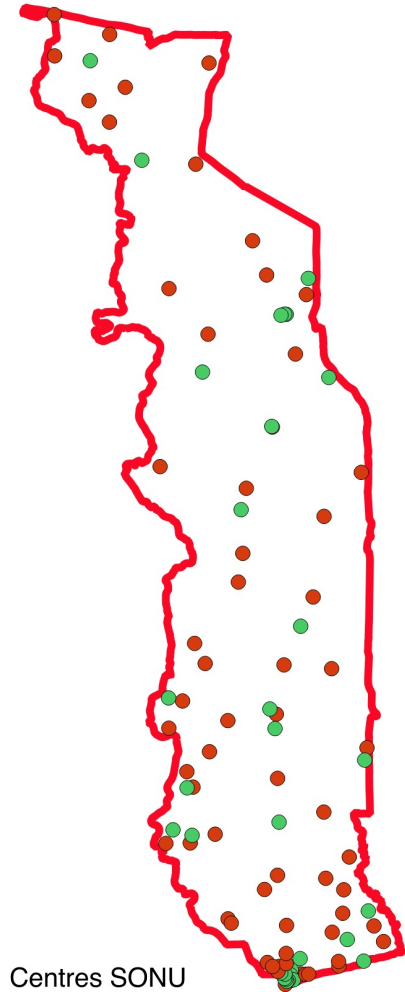
Source: Ministère de la Santé

Population

Nbr naissances / 6 mois
- 0.00277
- 0.00746
- 0.0122
- 0.0168
- 0.0215
- 0.0262
- 0.0309
- 0.0352
- 0.0388

Source: Worldpop

Roads

Routes
- ▬ principale
- ▬ secondaire
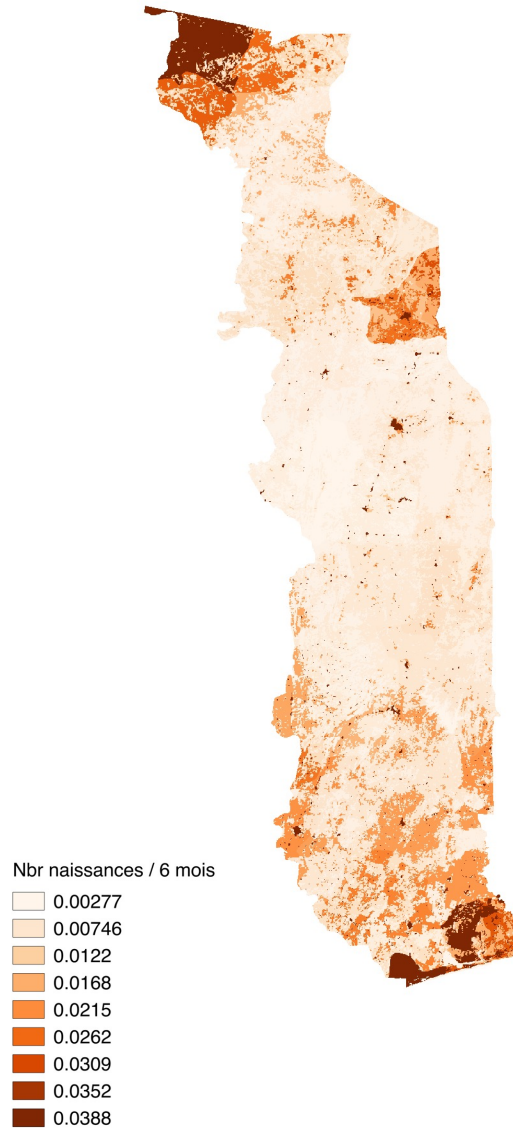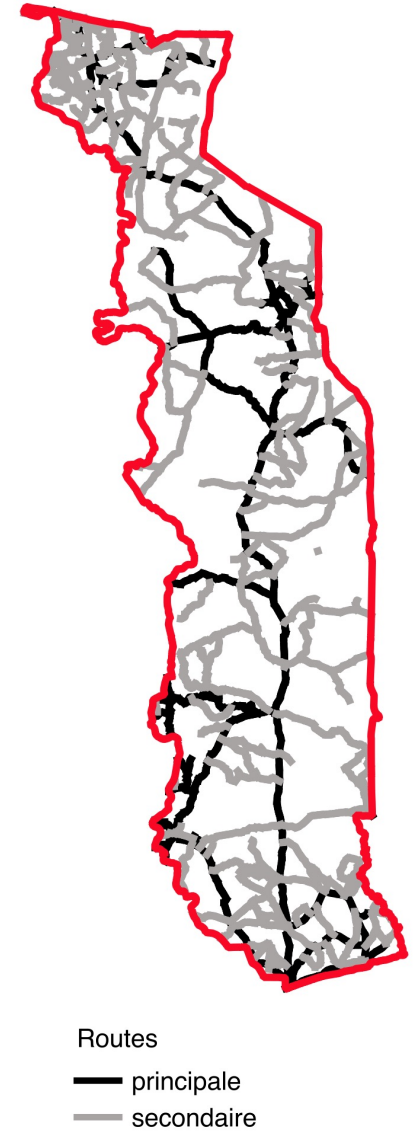
Source: Direction générale des travaux publics

Admin.
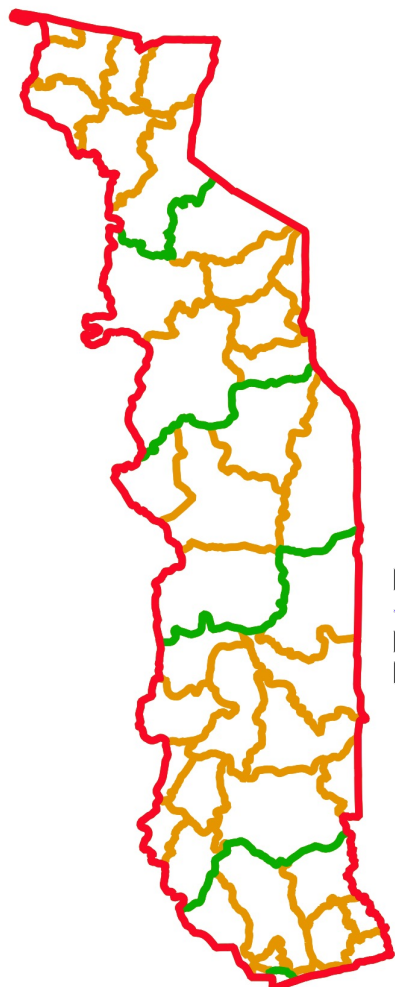
Limites administratives

- 🔴 Limite_d'Etat
- 🟢 Limite_Région
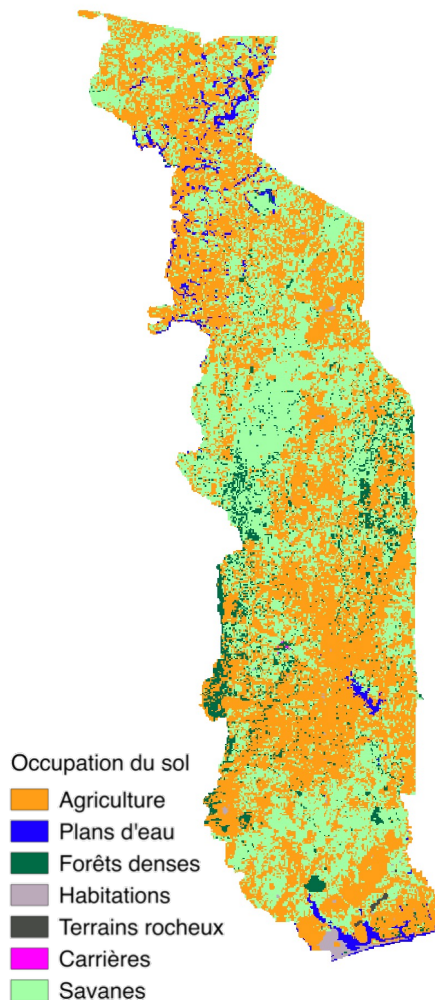- 🟠 Limite_Préfecture

Source: IGN / INSEED

Rivers
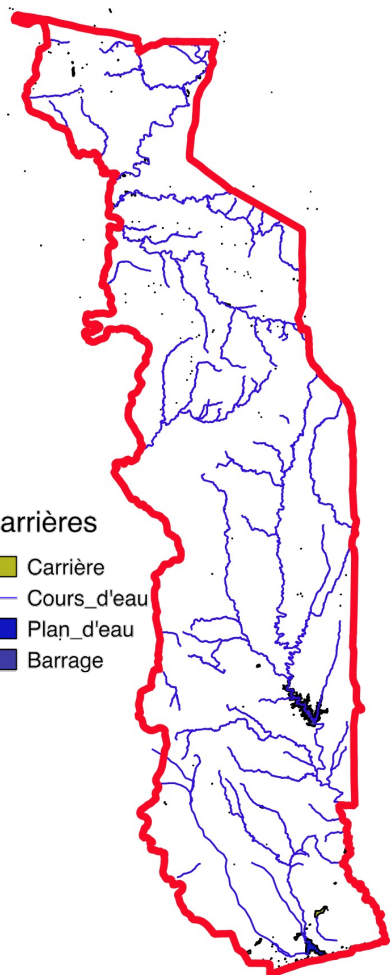
Barrières

- 🟨 Carrière
- ▬ Cours_d'eau
- 🟦 Plan_d'eau
- 🟦 Barrage

Source: Direction de l'hydraulique + INSEED

Land cover

Occupation du sol

- 🟧 Agriculture
- 🟦 Plans d'eau
- 🟩 Forêts denses
- 🟪 Habitations
- ⬛ Terrains rocheux
- 🟪 Carrières
- 🟩 Savanes

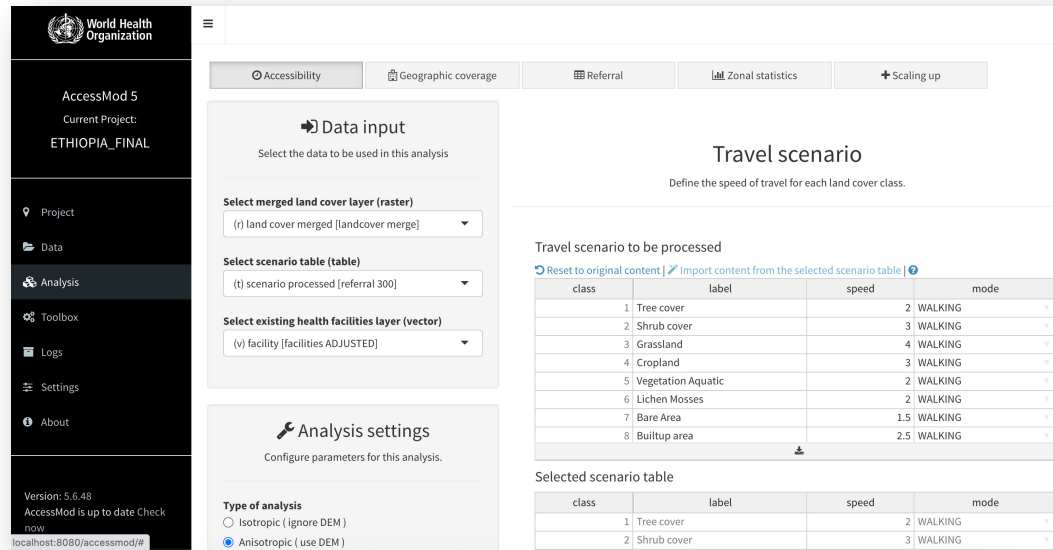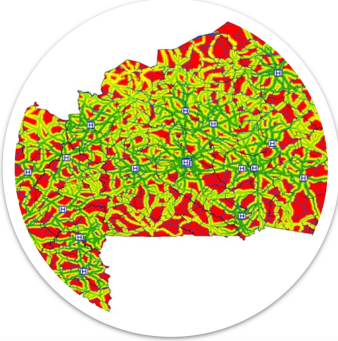Source: Agrhymet / INSEED / ANGE rééchantilloné de 500m. à 100 m.

Elevations
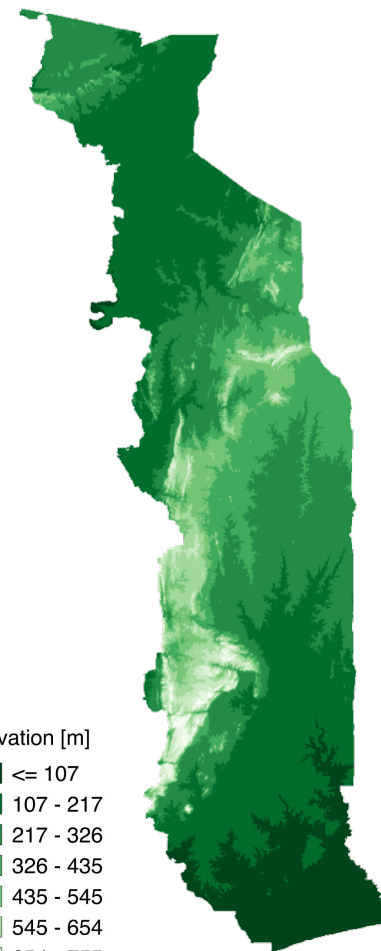
Elevation [m]

- <= 107
- 107 - 217
- 217 - 326
- 326 - 435
- 435 - 545
- 545 - 654
- 654 - 755
- 755 - 839
- > 839

Source: SRTM rééchantilloné de 90m à 100 m
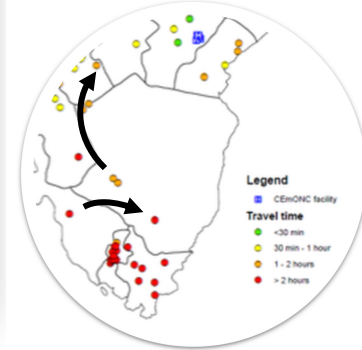
+ national and local expertise to inform about modes and speeds of transport of the population
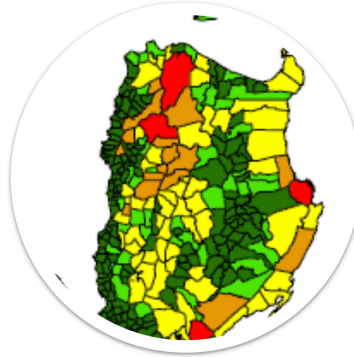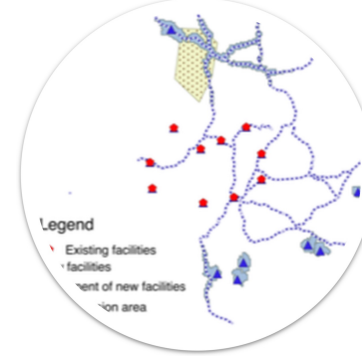
Accessibility analysis

Referral analysis

AccessMod 5
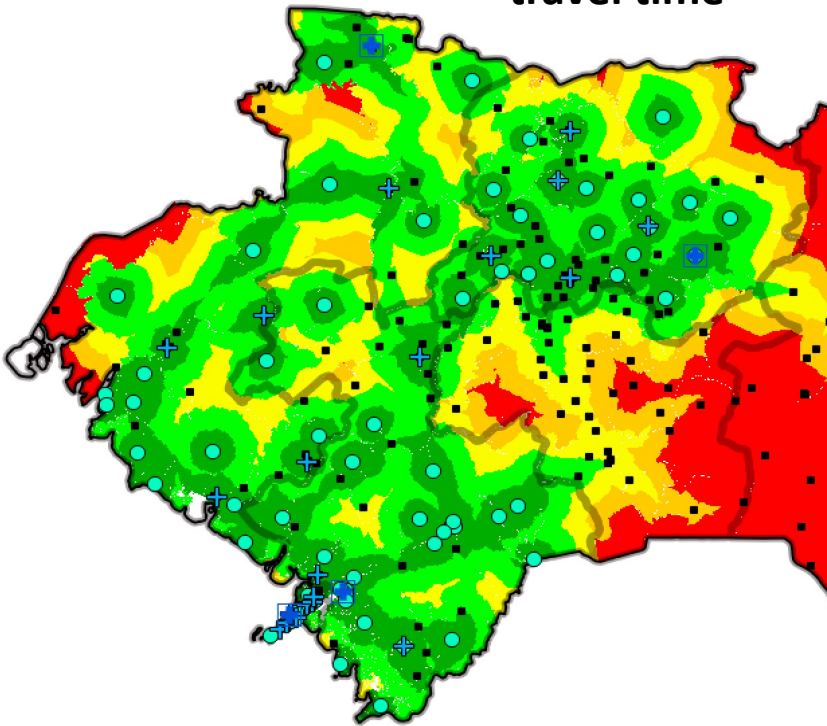
Catchment analysis

Zonal statistics

Scaling-up analysis

accessmod.org
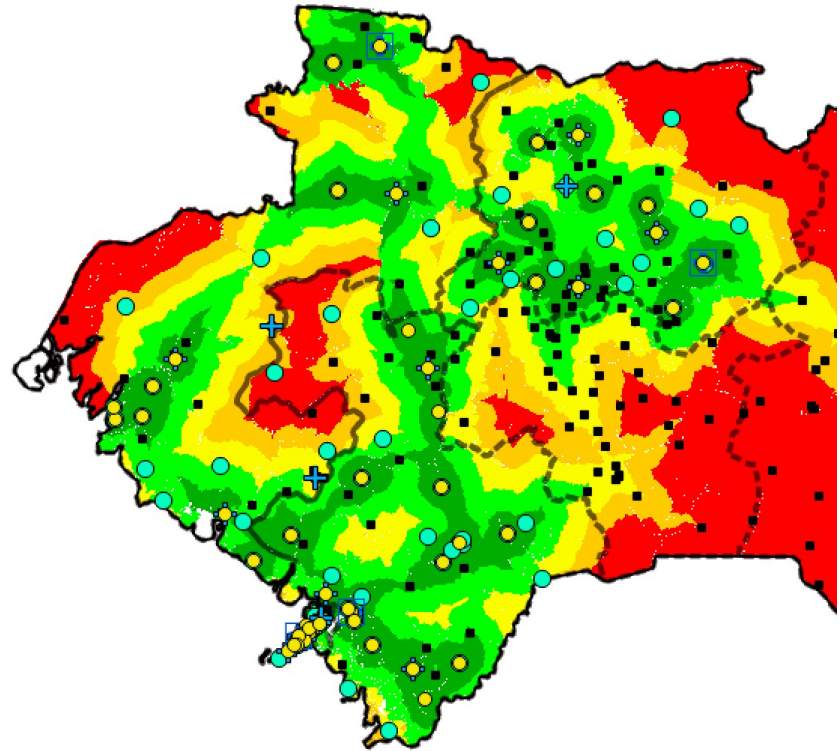
West of Rep. of Guinea

Before prioritization

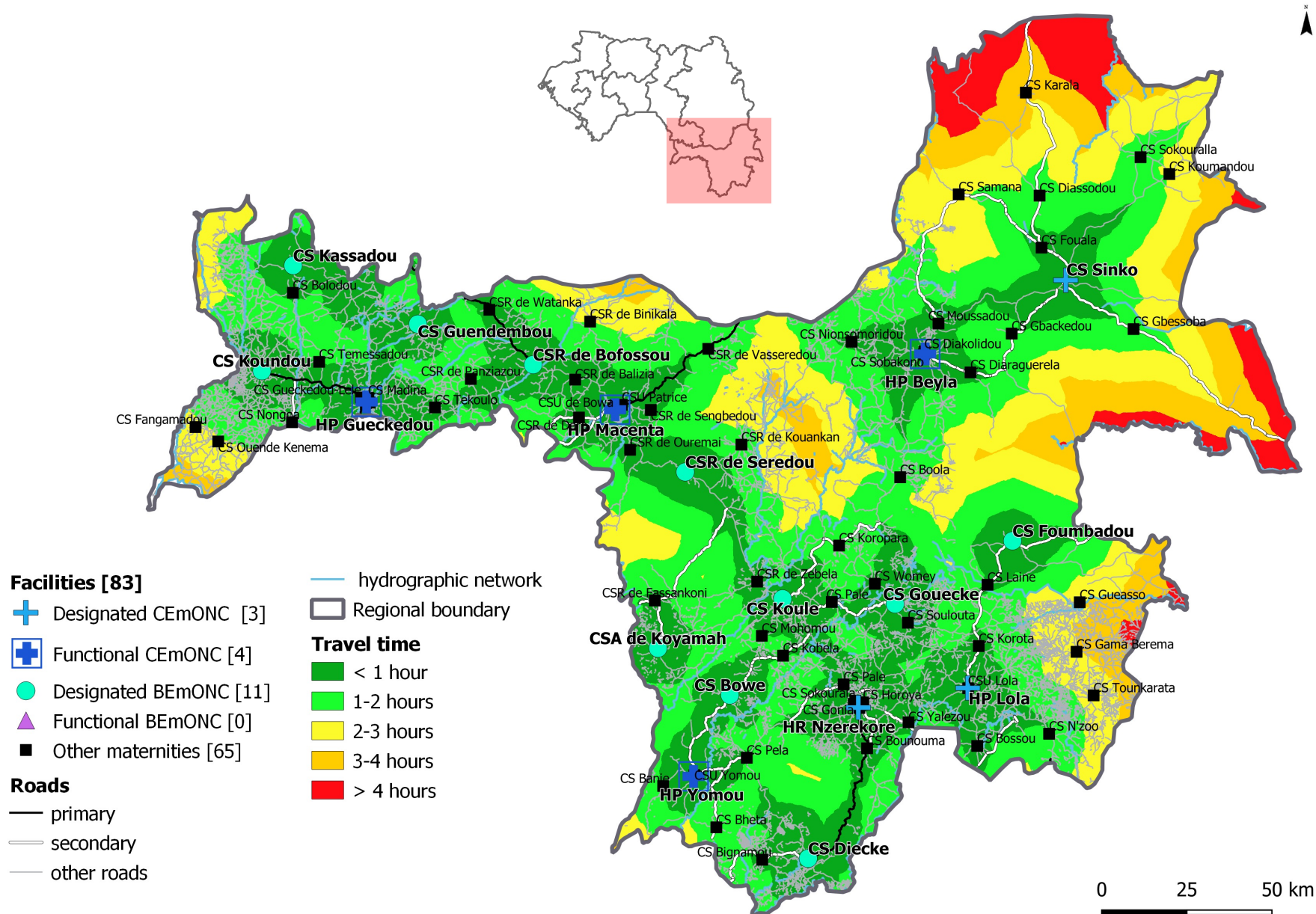**108 designated EmONC covering 89% of the population at 2 hours max travel time**

After prioritization

59 designated EmONC covering 83% of the population at 2 hours max travel time

Republic of Guinea – Nzerekore region

Facilities [83]

- ✚ Designated CEmONC [3]
- ✚ Functional CEmONC [4]
- ● Designated BEmONC [11]
- ▲ Functional BEmONC [0]
- ■ Other maternities [65]

Roads

- primary
- secondary
- other roads

hydrographic network
Regional boundary

Travel time

- < 1 hour
- 1-2 hours
- 2-3 hours
- 3-4 hours
- > 4 hours

CS Karala
CS Sokouralla
CS Koumandou
CS Samana
CS Diassodou
CS Fouala
CS Sinko
CS Moussadou
CS Gbessoba
CS Nionsomoridou
CS Diakolidou
Gbackedou
CS Sobakoro
CS Diaraguerela
HP Beyla
CS Kassadou
CS Bolodou
CSR de Watanka
CSR de Binikala
CS Guendembou
CSR de Bofossou
CSR de Vasseredou
CS Koundou
CSR de Panziazou
CSR de Balizia
CS Temessadou
CSR de Bowa
CSU Patrice
CS Gueckedou-Lele
CS Madina
CS Tekoulo
CSR de Sengbedou
CS Nongoa
CSR de Ouremai
CSR de Kouankan
CS Fangamadou
HP Gueckedou
HP Macenta
CS Ouende Kenema
CSR de Seredou
CS Boola
CS Foumbadou
CS Koropara
CS Gueasso
CSR de Zebela
CS Womey
CS Laine
CSR de Fassankoni
CS Pale
CS Gouecke
CS Koule
CS Soulouta
CS Gama Berema
CS Mohomou
CS Korota
CSA de Koyamah
CS Kobela
CS N'zoo
CS Pale
CSU Lola
CS Tounkarata
CS Bowe
CS Sokouralla
CS Horoya
HP Lola
CS Gonla
CS Yalezou
HR Nzerekore
CS Bounouma
CS Bossou
CS Pela
CS Banie
CSU Yomou
HP Yomou
CS Bheta
CS Bignamou
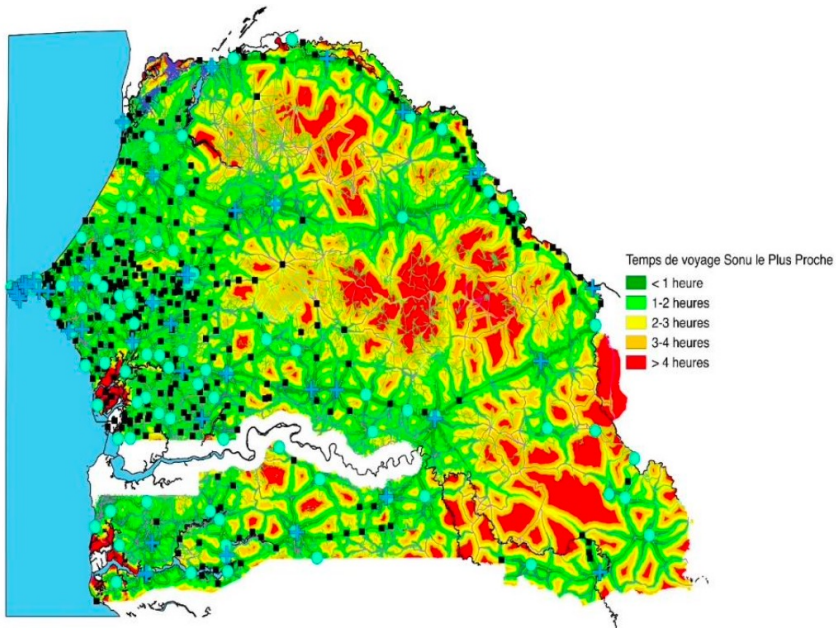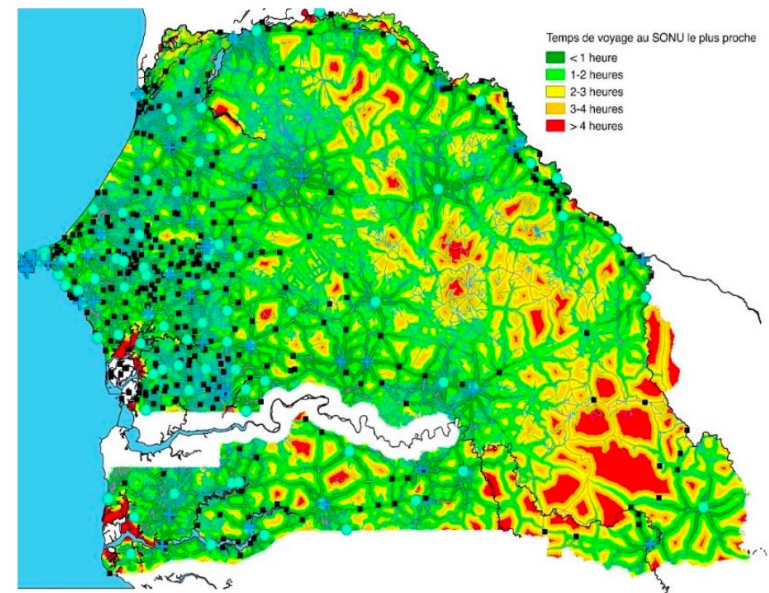CS Diecke

0   25   50 km

Senegal

Priorisation 2017 (without GIS)

174 designated EmONC facilities cover 87% of the population in 2 hour travel time

Priorisation 2017 (with GIS)

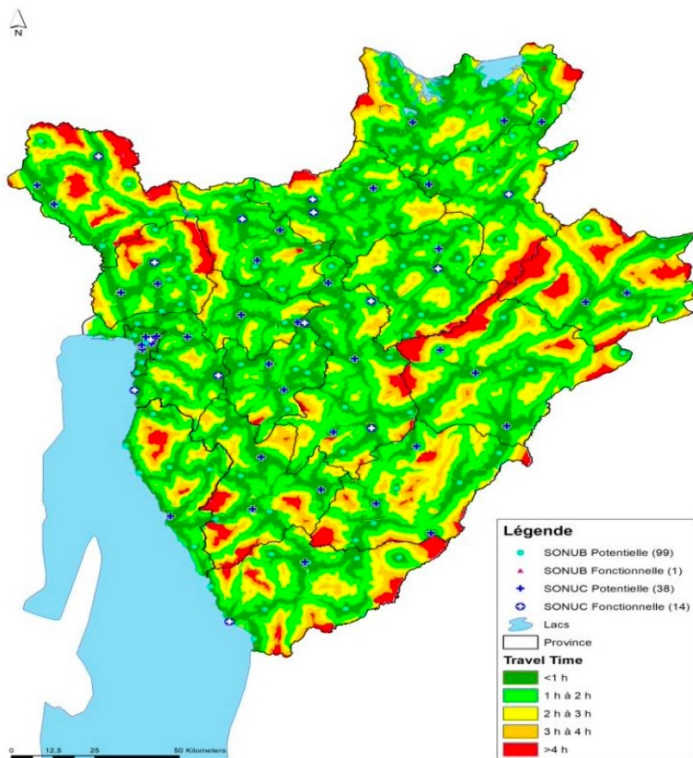**150 designated EmONC facilities cover 91% of the population in 2 hour travel time**

Temps de voyage Sonu le Plus Proche
- < 1 heure
- 1-2 heures
- 2-3 heures
- 3-4 heures
- > 4 heures

Temps de voyage au SONU le plus proche
- < 1 heure
- 1-2 heures
- 2-3 heures
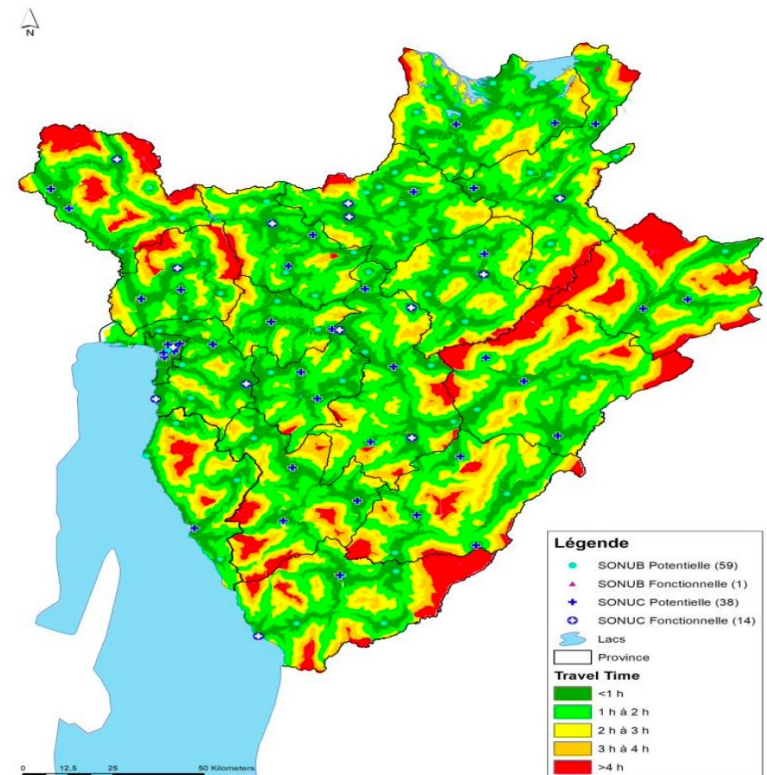- 3-4 heures
- > 4 heures

Burundi

Before prioritization

152 designated EmONC facilities cover 72% of the population in 2 hour travel time

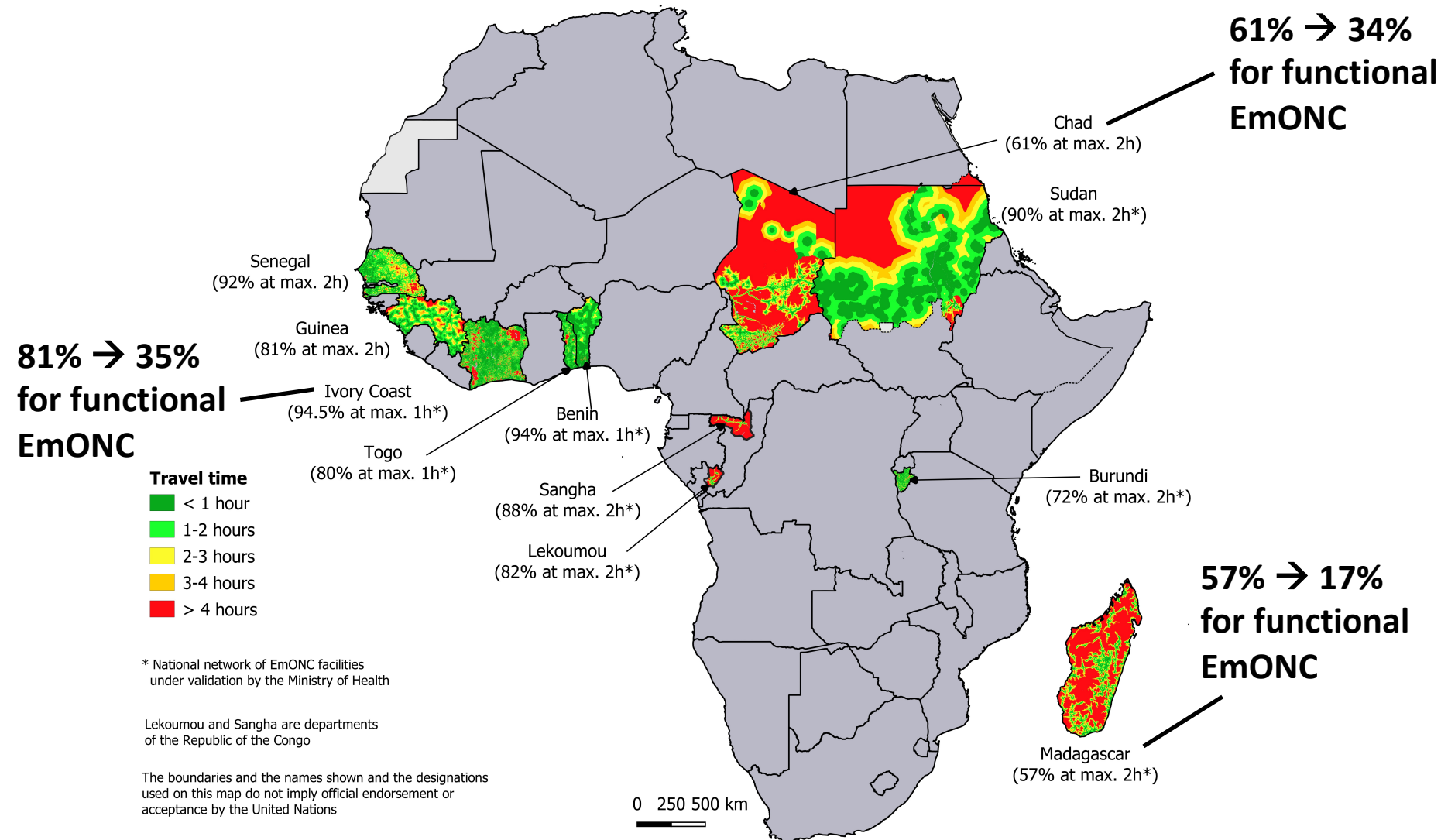**After prioritization**

112 designated EmONC facilities cover 68% of the population in 2 hour travel time

Légende
- SONUB Potentielle (99)
- SONUB Fonctionnelle (1)
- SONUC Potentielle (38)
- SONUC Fonctionnelle (14)
- Lacs
- Province

Travel Time
- <1 h
- 1 h à 2 h
- 2 h à 3 h
- 3 h à 4 h
- >4 h

Légende
- SONUB Potentielle (59)
- SONUB Fonctionnelle (1)
- SONUC Potentielle (38)
- SONUC Fonctionnelle (14)
- Lacs
- Province

Travel Time
- <1 h
- 1 h à 2 h
- 2 h à 3 h
- 3 h à 4 h
- >4 h

Similar work done in 11 countries, with UNFPA (2017-2021)

61% → 34% for functional EmONC

81% → 35% for functional EmONC

57% → 17% for functional EmONC

Chad
(61% at max. 2h)

Sudan
(90% at max. 2h*)

Senegal
(92% at max. 2h)

Guinea
(81% at max. 2h)

Ivory Coast
(94.5% at max. 1h*)

Benin
(94% at max. 1h*)

Togo
(80% at max. 1h*)

Sangha
(88% at max. 2h*)

Lekoumou
(82% at max. 2h*)

Burundi
(72% at max. 2h*)

Madagascar
(57% at max. 2h*)

Travel time
- < 1 hour
- 1-2 hours
- 2-3 hours
- 3-4 hours
- > 4 hours

* National network of EmONC facilities under validation by the Ministry of Health

Lekoumou and Sangha are departments of the Republic of the Congo

The boundaries and the names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations

0   250 500 km

Madagascar

Another use case for UNICEF: access to health facilities in Mozambique

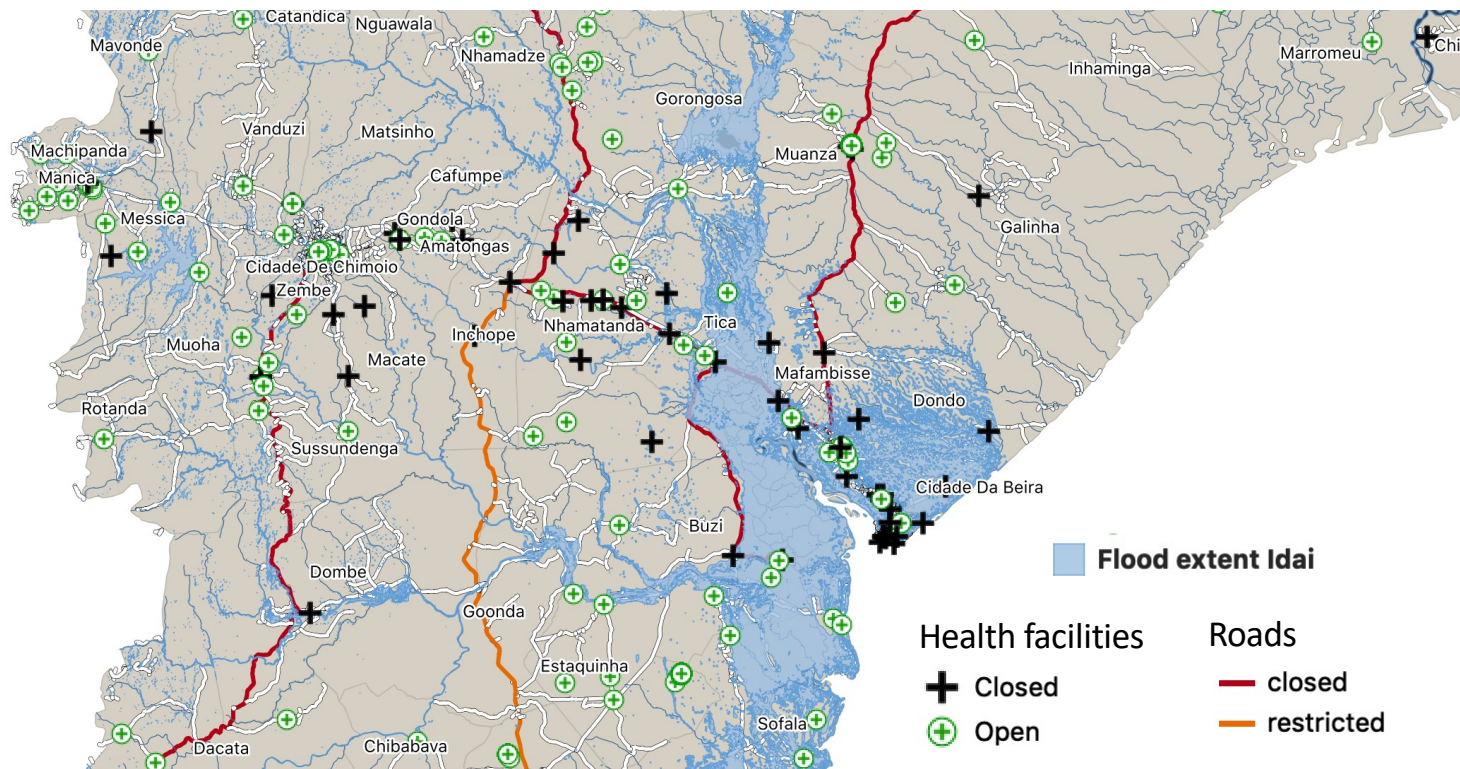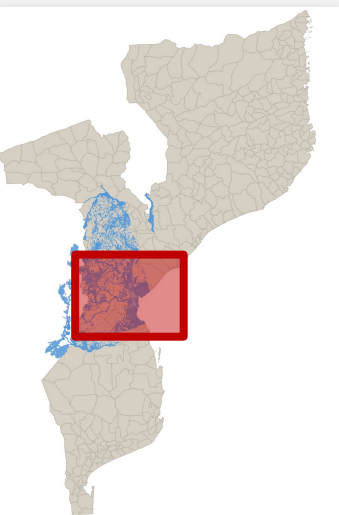## TROPICAL CYCLONE IN MOZAMBIQUE

Last Updated 03/22/19

281 CONFIRMED DEATHS	+600,000 IN NEED OF ASSISTANCE	+400,000 DISPLACED

~1 MILLION WITHOUT ELECTRICITY	+951,000 ACRES OF CROPS INUNDATED	+17,400 HOUSES DAMAGED OR DESTROYED	+2,800 CLASSROOMS DESTROYED	~40 HEALTH UNITS DESTROYED

AFFECTED AREAS: INHAMBANE, MANICA, SOFALA, TETE, AND ZAMBÉZIA PROVINCES
Source: Various Sources

RAINFALL
in millimeters
Over 600
481 - 600
361 - 480
241 - 360
121 - 240
60 - 120

Source: NASA GPM IMERG
7-DAY MEASUREMENT
03/11/19 - 03/17/19

Cyclone Idai made landfall in Mozambique in March 2019
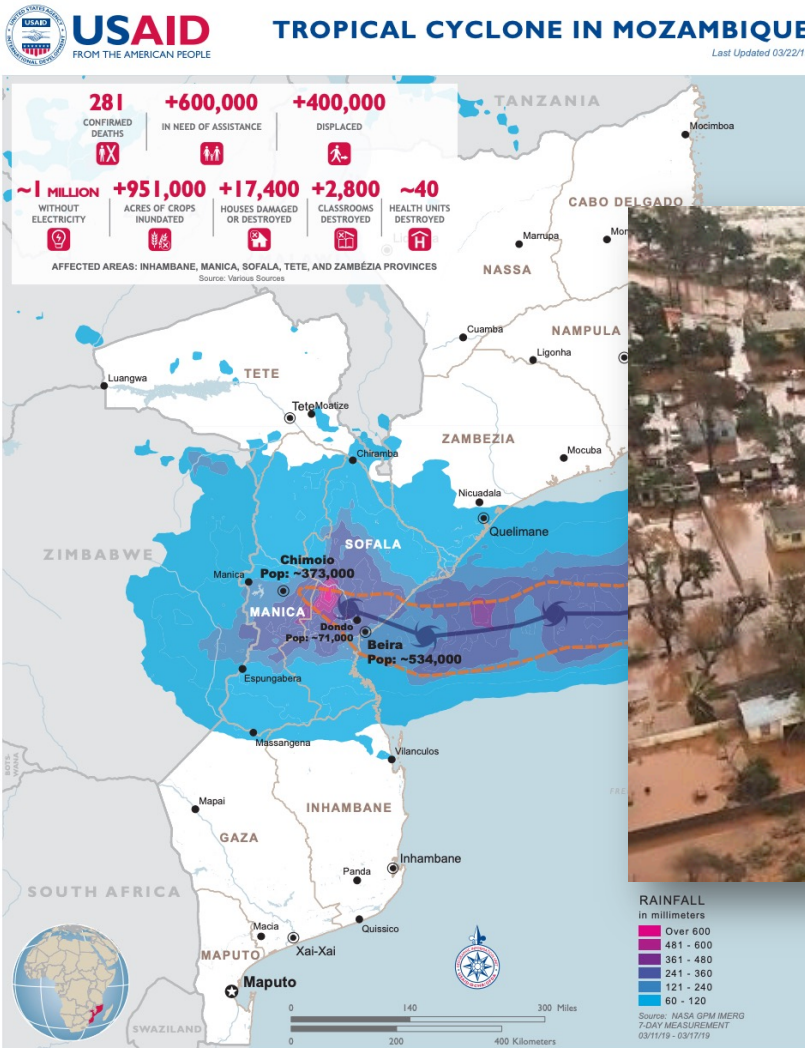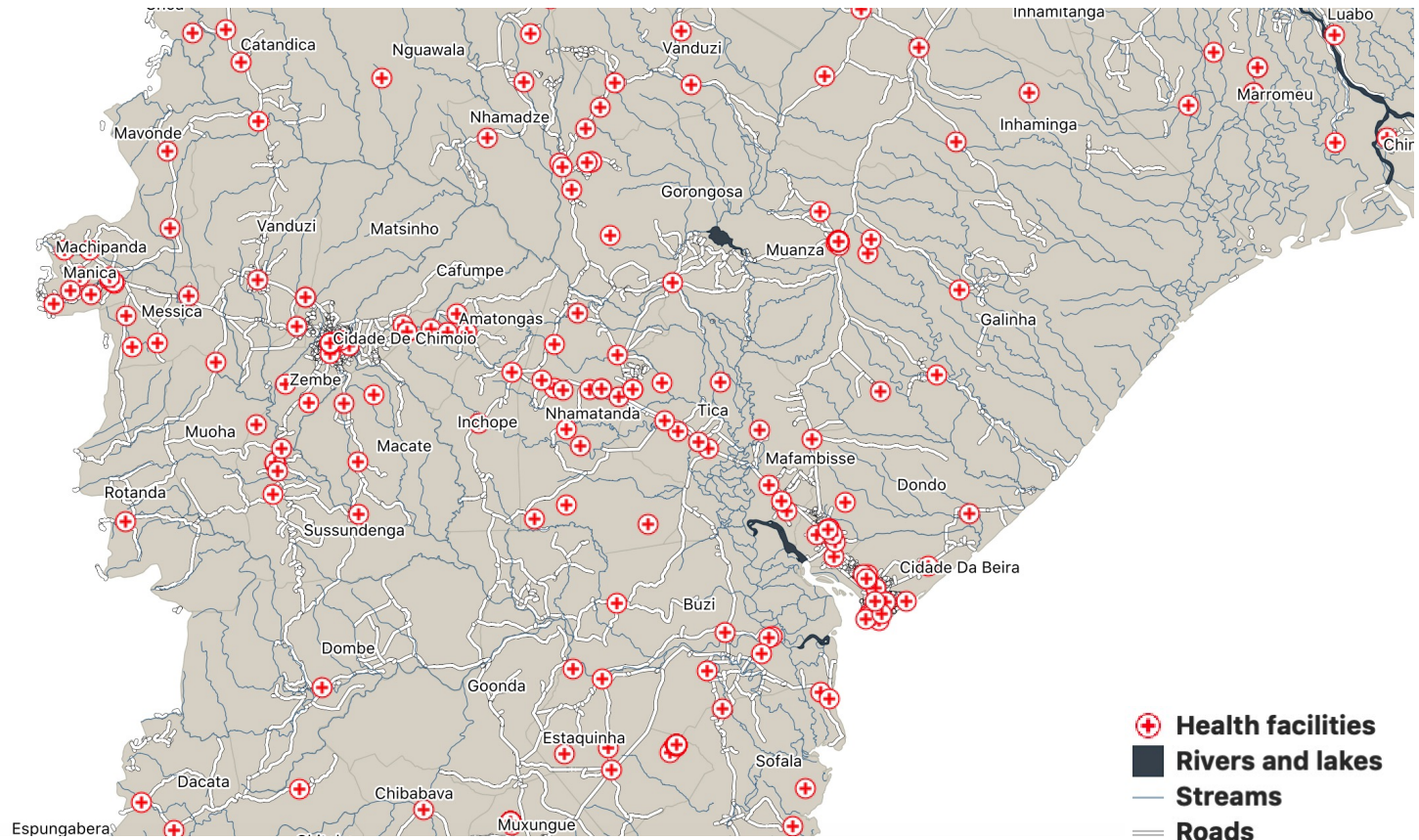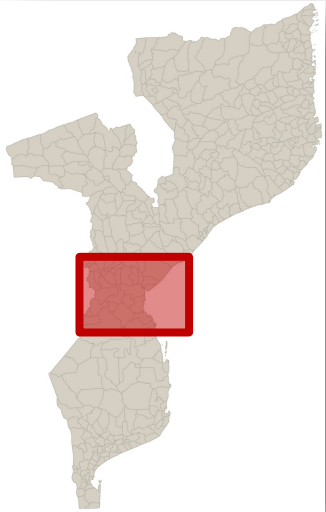
Pre-cyclone situation

Post-cyclone situation
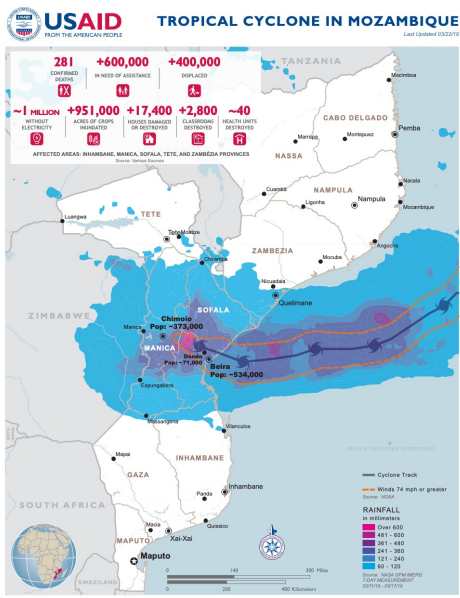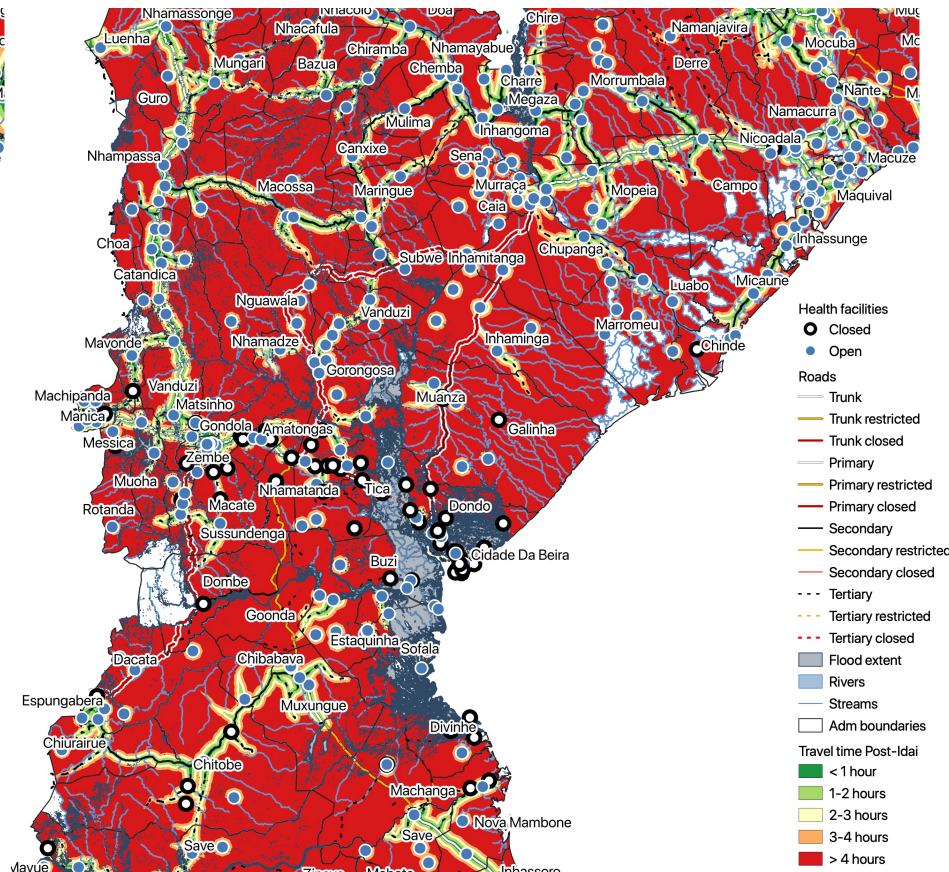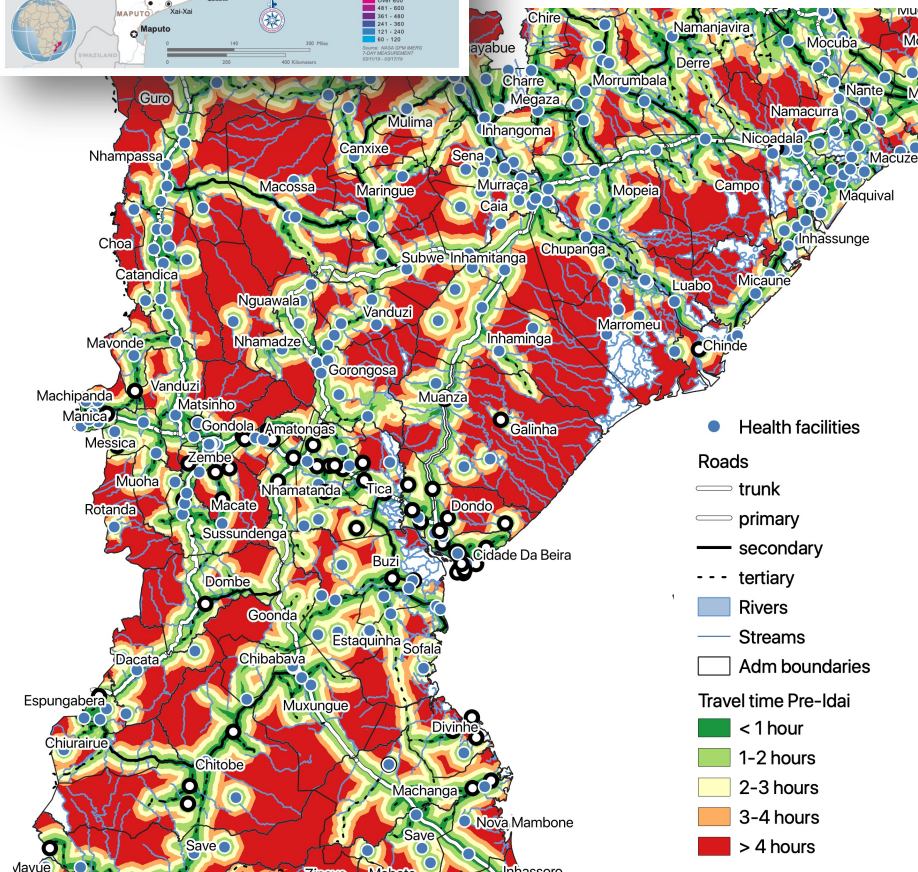
Accessibility maps to the nearest functional health facility, post cyclone Idai in 2019

25% of target population lost timely access to care

ESTIMATED TIME TO ARRIVAL 00:07:02
TIME LAPSED 04:52:56

THE WALK

Cordaid

0

km 26

The health center will be closed after 5pm.

Walk with her at www.cordaid.org

Thank you for your attention !

Prof. Nicolas Ray

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